

Information and Communication Technology (ICT) Adoption in Horticulture: A Comparison to the EFITA Baseline

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Abstract

Understanding and alleviating the constraints to ICT adoption are currently at the forefront of ICT for agricultural production and rural development. EFITA¹ is conducting since 1999 a survey to gain such understanding. The 2004 symposium of the International Society for Horticultural Science (ISHS) offered a unique opportunity to compare the EFITA survey results to symposium participant's perspectives. The following were identified as comparable adoption constraints: end user (ICT) proficiency, ICT benefit awareness, time, cost of technology, system integration, and software availability. The following constraints were mainly indicated by respondents originating from "developed" countries: no perceived economic benefits, do not understand the value of ICT and not enough time to spend on technology. The respondents from developing countries stressed the importance of cost of technology and lack of technological infrastructure suggesting that infrastructure and cost of technology are thresholds for adoption of ICT. They are no longer a threshold for ICT adoption in developed countries as understanding "how to get a benefit from the use of ICT" is. The indication of the importance of "training" to alleviate this constraint is supported by comparison of these results to the results of a similar Belgian case study in glasshouse horticulture. These three survey comparisons provide insights which suggest remedial steps to expedite ICT adoption and prioritize the necessary research.

Key words: ICT adoption, horticulture, EFITA questionnaire, innovation

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The 2004 symposium of the International Society for Horticultural Science (ISHS) offered a unique opportunity to compare the EFITA survey results to symposium participant's perspectives. This survey on ICT adoption in horticulture has been updated at the 2009 ISHS symposium in Chiang Mai, Thailand and a survey organised in 2005 by ILVO on a sample of 208 horticultural companies in Flanders, Belgium. The results have revealed the following comparable ICT adoption constraints: "end user (ICT) proficiency", "lack of training", "ICT benefit awareness", "time", "cost of technology", "system integration" and "software availability". These results are in line with the EFITA surveys over time, indicating a shift from ICT technical proficiency as a primary limiting factor towards a lack of understanding "how to get a benefit from the various ICT options". This remains a challenge for research, extension and ICT market services. The survey comparisons provide insights which suggest remedial steps to expedite ICT adoption and prioritize the necessary research. Since ICT innovations evolve rapidly, a constant 'catching up' training is needed. In the future more efforts are needed to enable farm managers to benefit from the economic and other advantages of ICT adoption, suggesting an on-going need for integrated training, extension and research programs.

¹ EFITA : European Federation for Information Technology in Agriculture

The following table summarizes the comparisons as compared to the EFITA baseline questionnaire:

Limiting factors	FARMERS				HORTICULTURAL GROWERS				
	EFITA BONN	EFITA MONT-PELLIER	EFITA VILA REAL	EFITA WAGENINGEN	ISHS BERLIN	ILVO FLANDERS	ILVO FLANDERS	ILVO FLANDERS	ISHS CHIANG MAI
	1999	2001	2005	2009	2004	2005	2005	2005	2009
	N = 28	N = 65	N = 59	N = 31	N = 31	N = 19	N = 16	N = 35	N = 15
COUNTRIES = 25	COUNTRIES = 25	COUNTRIES = 32	COUNTRIES = 16	COUNTRIES = 17				COUNTRIES = 12	
% of Replies	% of Replies	% of Replies	% of Replies	% of Replies	% of Replies	% of Replies	% of Replies	% of Replies	% of Replies
					Group 1 : Without PC	Group 2 : No PC use for business	Group 1 + Group 2		
Inability of farmers to use ICT	29	3	46	45	3	79	63	71	57
No perceived economic or other benefits	28	28	24	26	36	32	69	49	21
Lack of technological infrastructure	19	6	36	26	13	37	19	29	36
Cost of technology	18	32	25	29	26	21	13	17	21
Not enough time to spend on technology	12	17	12	30	32	42	63	51	29
Do not understand the value of ICT	9	17	31	13	26	26	38	31	21
Lack of training	9	17	17	58	39	79	88	83	64

1 Introduction

Although adoption of ICT in horticultural production is recognized as a problem, research on ICT adoption is very scarce. In several countries where such research was done it focused mainly on computer adoption for general agricultural production. It was found that adoption of ICT is strongly associated with the education level of the farmer and farm size (e.g. Putler and Zilberman, 1988; Batte *et al.*, 1990; Bonny, 1992; Gibbon and Warren, 1992; Warren *et al.*, 2000). The impact of age is not so clear (Putler and Zilberman, 1988; Gibbon and Warren, 1992; Warren *et al.*, 1996), however some researchers found a negative effect of age on ICT adoption (Batte *et al.*, 1990; Warren *et al.*, 2000). Austin *et al.* (1998) incorporated psychological and social variables and found a positive impact of achievement in farming, production-oriented behaviour and intelligence/openness on adoption of computers.

Every four years the Economics and Management Commission of the International Society for Horticultural Science (ISHS) organizes an international symposium on present and future developments in horticulture. The 2004 symposium was organized by the Humboldt University in Berlin and focused on "Creating value in a changing society". Currently horticultural enterprises are facing ever-growing international price and quality competition. Regardless they have to adhere to demanding social and environmental requirements within their traditional and new technologies. It is commonly accepted that enterprises can ensure their long-term survival and their acceptance by society only if they are able to create value for the consumer and the wider community of stakeholders. Knowledge and innovation processes are the very essence of creating value and growth in turbulent markets. In this context ICT adoption can be considered as an important tool for value creation.

85 participants from 21 different countries participated in the ISHS 2004 symposium. During the conference 3 invited papers, 59 contributed papers and 19 posters were presented covering a wide range of themes in horticulture including competitiveness, international trade, chain development, consumer behaviour, sustainable production systems, education, knowledge transfer, entrepreneurship and more. Papers related to ICT dealt mainly with Decision Support Systems (DSS). Hakansson (2004) presented a horticultural management game dealing with the problem of crop planning in pot plant production. Lončarić and Lončarić (2004) developed a DSS system for economic analysis and fertilization recommendations in field vegetable production.

The ISHS symposium offered a unique opportunity to compare and evaluate the EFITA questionnaire dealing with ICT adoption. This questionnaire has been distributed over time to various groups of international specialists in agriculture at the EFITA conferences. Each ISHS symposium participant was requested to fill out such a questionnaire. 31 participants from 17 countries complied and took part in this study². The respondents were mainly specialists in farm management and entrepreneurship - experienced and familiar with ICT in horticulture. They were from developed as well as developing countries enabling an additional comparison perspective.

The ISHS replies are compared to results obtained from the EFITA conference replies. These results are further related to the adoption of ICT in horticulture via a comparison with the results obtained in a Belgian case study in glasshouse horticulture (Taragola *et al.*, 2002). It must be noted that these comparisons are indicative. They are not statistically sufficient, the sample base is small and they do not represent opinions of the horticultural producers themselves. They are however robust enough to indicate issue rankings and trends over time. Representation of the replies as percentages facilitates their comparison but can be misleading. Caution throughout is strongly advised.

2 Methodology

The EFITA questionnaires were distributed for the first time during the EFITA conference in Bonn, Germany in 1999, reiterated in the EFITA conference in Montpellier, France in 2001 and in the EFITA conference in Debrecen, Hungary in 2003. During these conferences ICT adoption constraints were identified for the agricultural sector in general. As the ISHS conference focuses on horticultural production, the ISHS questionnaire enables relating specific adoption constraints in horticulture as compared to agriculture in general.

The ISHS questionnaire asked the following questions:

- a. Do you think there are problems with the uptake of ICT in horticulture ? (yes/no)
- b. Do you think there are unique uptake problems with any of the following : Decision Support Systems (DSS), Management Information Systems (MIS), Internet, Precision Farming, Process Control, Production Models, E-commerce, Others ? (yes/no for each)
 1. What are the factors limiting the use of ICT by farmers?
 2. What are the factors limiting the use of ICT by extension working with farmers?
 3. What are the factors limiting the use of ICT by research working with farmers?

² The following countries were represented in the ISHS survey : Belgium, Croatia, France, Germany, Holland, Hungary, Iran, Malaysia, Poland, Spain, Syria, New Zealand, Sweden, Switzerland, Turkey, USA, Vietnam

4. What are the consequences for farmers not using ICT: Today and in the near future?
5. What are the consequences for extension not using ICT: Today and in the near future?
6. Should public funds help to finance information technology services for farmers?

3 Results

In the following tables the ISHS replies for the above questions are summarized and compared to the EFITA conferences in Bonn (1999), Montpellier (2001) and Debrecen (2003). It is important to note that if there was more than one replying participant from a country their average was used to avoid a bias resulting from the number of replies from each country.

Table 1 summarizes the replies related to ICT uptake. It is noteworthy that 94.0% of the ISHS respondents and 94.0% of the ISHS countries indicated that there are ICT uptake problems in horticulture, which is a higher percentage than the one observed during the EFITA conferences. These indicate a substantial increase in ICT uptake problems in agriculture by comparing the results in Debrecen in 2003 to those in Montpellier in 2001. This is counter intuitive considering the fact that today we are living in an advanced “information society”. These results substantiate the importance of our research priorities – why is ICT uptake still an issue and in turn what can be done to alleviate this situation?

A closer look at Table 1 identifies different EFITA and ISHS replies for the various ICT uptake categories. Most ISHS mentioned problems are related to the adoption of ICT in process control (48.4% in 47.0% of the countries), decision support systems (DSS) (45.2% in 52.9% of the countries) and production models (42.0% in 65.0% of the countries).

It is interesting that only 3.0% of the respondents (in 6.0% of the countries) indicate problems with e-commerce, which is much lower than the percentage obtained in the EFITA questionnaires. The results need to be interpreted with caution as the horticultural sector is very heterogeneous (e.g. glasshouse production, production in the open, vegetables, ornamental plants, fruits, etc.) and the problems can differ from one country to another. For example, process control implementation will be a greater problem for production in the open, whereas its use is common in glasshouse production in developed countries.

Table 2a gives an ISHS perspective of the factors limiting the use of ICT by horticultural producers. For reference Table 2a also reports the results from the EFITA conferences. The replies give an indication of the most important reasons for uptake problems and suggest possible ICT adoption bottlenecks.

Table 1. Do you think there are problems with the uptake of ICT in agriculture?

<i>Montpellier (n=65, Countries n=25)</i> <i>Debrecen (n=51, Countries n=22)</i> <i>ISHS (n=31, Countries n= 17)</i>	Montpellier 2001		Debrecen 2003		ISHS 2004	
	% Yes*	% of Countries Yes**	% Yes*	% of Countries Yes**	% Yes*	% of Countries Yes**
Do you think that there are problems with the uptake of ICT in agriculture?	52.3	72.0	72.5	86.3	94.0	94.0
Do you think there are unique uptake problems with any of the specific following technologies?						
Decision Support Systems (DSS)	50.7	80.0	47.0	72.7	45.2	52.9
Management Information Systems (MIS)	32.3	60.0	27.4	45.4	35.5	52.9
Internet	33.8	56.0	29.4	50.0	39.0	58.9
Precision Farming	47.6	60.0	37.2	68.2	35.3	41.0
GIS	-	-	31.4	40.9	35.5	41.0
Process Control	24.6	56.0	21.6	31.8	48.4	47.0
Production Models	49.2	72.0	35.3	59.1	42.0	65.0
E-commerce	46.1	76.0	39.2	50.0	3.0	6.0
Distance extension			21.6	36.4	3.0	6.0

* Calculated from all “yes” replies with “no” and “blank” replies making up the difference.

** Calculated from all country replies received regardless of content – yes, blank or no.

Table 2a. What are the factors limiting the use of ICT by farmers?

Limiting factors	Bonn 1999		Montpellier 2001		Debrecen 2003		ISHS 2004	
	% of Replies	* % of Countries	% of Replies	* % of Countries	% of Replies	* % of Countries	% of Replies	* % of Countries
1. Inability of farmers to use ICT	29.3	40.0	3.0	8.0	9.8	13.6	3.0	6.0
2. No perceived economic or other benefits	27.6	32.0	27.6	32.0	39.2	54.5	35.5	47.0
3. Too hard to use/unfriendly	22.4	28.0	29.3	48.0	5.9	13.6	16.0	12.0
4. Lack of technological infrastructure	18.9	36.0	6.0	12.0	19.6	40.9	13.0	29.0
5. Cost of technology	17.6	32.0	32.3	48.0	39.2	45.5	26.0	47.0
6. Not useful information/not relevant problems	12.1	24.0	1.0	4.0	7.8	18.2	3.0	6.0
7. Fear of technology	12.1	16.0	7.0	16.0	---	---	3.0	6.0
8. Not enough time to spend on technology	12.1	16.0	16.9	24.0	23.5	27.2	32.2	41.0
9. Do not understand the value of ICT	8.6	16.0	16.9	40.0	---	---	26.0	29.0
10. Lack of training	8.6	20.0	16.9	44.0	35.3	63.6	39.0	65.0
11. Better alternatives	5.2	8.0	4.0	12.0	--	--	13.0	12.0
12. Personal impediments	3.4	8.0	3.0	8.0	5.9	13.6	3.0	6.0
13. Lack of integration with other farm systems	3.4	8.0	7.0	12.0	1.9	4.5	6.5	12.0
14. Other **							29.0	24.0

* % of countries with at least one participant from that country replying "yes".

** The following factors were identified in the EFITA questionnaires as "other": inadequate assistance in implementation of ICT, farmer's traditions, farmer's age, type and size of farm, ICT is not dependable, lack of managerial experience, no connection to research, no connection to research and language. For comparison the following factors were listed in the 2004 ISHS questionnaire: lack of user confidence in the systems, mismatch between farmer's and developer's perceptions, suitable system unavailability, lack of user involvement, no incentive, lack of confidence in results, unsatisfactory support by extension, lack of reliable data, lack of communication between users, resistance to change, external factors, fear of loss of job (extension), need for personal touch (extension), better alternatives, personal impediments, lack of integration with other various farm systems and adoption-inhibiting constraints.

The most important factors indicated by the ISHS respondents are lack of training (39.0% of the respondents in 65.0% of the countries), no perceived economic or other benefits (35.5% of the respondents in 47.0% of the countries), not enough time to spend on technology (32.2% of the respondents in 41.0% of the countries) and cost of technology (26.0% of the respondents in 47.0% of the countries). The results are quite comparable to the outcomes of the last EFITA questionnaire in Debrecen (2003). If compared to Montpellier and Bonn, the replies of Debrecen and ISHS give an indication that ICT technical proficiency, too hard to use/unfriendly and fear of technology as constraints are not much of a problem as is understanding how to, and getting a benefit from the various ICT options (Gelb, 1996; 2004).

In considering the results of table 2a it is important to recall that many horticultural producers and farmers are not only decision-makers but are also involved in operational activities (e.g. van der Schilden and Verhaar, 2003; Taragola *et al.*, 2004). This is especially the case in small holdings, which may result in the fact that they often are focused on short term "intuitive" decisions based on their experience. Some ISHS respondents remarked that many horticultural producers prefer to work with their hands instead of spending their time in the office, working with the PC. Warren (2002) found that it is perhaps most significant that the use of ICT does not fit the working day pattern of farmers who are engaged full-time

in manual farm work (a high proportion in many areas of Europe). Staring at a computer screen is not an attractive proposition after a long and hard day's work outside. One can assume that only the horticultural producers and farmers who are convinced of the economic benefits will allocate the time needed to use ICT.

Whereas Table 2a reflects opinions of why the ICT adoption rate by farmers is so slow Table 2b reports for comparison why the Debrecen and ISHS respondents think extension was slow in adopting ICT for use with farmers. There is a similarity in the percentage of countries identifying cost of technology, lack of useful information and lack of training as a constraint for ICT adoption by extension. It should be read as follows: 45.5% of the Debrecen and 47.0% of the ISHS responding countries identified cost as a factor limiting farmer's use of ICT. 45.0% of the Debrecen and 41.0% of the ISHS responding countries identified cost as well as a factor limiting the use of ICT by extension in their service to farmers. There is a different count regarding infrastructure perhaps because horticulture is relatively more capital intensive in several countries. The ISHS reply that farmers seem to have less time is hard to explain. Lack of training for extension agents is perhaps due to service priorities. Lack of information seems to be more of a limiting adoption factor for extension than for farmers.

At the ISHS conference respondents from developed as well as developing countries filled out the questionnaire, permitting to make a comparison of their results. In Table 3 a summary of the factors limiting the adoption of ICT is presented for the different countries. When there was at least one reply from a certain country, the factor is indicated to be important for this country. The results reveal that "lack of training" is important in most countries, regardless of the level of development. This is a recognized problem being addressed and remedied. During the discussions with the ISHS respondents it was generally assumed that the magnitude of "lack of computer-literacy" will decrease in the near future, especially in the developed countries. In these most of the younger horticultural producers are well-educated and have learned to work with computers at school. It is illuminating that the factors "no perceived economic benefits", "do not understand the value of ICT" and "not enough time to spend on technology" are mainly indicated by respondents originating from developed countries, whereas the respondents from developing countries stress the importance of "cost of technology" and "lack of technological infrastructure".

These results suggest that the most important limiting factors in developing countries in terms of infrastructure and cost of technology are no longer a threshold for ICT adoption in developed countries. In developed countries however the understanding how to get a benefit from the use of ICT seems to be one of the most important thresholds for ICT adoption.

Table 2b. Comparing the factors limiting the use of ICT by farmers and by extension for farmers (% of countries *)

Limiting factors	Bonn Farmers	Montpellier Farmers	Debrecen Farmers	ISHS Farmers	Debrecen Extension	ISHS Extension
Inability of farmers to use ICT	40.0	8.0	13.6	6.0	14.0	12.0
Lack of technological infrastructure	36.0	12.0	40.9	29.0	41.0	12.0
Cost of technology	32.0	48.0	45.5	47.0	45.0	41.0
Not useful information/not relevant problems	24.0	4.0	18.2	6.0	23.0	24.0
Fear of technology	16.0	16.0	-	6.0	-	-
Not enough time to spend on technology	16.0	24.0	27.2	41.0	23.0	29.0
Lack of training	20.0	44.0	63.6	65.0	28.0	29.0
Other	-	-	24.0			**

* % of countries with at least one participant from that country replying "yes".

** 41.0% mentioned lack of suitable software and/or tools, 29.0% mentioned farmer resistance.

Table 3. Factors limiting the use of ICT by farmers for the different countries

Country (replies) /question 2a	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Belgium (2)		x						x	x	x	x			
Croatia (2)		x		x	x			x		x				x
France (1)					x					x				
Germany (6)		x				x		x	x	x			x	
Holland (6)		x	x					x				x		x
Hungary (1)					x				x	x				
Iran (1)		x		x										
Malaysia (1)		x												
New Zealand (1)								x		x				x
Poland (1)	x			x	x						x		x	x
Spain (1)								x	x					
Sweden (1)							x	x		x				
Switzerland (1)									x					
Syria (1)				x	x					x				
Turkey (1)				x	x					x				
USA (3)		x	x		x					x				
Vietnam (1)		x			x					x				
17 countries (31 replies)	1	8	2	5	8	1	1	7	5	11	2	1	2	4

Discussions with the respondents stressed the need for specialized software in horticulture. Specifically the lack of ICT programs for horticulture was defined by the limited availability of unique software programs. Those currently available are focused on general agricultural production and often do not meet the needs of horticultural producers. The complexity and heterogeneity of horticultural production seems to be an important obstacle for software developers. One can suggest that an evaluation of the existing software programs in horticulture to pinpoint needs is an effort worthy of future academic and commercial attention. In this case end-user involvement and a “bottom-up” approach would be useful.

Assuming that there is a benefit to be gained from the use of ICT in horticultural production the perceived consequences for horticultural producers not using ICT are presented in table 4. 77.4% of the respondents from 58.9% of the countries identified a loss of competitiveness/efficiency, 42.0% from 52.9 % of the countries expect becoming “out of touch” but only 9.7% in 11.7% of the countries expect the extreme consequence of going out of business. 13.0% from 23.5% of the countries assumed that there will be no consequences. These last two results can be interpreted to mean that there are satisfactory alternatives to the use of ICT – an assumption that justifies verification, identification of these alternatives and further study of the benefit to be derived from their future development.

Table 4. Consequences for farmers not using ICT now and in the future (% of replies)

	Bonn 1999		Montpellier 2001		Debrecen 2003		ISHS 2004	
	Now	Later	Now	Later	Now	% of Countr.	Now	% of Countr.
No consequence	32.7	-	7.7	-	23.5	31.8	13.0	23.5
Loss of competitiveness/efficiency	32.7	48.3	52.3	4.6	49.0	72.7	77.4	58.9
Becoming "out of touch"	27.6	13.8	18.5	6.1	29.4	45.5	42.0	52.9
Wasting resources	3.4		-	-	11.7	22.7	19.3	35.3
Go out of business	-	13.8	4.6	7.7	15.7	22.7	9.7	11.7
Reorganization of business/ICT infrastructure	---	---	---	---	---	---	3.2	5.9
Other	----	---	---	---	---	---	3.2	5.9

Taking into account that “training” is a major ICT adoption constraint, recognized over time (see Table 2a) the opinion of the respondents regarding public funding for ICT services was sought. In this case Public ICT services are a good example: extension, ICT training, “free” e.g. internet provided recommendations, etc. would be such an eligible “Public” ICT service. Public funding would be justified under the assumption that the public in large would benefit from “cheaper and better” agricultural products. Responses to this consideration are shown in table 5. The option “support is justified” received an affirmative reply from more than half of the ISHS respondents (54.8% of the respondents from 52.9% of the countries). This result is comparable to the results from the last EFITA conference in Debrecen. These indicate a dramatic increase compared to the earlier conferences. However, only 3.2% of the ISHS respondents in 5.9% of the countries agree that support is essential, which is also comparable to the Debrecen results again suggesting satisfactory alternatives. Although not considered essential the finding that support should not be provided received an affirmative answer from 19.3% of the ISHS respondents in 17.6% of the countries, which again is compatible with the Debrecen results. Overall the ISHS results indicate that public funding for ICT services is seen as justified for horticultural producers as well.

Research on ICT adoption in Belgian glasshouse horticulture was presented at the EFITA conference in Montpellier (Taragola *et al.*, 2001). This detailed research focused on the influence of the firm manager’s personal and business characteristics on adoption of computers, internet and farm accounting software. The results revealed a trend of adoption of computers and internet by larger businesses and well-educated (especially computer trained), innovative and creative firm managers. Adoption of farm accounting software was strongly influenced by the personal characteristics of the firm manager. These results are in line with the opinions of the ISHS respondents, where “lack of training” was indicated as the most important factor limiting the use of ICT. One can also assume that the “perceived economic benefits” will be higher when the horticultural holdings are larger, the firm managers are innovative and have better management training. This has yet to be established.

The Belgian glasshouse horticulture study indicated that the computer proficiency of the spouse or partner has a significant effect on adoption of computers. This finding is not surprising, since research on the task allocation at these holdings revealed that more than one third of the total time needed for financial-administrative tasks can be allocated to the spouse or partner (Taragola *et al.*, 2004). Relating this finding to the EFITA Baseline explains to some extent the indication of “training” as an important ICT adoption limiting factor. Another result of the Belgian glasshouse horticulture study is that a positive association between the firm’s financial performance and adoption of computers was found. However due to the cross-sectional character of the data no conclusion about the causality of this relation could be made.

4 Conclusion

In general the results of the ISHS questionnaire are in line with the EFITA results namely that there are numerous explanations for ICT uptake problems in horticulture. Comparing the EFITA baseline results with the ISHS replies gives an indication of the ranking of ICT uptake problems in relation to horticulture.

Table 5. Is public funding for ICT services for farmers justified?

Replies : Bonn n= 58 Montpellier n=65 Debrecen n=51 ISHS n=31	% of Bonn Replies	% of Montpel- lier Replies	% of Debrecen Replies	% of Debrecen Countries *	% of ISHS Replies	% of ISHS Countries
Support is essential	12.1	3.1	3.9	9.0	3.2	5.9
Support is justified	17.2	26.2	56.8	77.6	54.8	52.9
Support is justified with qualifications	50.0	38.5	23.5	40.9	19.3	29.4
Support should not be provided	20.7	21.5	15.7	22.7	19.3	17.6
No comment	-	10.7	-	-	3.2	5.9

* Due to the possibility of more than one reply per country the e.g. Debrecen results should be read as follows – at least one respondent from 9.0% of the countries thought that public funding is essential; at least one respondent from 77.6% of the countries answered that public funding is justified, etc.

The results suggest that the most important limiting factors in developing countries in terms of infrastructure and cost of technology are no longer a threshold for ICT adoption in developed countries. In developed countries understanding how to get a benefit from the use of ICT seems to be one of the most limiting factors for ICT adoption at this moment. Still more research is needed in order to get a clear insight of the relative importance of the different limiting factors. These in the context of different horticultural sectors, types of firm manager and management styles, various production technologies (e.g. glasshouse production vs. uncontrolled environment), different countries (including a developed vs. developing countries perspective), and more. In this sense ICT adoption should be differentiated from computer and ICT literacy. Since many horticultural holdings are family businesses where the spouse or partner is often involved in financial-administrative activities, the impact of the spouse/partner's proficiency on computer adoption should not be neglected. Furthermore, it would be useful to have an evaluation of the existing software programs relevant for horticulture for identifying compatibility with perceived needs and shortcomings.

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