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Competencies Needed for Guiding the Digital Transition of Agriculture: Are Future Advisors Well-Equipped?

Chrysanthi Charatsari [1,*], Anastasios Michailidis [1], Evagelos D. Lioutas [2], Thomas Bournaris [1], Efstratios Loizou [3], Aikaterini Paltaki [1] and Dimitra Lazaridou [4]

1 Department of Agricultural Economics, School of Agriculture, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece; tassosm@auth.gr (A.M.); tbournar@agro.auth.gr (T.B.); apaltaki@agro.auth.gr (A.P.)
2 Department of Supply Chain Management, International Hellenic University, 60100 Katerini, Greece; evagelos@agro.auth.gr
3 Department of Regional and Cross Border Development, University of Western Macedonia, 50150 Kozani, Greece; lstratos@agro.auth.gr
4 Department of Forestry and Natural Environment Management, Agricultural University of Athens, 36100 Karpenisi, Greece; dimitral@for.auth.gr
* Correspondence: chcharat@agro.auth.gr

Abstract: As the penetration of digital technologies in agriculture deepens, farm advisors have to cope with new roles, which generate the need for updating already possessed and developing new competencies. Although in-service advisors can build such skills through their involvement with the practice of digital agriculture, students of agronomy (and related) departments who will undertake the role of advisors in the future are expected to develop relevant competencies during their university education. Do current curricula supply them with such competencies? In pursuing this question, in the present study, we developed a theoretical scheme involving eight sets of competencies. After constructing a scale for each set, we collected data from students enrolled in an agronomy department of a Greek university. Our findings revealed that participants' overall competency in dealing with digital agriculture was considerably low. Among the eight sets of competencies, the highest scores were observed for empathy and future orientation, while students had low levels of technology exploitation, technology integration, and transition facilitation competencies. A regression analysis indicated that the two last sets shape students' overall competency. These results point out the need to integrate a farmer-centered philosophy in digitalization-related higher agronomic education and consider the critical role that social science can play in equipping future advisors with competencies needed to facilitate the digital agricultural transition.

Keywords: agricultural digitalization; advisers; competencies; skills; agricultural education; smart farming; precision agriculture; digital transition; digital technology; advisory services

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1. Introduction

The transition to digital agriculture requires changes in the practices and ways of doing business by the actors involved in the farming nexus. The introduction of new technologies at the farm level leads to a reallocation of activities and resources, while the need to develop new skills and competencies is pressing [1]. In this vein, support from other actors is necessary to facilitate adoption [2] and help farmers build new competencies [3]. In most cases, farm advisors have the challenging task of undertaking this role. Nevertheless, to guide—or at least facilitate—the smooth transition towards digital agriculture, advisors should occupy the competencies needed to introduce technologies into everyday farming practices and extract value from this mixing.

In-service advisors build these capacities by actively participating in the digital transition process through job experimentation and trial-and-error learning [4]. Of course, many, if not most, advisors whooperate today in the field received their education before digital technologies came into public view. For instance, deep learning applications and the Internet of Things were introduced into agriculture after 2010, penetrating the curricula of agronomy and/or polytechnic universities as a topic of study much later. Hence, advisors who finished their studies before the agri-digital boom did not have the opportunity to be exposed to these technologies during their education. Today, most higher education institutes realize the importance of preparing future professionals to face the challenge of digitalization [5]. However, little is known about the degree to which agricultural universities supply those who study to become advisors with the competencies needed to deal with the transition towards a digitalized farming future.

This study focuses on Greece, a country where the digitalization of agriculture is proceeding slowly and often in an ill-designed fashion [6]. Previous work indicates that Greek agricultural universities emphasize theory over practice and technical mastery over soft skills [7,8], thus not supplying students with the competencies needed to co-shape transitions with farmers and other actors [9]. The study aims to uncover the levels offuture advisors' competencies in three different general areas. The first area concerns technocentric competencies, which represent capabilities related to digital technologies, their integration into farms, and their efficient and responsible exploitation. The second refers to future-oriented competencies, which help farm advisors to forecast and deal with the future trajectories of digital agriculture, thus improving their capacity to foresee potential impacts, minimize potential risks, and orient themselves and farm enterprises toward a digitalized future. The last category involves competencies centered on the adopters of digital technologies, namely the ability to facilitate the transition from process-driven to data-driven and technology-enabled digital farming, and the empathy necessary to navigate this transition.

To what extent do students in agronomy departments in Greece possess such competencies, and which of these sets determine their overall level of competency in dealing with digital agriculture? To pursue these questions, we first developed a theoretical framework (presented in the next section) and performed a study based on a quantitative research design, detailed in Section 3. Section 4 of the article presents the results derived from our analysis. The article closes by discussing the implications of our findings and proposing future research paths.

2. Theoretical Framework

2.1. Defining Digitalization and Digital Agriculture

Although the term "digitalization" is widely used, it is still open to varying definitions because of its dynamic character and the multiple angles from which it can be grasped [10]. In this work, combining definitional elements from several studies [11–13], we designate digitalization as the application of digital technologies across different sectors of economic activity and areas of social life with the aim of turning "analog" signals into fragments of information available in the form of digital language. However, digitalization is not a purely sectoral activity with clear boundaries. Digital innovations from different sectors of the economy and society converge to shape the scene of digitalization [14], thus transforming—at multiple levels—industries and actors that participate in them.

A common denominator in digitalization literature is the emphasis on the transformative potential of digital technologies. Gong and Ribiere [15] define digital transformation as a digital technology-enabled change process that brings the characteristics of radical innovation and has the potential to positively alter social units (individuals, organizations, networks, communities, or even society as a whole) by opening up new value creation opportunities [16]. Digital artifacts indeed change individuals' lifestyles, everyday routines [17], ways of interaction [18], work processes [19], professional values, and identities [20], to mention just a few.

However, not all transformations are positive. Uncertainty and possible adverse effects accompany digitalization. Agriculture is one of the few areas of study in which the potential negative impacts of digitalization have received considerable attention. Agricultural digitalization (i.e., the process of using data-rich software, hardware, and services to increase farm productivity and efficiency while reducing costs, labor effort needed, and environmental externalities of farming [21,22]) and the consequent rise of a new form of high-tech and data-driven agriculture—known as digital agriculture [23,24], smart farming [25,26], or Agriculture 4.0 [27,28]—are followed by several risks and open issues.

2.2. Farm Advisors' Digitalization-Related Competencies

From seminal works in the field [29–31] to more recent studies [32,33], there is an agreement that the irruption of digital technologies into the farming sector has a strong effect on farming and food systems. Prior work focusing on farm-level challenges has provided many insights into the difficulties faced by adopters. Before adoption, producers must choose among the many alternative offerings [34,35] without always being able to shift the design of these technologies to their needs [36] or to assess the benefits and risks associated with each digital artifact [37]. In the post-adoption phase, farmers have to learn how to work with new technologies [38], bundle them with older technologies [39], and adapt them to conventionally used farming practices [40], thus facing difficulties in extracting value from their use [41] and receive the full range of benefits that they can offer [42].

To overcome these challenges and achieve the main aim of digital agriculture, which is to use digital artifacts to produce actionable knowledge [43], farmers need support from advisory services. In this vein, the transition to digital agriculture also affects the work of advisors, who, according to Hansen et al. [44], represent the "next users" of technologies that assist end-users (farmers) in transforming technologies into productive tools. To perform this role, advisors need to develop new (or enhance already processed) technical skills and competencies in envisioning the future of digitalized farms and helping farmers effectively navigate it [4,22] while maintaining and improving their capacity to show empathetic behaviors toward their clients [45] and facilitate their transition to digital agriculture [6].

Given that, to date, a general framework for determining the competencies needed to effectively perform the profession of an advisor in a rapidly digitalized world does not exist, we have built a scheme consisting of the three above-mentioned general competency clusters, divided into eight sets (Figure 1). The first cluster includes technocentric competencies, i.e., capacities that help advisors effectively interact with technologies and mediate farmer-technology interaction [4,46]. This category accommodates competencies related to "technology understanding", which involves basic skills and abilities to understand the potential of technologies for farming and efficiently use them [47].

It also contains a set related to the capacity to assist farmers in integrating technologies into their farms (technology integration competencies). Given that farmers face difficulties in selecting suitable technologies for their enterprises [48,49] and lack the expertise to adapt their farms to the new modus operandi of digital agriculture [50,51], the role of advisors in integrating digital artifacts into currently followed production paradigms is pivotal. In addition, since digital and legacy technologies are expected to co-exist on adopters' farms, advisors have the critical task of bundling high-tech digital artifacts with analog technologies that, as observed by Klerx and Rose [52], have not yet fully unfolded their potential in many cases.

A final set belonging to this category is "technology exploitation" competencies. It concerns advisors' capability to uncover and realize the value proposition of technologies [53], and help farmers deal with the complexity of digital tools, translate the data offered by decision support systems and other applications into valuable insights, and derive benefits from them, which, as research indicates [46,50,54], is a challenge for adopters.

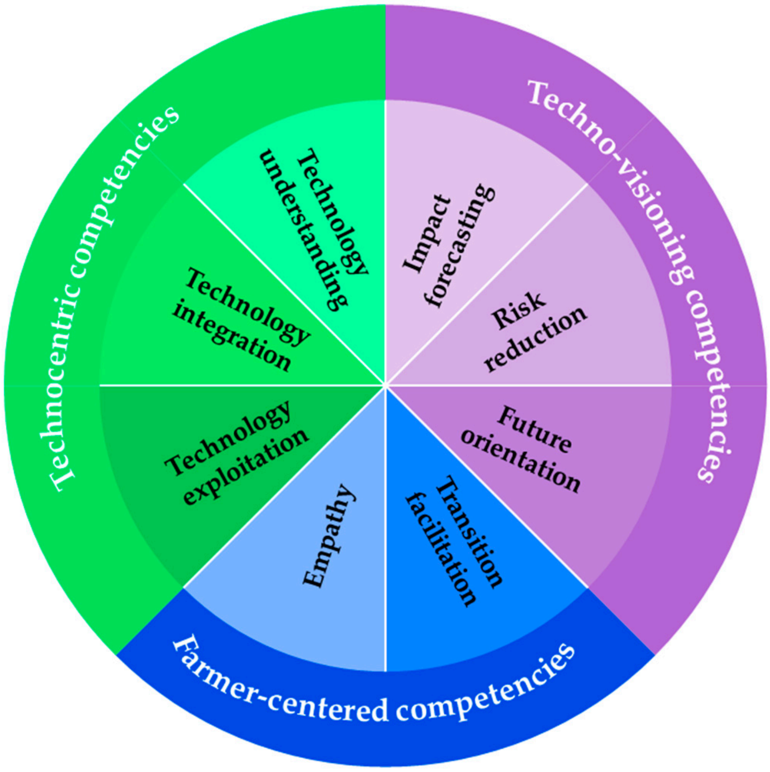

Figure 1. Categories and sets of digitalization-related competencies.

The second cluster incorporates competencies associated with advisors' ability to envision the future trajectories of digital agriculture. Such "techno-visioning competencies" allow professionals to improve their offered services and design new ones to target potential future needs and demands of adopters [55]. The capacity to forecast the consequences of digital technology adoption—herein labeled "impact forecasting competency"—is crucial in this respect, since it permits advisors to anticipate how technologies will affect not only farms but also farming systems and farmers' lives. Research confirms that digitalization may have mixed impacts on how farmers work, learn, and live [54,56,57], while the implications of their adoption for the broader agrifood systems can also affect the context in which farm enterprises operate [58]. Advisors with the capacity to anticipate these impacts can effectively drive the digital transition by adapting themselves and facilitating the adaptation of their clients' enterprises to external changes through promoting transformational changes when needed and bundling solutions to achieve that purpose.

Another set within this cluster concerns "risk reduction competencies". The risks associated with the digitalization of agriculture are well-documented in the relevant literature. These risks directly—when talking about financial perils [30,59]—or indirectl—as in the case of social [60,61], environmental [62,63], and ethical risks [41,50,64]—influence the sustainability of farms. By being capable of reducing these risks, advisors can help farm enterprises survive and achieve their desired goals.

Finally, "future orientation competencies" include the ability to foresee potential future states, conceive of, and adjust to varying future scenarios [65]. Future orientation also involves advisors' capability to translate their transition experience into usable knowledge, or, in Mulder's words [66], their "integrative learning competence". This competency impels individuals to develop goals and set strategies to achieve them [67]. Moreover, by affecting advisors' perceptions of the future, future orientation can influence other competencies and their professional responses to digitalization [4].

The final cluster comprises "farmer-centered competencies", which describe the capabilities to empathize with adopters and facilitate their transition to digital agriculture. Building upon classic definitions of the term [68–70], in our framework, we conceptualize empathy as an advisor's capacity to understand how adopters experience the transition process and to recognize farmers' feelings while differentiating themselves from clients. Empathy is a vital competency—especially for the farm advisor profession [71]—since it can improve interpersonal communication and enhance the quality of the service offered [72]. On the other hand, transition facilitation competencies involve making the transition to a new status easier by designing and implementing effective plans [73] in collaboration with farmers [74] and, in the case of digital agriculture, resolving the frequently emerging human-technology conflicts [6].

3. Methods

3.1. Participants and Procedure

Participants in this study were students enrolled in an agronomy department at a large Greek university. After developing the research instrument, we released a recruitment announcement which included a link directing potential respondents to an electronic questionnaire. Then, we asked some students to post the announcement on their personal pages. The data collection process lasted seven weeks (29 November 2022 to 17 January 2023).

The questionnaire began with a compulsory open-ended question asking participants to define digital agriculture. Then, a series of closed-ended questions followed. We analytically present the scales used in the next section. After collecting data, the first three authors evaluated the answers to ensure that the participants understood what digital agriculture is. Overly general statements (e.g., "digital agriculture is a step towards sustainable farming") led us to exclude corresponding questionnaires.

The final sample for this study was 108 students. Among them, 55.6% were women. The mean age of the respondents was 23.5 years (S.D. = 4.1). Most of them (94.7%) were either in their fourth year of study or their graduation year.

3.2. Measures

3.2.1. Technocentric Competencies

To assess students' technocentric competencies, we built three new scales (Table 1). The first one refers to basic technology understanding skills, i.e., the participants' ability to use digital technologies and understand their operating principles and potential. Since research has shown that advisors do not always possess such skills [6], we considered it crucial to estimate the levels of future advisors' elementary competencies in dealing with and understanding technologies.

The second scale concerns the capacity to integrate digital technologies into farm enterprises by selecting appropriate technologies, estimating their efficiency by evaluating the pros and cons of digitalization, and taking actions to facilitate their post-adoption usage through, for instance, bundling digital and "analog" technologies and solving problems that may arise due to the introduction of digital artifacts into farms.

Finally, the third scale includes seven items that describe technology exploitation competencies, like developing plans to exploit technologies and extract value from them. Such competencies allow advisors to unlock the full potential of technologies and facilitate the translation of their value propositions into value-in-use, which is not an easily solved issue [44,75].

During the item generation process for these three scales, we exploited theoretical contributions and research findings from studies that variously refer to the scientific competencies needed to deal with agricultural digitalization [4,43,46,76]. For all items, we asked students to determine the extent to which they have each of the corresponding competencies, utilizing a scale ranging from 1 (not at all) to 5 (very much).

Table 1. Technocentric competencies: scales, items, results of factor analyses, and Cronbach's α.

Scale/*Items* [1]	**Eigenvalue**	**Explained Variance**	**Cronbach's Alpha**
Basic technology understanding competencies	2.09	69.6%	0.86
Understanding how technologies work			
Understanding the potential of technologies			
Handling/using technologies			
Technology integration competencies	5.41	67.6%	0.94
Choosing appropriate technologies for farms			
Estimating the costs and benefits of new technologies for farms			
Introducing new technologies to farms			
Properly using technologies			
Reorganizing work after technology adoption			
Solving problems associated with newly introduced technologies on the farms			
Connecting digital agriculture technologies with traditionally used technologies			
Integrating technologies in current production systems			
Technology exploitation competencies	4.29	61.3%	0.91
Exploiting technologies			
Creating value from technologies			
Transforming technologies to productive resources			
Designing effective technology exploitation plans			
Using technologies for improving farm production			
Using technologies for improving farming systems			
Using technologies for making work easier for farmers			

[1] The term "technology" refers to any digital agricultural technology.

To test if the items belong to the expected factors, we performed a series of principal axis factor analyses. In all cases, the procedure confirmed single-factor solutions with eigenvalues higher than 1.0 (Table 1). For each of the scales, we calculated a total score by averaging the relevant items. Cronbach's alphas were high for all sets of variables.

3.2.2. Techno-Visioning Competencies

For the techno-visioning competencies, we developed three sets of items, each measured on a five-point scale, ranging from 1 (not at all) to 5 (very much). Participants were instructed to choose the option that best described their level of competency for each of the topics reflected by the items.

The first three items relate to students' capability to predict the impacts of digital technologies. Relevant work [41,77] has indicated that farmers, farms, and farming systems absorb (or are expected to absorb) a series of direct positive and negative outcomes of digitalization. Hence, we created items reflecting future advisors' competencies in forecasting how digitalization will transform adopters' lives, their farm enterprises, and farming systems.

The second scale ("risk reduction competencies") involves items associated with the competency to minimize the risks that follow agricultural digitalization, which include financial, socio-ethical, and environmental threats. For the third scale, we developed items that depict respondents' ability to anticipate and orient themselves toward potential futures by learning while undergoing transitions to digitalization. This future orientation affects professionals' ability to foresee changes and draw plans to keep up with and co-shape the future [78,79].

As revealed by our principal axis factor analyses, all scales had unidimensional structures, with eigenvalues ranging from 2.04 to 2.18 (Table 2). Cronbach's alphas were sufficient for all constructs. For each scale, we computed a composite score as the average of its items.

Table 2. Techno-visioning competencies: scales, items, results of factor analyses, and Cronbach's α.

Scale/*Items* [1]	**Eigenvalue**	**Explained Variance**	**Cronbach's Alpha**
Impact forecasting competencies	2.04	68.2%	0.86
Predicting how technologies will transform farms			
Predicting how technologies will transform farming systems			
Predicting how technologies will change farmers' lives			
Risk reduction competencies	2.97	74.3%	0.92
Minimizing the financial risks associated with technologies			
Minimizing the social risks associated with technologies			
Minimizing the environmental risks associated with technologies			
Minimizing the ethical risks associated with technologies			
Future orientation competencies	2.18	54.6%	0.82
Being able to learn while helping farmers integrate technologies in their farm enterprises			
Learning how to learn from technologies			
Orienting myself and farm enterprises to the future			
Anticipating the potential futures that technologies create			

[1] The term "technology" refers to any digital agricultural technology.

3.2.3. Farmer-Centered Competencies

To depict farmer-centered competencies, we constructed two scales. For measuring empathy competency, we were inspired by relevant studies [72,80] that focused on the cognitive and communicational aspects of this construct. Our scale involves items concerning the prioritization of farmers' interests, the ability to understand farmers' feelings toward digital technologies, and future advisors' capacity to handle their emotions when interacting with technology adopters.

To illustrate transition facilitation competency, leaning on previous work [4], we generated items that referred to drawing plans for exploiting the opportunities offered by digital technologies, facilitating the transition to a new, technologically enabled farm status quo, and making human-technology collaboration easier.

As with the previous sets of competencies, we used a five-point scale to assess students' competency levels, ranging from "not at all" to "very much". The results of the principal axis factor analyses are presented in Table 3. By averaging item scores, we generated composite variables for both scales.

Table 3. Farmer-centered competencies: scales, items, results of factor analyses, and Cronbach's α.

Scale/*Items* [1]	**Eigenvalue**	**Explained Variance**	**Cronbach's Alpha**
Empathy competency	2.02	67.4%	0.85
Handling emotions when communicating with farmers/technology adopters			
Follow a farmer-first approach			
Understanding how farmers feel about technologies and resolving potential conflicts			
Transition facilitation competency	1.73	57.8%	0.80
Planning how to help farmers effectively exploit the opportunities that technologies offer			
Facilitating through my collaboration with farmers the technology-enabled transition of farm enterprises			
Facilitating the collaboration of human actors and technologies in farm enterprises			

[1] The term "technology" refers to any digital agricultural technology.

3.2.4. Attitude towards Digital Agriculture

To assess attitudes toward digital technologies, we used a seven-point semantic differential scale derived from Lioutas and Charatsari [81]. Respondents read a statement asking them to rate digital agriculture using five opposite adjectives (e.g., worthless/valuable). For each oneof the pairs, the positively worded adjective corresponded to a value of 7, and the negatively stated adjective had a value of 1. Hence, higher scores on the scale indicate a more positive attitude.

A principal axis factoring suggested that the items load on a single factor, accounting for 64% of the total variance (Eigenvalue = 3.2). The new variable we calculated was the average of the item scores. Cronbach's alpha was satisfactory ($\alpha = 0.85$).

3.2.5. Overall Competency in Digital Agriculture

To measure the overall level of competency in dealing with digital agriculture, we employed a single item measured on a one-to-ten scale.

3.3. Data Analysis Overview

To provide basic information on our data, we used descriptive statistics. For comparisons between sets of competencies, we performed paired-sample *t*-tests. We also employed Pearson's correlations to examine relationships between constructs. Gender effects on the variables of interest were tested using independent samples *t*-tests.

We also developed a hierarchical regression model to examine whether and which of the eight sets of competencies affected students' overall competency in dealing with digital agriculture. Since students' attitudes towards a concept may impact their competency in it [82], we added attitude towards digital agriculture as a control variable in the first step of our model. In the next step, we entered all eight sets of competencies.

4. Results

4.1. Preliminary Results

The mean scores of the variables related to the eight competency sets (Figure 2) indicate that students have low to moderate levels of technocentric competency. The highest mean score was observed in technology understanding competencies (M = 3.22, S.D. = 1.05), while more challenging types of competencies received mean scores below 3.00. The observed differences among technology understanding competencies, technology integration ($t = 3.18$, $p = 0.002$), and exploitation competencies ($t = 4.61$, $p < 0.001$) were significant.

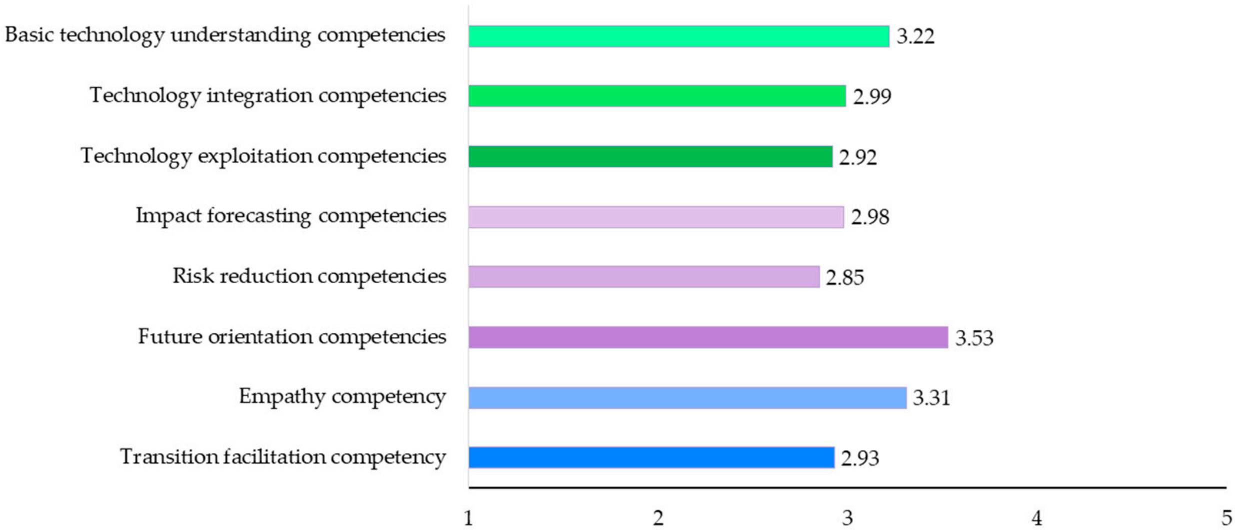

Figure 2. Mean scores of digitalization-related competencies.

Concerning the cluster of techno-visioning competencies, the mean scores ranged from 2.85 to 3.53. Future orientation competencies had a significantly higher mean score than impact forecasting and risk reduction competencies (*t* values were 6.80 and 7.23, respectively, corresponding to *p* values lower than 0.001). Interestingly, the two sets referring to impacts and risks associated with agricultural digitalization did not significantly differ ($t = 1.89$, $p = 0.062$) despite the lower mean score observed for risk reduction competencies, which, as Figure 2 highlights, was the lowest among the eight scales used.

On the other hand, farmer-centered competencies yielded mean scores ranging from 2.93 (S.D. = 0.92) for transition facilitation competency to 3.31 (S.D. = 1.00) for empathy competency. Paired samples t-tests uncovered significant differences between these sets of competencies, with empathy yielding a higher mean score than transition facilitation competency ($t = 6.21$, $p < 0.001$).

A notable finding was that students' overall competency in dealing with digital agriculture was considerably low, receiving a mean score of 4.10 (S.D. = 1.89) on a ten-point scale. Interestingly, overall competency was found to correlate with all the farmer-centered competencies. Pearson's r values were 0.39 ($p < 0.001$) for empathy and 0.51 ($p < 0.001$) for transition facilitation. We observed the same pattern for techno-visioning competencies, where r values for the correlations of overall competency with impact forecasting (r = 0.28, $p = 0.004$), risk reduction (r = 0.25, $p = 0.009$), and future orientation competencies (r = 0.35, $p < 0.001$) were positive and significant. Within the cluster of technocentric competencies, we also observed positive correlations with technology integration (r = 0.38, $p < 0.001$), exploitation (r = 0.37, $p < 0.001$), and basic understanding of technology (r = 0.26, $p = 0.006$).

Another remarkable observation was that students' attitude towards digital agricultural technologies was very positive (M = 5.53, S.D. = 1.29). The attitude score was not associated with participants' gender ($t = 0.40$, $p = 0.690$) and age (r = −0.04, $p = 0.662$), and we did not find a significant correlation with the grade year of studies (r = −0.01, $p = 0.957$).

4.2. Regression Analysis

The regression model developed to examine if and how the eight sets of competencies relate to students' overall competency in dealing with agricultural digitalization (Table 4) revealed that the outcome variable was not associated with participants' attitude toward digital agriculture. The R^2 change for the first step was not significant ($\Delta R^2 < 0.01$, $\Delta F = 0.11$, $p = 0.740$). When we added the eight sets of competencies to the model, we observed a significant change in R^2. As a group, the variables entered in the second block explained 29.7% of the variance in overall competence ($\Delta R^2 = 0.30$, $\Delta F = 5.17$, $p < 0.001$).

Table 4. Final model of the regression analysis: standardized beta coefficients and p values.

Variable	β	p
Attitude towards digital agricultural technologies	0.03	0.724
Basic technology understanding competencies	−0.10	0.523
Technology integration competencies	0.45	0.046
Technology exploitation competencies	−0.23	0.330
Impact forecasting competencies	−0.01	0.943
Risk reduction competencies	−0.12	0.476
Future orientation competencies	0.05	0.741
Empathy competency	−0.09	0.578
Transition facilitation competency	0.56	0.002

Among the examined competencies, transition facilitation (β = 0.56, $p = 0.002$) and technology integration capacity (β = 0.45, $p = 0.046$) significantly contributed to the total competency score. The signs of the beta coefficients for these two variables indicate a positive association, uncovering the pivotal role of transition facilitation and technology integration competencies in building a total competency associated with digital agriculture.

5. Discussion and Conclusions

5.1. Discussion

The need to equip professionals working in fields undergoing digital transitions with new competencies is evident in the literature [83,84]. In agriculture, digitalization urges farm advisors to undertake new duties and roles as they become sense-makers, helping farmers translate signals and data into actionable information [53] and connecting digital and practical knowledge [85]. This role reorientation impels them to refresh their palette of skills. Despite its newness, research in this area has already offered some notable insights into the skills and competencies that farm advisors should possess to expedite the digital transition [4,46,53,86]. Aspiring to add to this body of knowledge, we conducted a study shifting ourfocus from in-service advisors to future advisors, aiming to assess their technocentric, techno-visioning, and farmer-centered competencies and evaluate their overall competency in digital agriculture.

The results revealed a rather disappointing level of overall competency among students. Our analysis showed that the competency score for the total sample was rather low despite the positive attitude expressed by students toward digital agriculture. Regarding the eight sets of competencies examined, results indicated that those involving a high degree of self-regulation and self-direction, i.e., empathy and future orientation, had the highest mean scores. The data at hand did not allow us to conclude whether this phenomenon was an outcome of the offered courses or was an attribute associated with personality traits.

However, the fact that students scored low in competencies related to the potential negative externalities of agricultural digitalization (impact assessment and risk reduction competencies) might indicate a narrow emphasis paid by the offered curriculum on the social dimension of digitalization. Of course, in the early stages of technology development and social diffusion, limited consideration of negative societal impacts is a common issue since there is little knowledge of how technology will affect society or specific social groups [87]. Nevertheless, integrating societal issues into digitalization-related higher agronomic education is strongly recommended. Such an approach does not lessen the emphasis placed by curricula on technocentric competencies associated with the tools that enable digital transitions. Instead, it opens up a parallel line for competency development that brings the human-centered dimension of digitalization to the fore [88].

Another interesting finding was that technocentric competencies received moderate mean scores. Although the score was higher for basic technology understanding competencies, our analysis led us to conclude that wide margins for improving students' technical competencies exist. The traditional prominence given by the Greek agronomy education system to theoretical knowledge over practical and hands-on learning [7,9] probably reduces the opportunities for students to understand the uses and potential of digital technologies and, more importantly, to develop competencies in integrating and exploiting these technologies at the farm level.

Our regression analysis revealed some remarkable findings. Participants' overall competency in dealing with digital agriculture was found to be shaped by two sets of competencies: the ability of future advisors to integrate digital technologies into farms and their capacity to facilitate the transition to a digitalized farm production model. Technology integration represents a challenging task that requires advisors to have a variety of competencies, ranging from technology selection to their smooth introduction into farms and bundling them with older technologies. Since in-service advisors in Greece seem to lack these competencies [4,6], the need to supply students with at least baseline skills in technology integration seems acute.

Transition facilitation, on the other hand, seems to be a key competency in the new identity of farm advisors, as supported by theoretical viewpoints [85] and empirical findings [89]. Requiring a thorough understanding of farming systems, the role of farmers within them, and the tools that initiate transitions, this type of competency is perhaps the most challenging to develop among the eight examined sets. This might explain its high contribution to the overall competency score revealed through our regression.

However, how can agricultural universities supply students with these competencies? This question is challenging and calls for further research on the topic. Given that social science thinking can lead to more inclusive and responsible digital transitions [90,91], a better representation of social issues in the current curricula could help students see digitalization through a different lens and develop socially relevant knowledge associated with digitalization [92]. Our results also imply that placing more emphasis on practical education and shifting the focus of higher agronomic education from theoretical knowledge to equipping students with the skills to apply this knowledge in authentic farm settings can improve future advisors' competencies. Developing digitalization-related competencies becomes easier when advisors (or, in our case, prospective advisors) and farmers co-experience digital agriculture where it takes place: on the farm [57]. Building alliances with the agricultural innovation system (e.g., advisory organizations, public agricultural research institutes, private companies, etc.) can help universities connect students with farmers and other actors, understand the difficulties faced by digital technology adopters [93], and adapt their curricula and teaching methods to meet industry needs. The list of potential strategies is long, and future research can provide empirically validated insights into this topic.

5.2. Limitations and Future Research Directions

Despite the interesting findings yielded by our analysis, we should acknowledge a couple of limitations in this study. First, the results are based on a self-rating instrument. The development and use of other, perhaps more objective assessment techniques by future investigators can help better capture the levels of prospective advisors' digitalization-related competencies. Second, emerging from a sample of 108 students from a university department, our findings reflect the situation within one academic institute. Further studies can provide data on the preparedness of future advisors to deal with digitalization in other institutes and countries. Another valuable avenue for future research involves evaluating the degree to which different teaching approaches and styles can enhance students' competencies in digital agriculture.

5.3. Conclusions

The present study offers initial results on the digitalization-related competencies of future advisors. Although, as mentioned above, our research cannot deliver generalizable findings, it contributes to the literature by exposing gaps in future advisors' competencies and discussing the role of university education in facilitating an efficient and responsible transition to digital agriculture. The competency framework developed in our work is, we hope, a useful theoretical tool for evaluating in-service and future advisors' digitalization-related competency. Considering the attention paid to the role of farm advisors in supporting agricultural innovation—especially in the European Union [94]—similar tools can be valuable for assessing the current status of competencies possessed by advisors and developing plans to enhance their capacity to drive innovation. Suggesting strategies to help advisors increase their competency in dealing with and guiding agricultural digitalization is a challenging endeavor that we leave for future work.

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