SPARKLE

Sustainable Precision Agriculture:
Research and Knowledge for Learning
how to be an agri-Entrepreneur

TRAINING NEEDS ASSESSMENT in the field of SUSTAINABLE PRECISION AGRICULTURE

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Table of Contexts

1. Introduction

Precision Agriculture (PA) or farming is a management concept using digital techniques for monitoring and optimising agricultural production processes. However, the significant differentiation in the characteristics of farmers, their knowledge and their interest in PA creates a huge gap in their training needs and the way they manage the decisions they take. Besides, the European Common Agricultural Policy after 2020 is still not very clear (for example if precision farming will be linked to the direct payments pillar or to the environmental performance in general), which prevents PA from being broadly integrated. The key question in this report is to make PA closer to agripreuners, researchers, farmers and students helping to reduce their training gap. Thus, the main challenge is to develop a common training framework that can cope with the potential threats from precision farming and autonomy of individual European farmers in a pragmatic, inclusive and dynamic manner. To achieve this goal, a survey was carried out on a sample of stakeholders from four European countries of the Mediterranean.

The main aim of this "Training Needs Assessment" report is to define and present the training needs regarding Precision Agriculture based on the feedback of: a) PA researchers, b) agricultural science students, and c) farmers adopting PA technologies. Additionally, the "Training Needs Assessment" report aims to determine the extent of the PA knowledge gap, especially among students.

This report is one of the main deliverables of the project's first work package (WP): Training Needs Assessment (Fig 1). It combines the findings of several national quantitative studies on researchers and students (R1.3) and feedback of farmers who are currently implementing the technologies (R1.4).

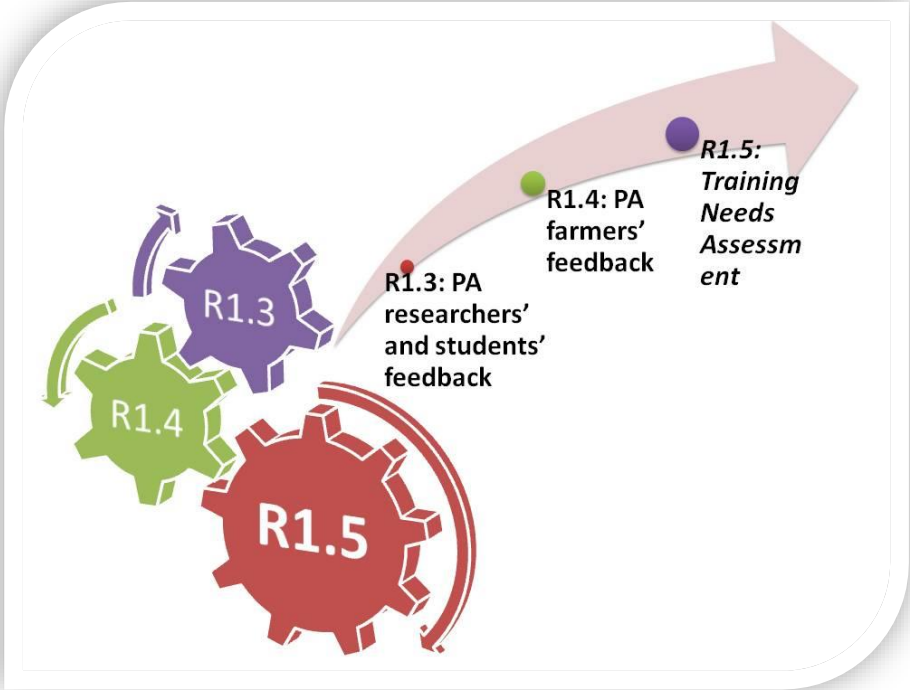


Figure 1. WP1 interconnection

This report will form the basis for subsequent objectives (Fig. 2) regarding the development of an e-learning course on precision agriculture (WP3 and WP4).

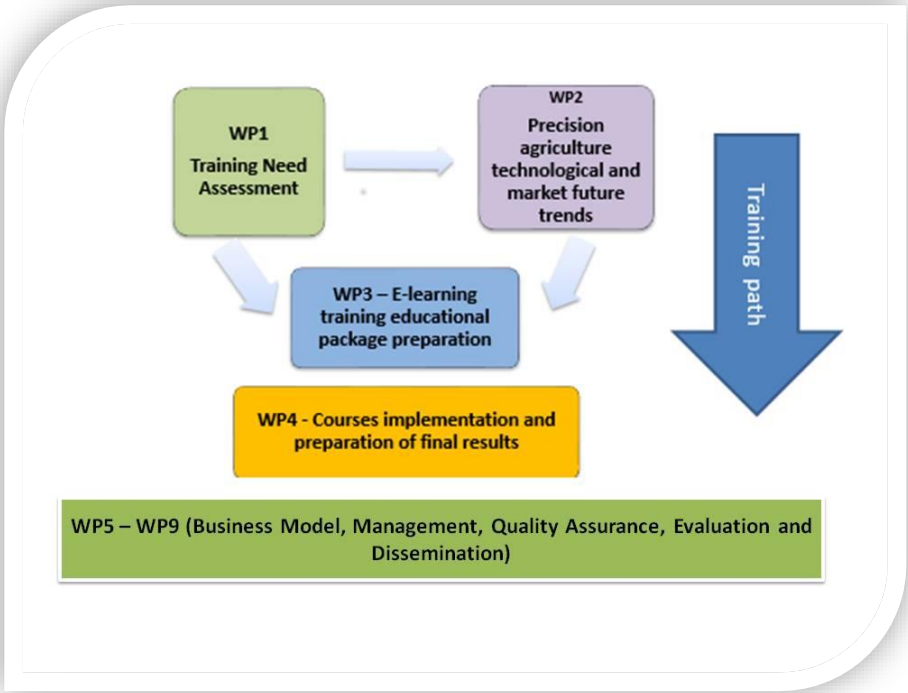


Figure 2. Contribution of WP1 "Training Needs Assessment" to the SPARKLE project

The “Training Needs Assessment” outcomes have materialized from three separate surveys, in each country, two qualitative and one quantitative. In particular, the quantitative survey aimed to provide input for the identification of students’ training needs and students’ knowledge gap. On the other hand, the qualitative surveys were focused on farmers’ attitudes and PA experts’ perceptions about the training needs in the field of PA implementation. The following figure presents graphically the structure of the data collection analysed in the “Training Needs Assessment” report (Fig.3).

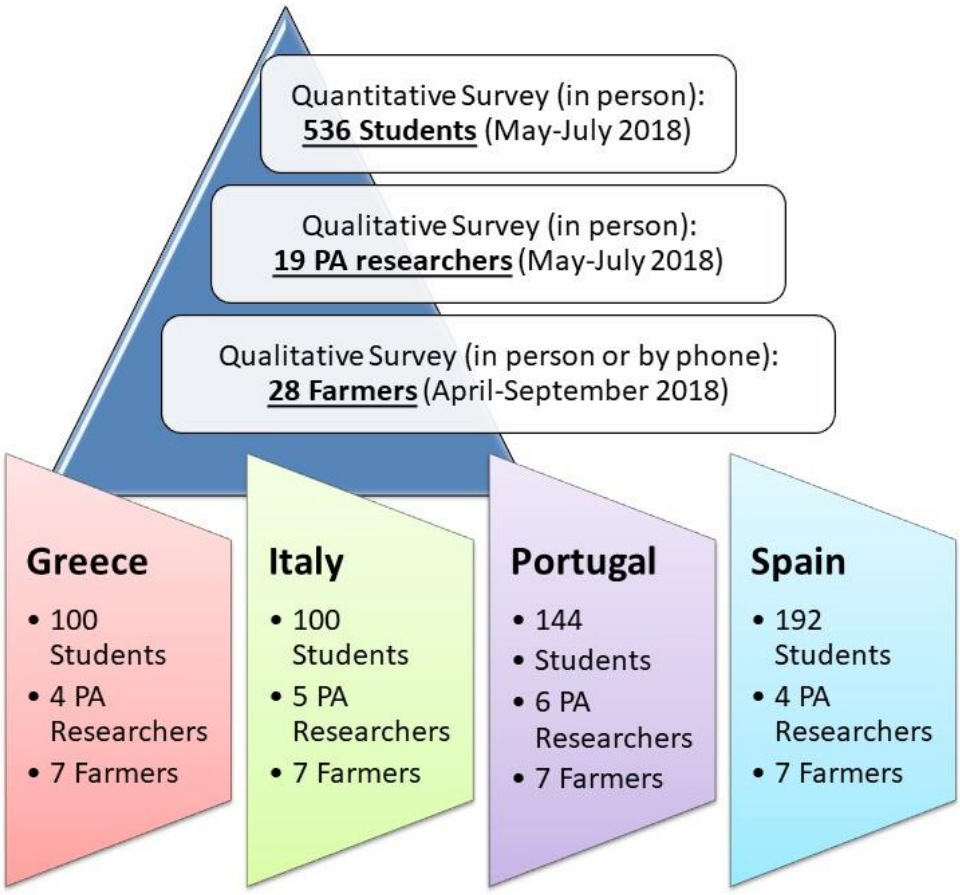


Figure 3. Data origin and collection

2. Materials and methods

According to the SPARKLE project functionality and structure, this report is one of the most important preparative tools as it forms a solid base for the forthcoming required actions. Therefore, special focus has been given to determine why training is needed? Other core questions are "how will training cure the problems identified?", "What is the best way to get the best results?", and "when should training take place?" as graphically summarised in Figure 4. Moreover this section presents the validity and reliability tests, which are important for the further statistical investigation of the dataset, as well as presents the methodological framework of the employed models.

Figure 4. Extracting the important questions

2.1 Data collection

Since the data collection and analysis of this report is the cornerstone of the SPARKLE project, special attention was given to ensure its reliability, validity, and trustworthiness. Data collection and analysis procedures will be highlighted, with validity and reliability issues also considered in order to ensure the trustworthiness of the research findings.

As aforementioned (Fig.3), the quantitative research was conducted with the following characteristics:

- In **Greece,** from May to June 2018 in the following universities: a) Aristotle University of

Thessaloniki (Faculty of Agriculture, Forestry and Natural Environment), b) Alexander Technological Educational Institute of Thessaloniki (School of Agricultural Technology and of Food and Nutrition Technology), c) Technological Educational Institute of Thessaly (School of Agricultural Technology and of Food and Nutrition Technology). In total 100 students participated in the survey.

- In **Italy**, from May to June 2018 in the University of Florence, Tuscany, Italy**.** In total 100 students were personally surveyed.
- In **Portugal,** from May to July 2018 in five High Education Institutions: a) Escola Superior Agrária de Santarém, b) Universidade de Trás-os-Montes e Alto Douro, c) Escola Superior Agrária de Beja, d) Universidade de Évora and e) Escola Superior Agrária de Elvas. In total 144 students were personally surveyed.
- In **Spain,** from May to June 2018 in the following Universities: a) Universidad Politécnica de Madrid (UPM), b) Technical School of Agri-food and Environment, c) Universidad de Sevilla and d) Universitat Politécnica de Valéncia. In total 192 students were surveyed.

The first qualitative research, focused on PA researchers/experts, was conducted from May to July 2018 in the four participating countries of the SPARKLE project. A number of research experts were interviewed using a specially developed interview guide. The researchers were chosen based on their expertise in PA, such as remote sensing, agricultural engineering, or agricultural mechanics. The number of participants varied per country, from 4 in both Greece and Spain, 5 in Italy, and 6 in Portugal.

Finally, the second qualitative research focused on farmers, and took place from April 18th to September 2nd 2018. The interviews were conducted in person or by phone in the: regional area of Thessaloniki in Greece, Alentejo and Ribatejo regions in Portugal, Tuscany Region in Italy, and across the southwest of Spain.

2.2 Expert validation

The concept of validity is central to any research design and important in both qualitative and quantitative research. Validity represents the extent to which research findings accurately reflect what is really happening (Neuman, 2011). Validity is considered as a measure of the quality of the process of measurement and one that reflects the essential value of a study, and which is accepted, respected and expected by the researchers and users of research (Sarantakos, 2005). Punch (2005)

describes validity from the perspective of data accuracy and representativeness. For Punch, validity refers to how well the data represent the phenomena for which they stand.

In this report, qualitative and quantitative research instruments were validated using three education experts to review questionnaires before they were administered to the target population. In particular, using the typical 5-point likert scale of agreement the education experts validated each question and each statement. When the evaluation of an education expert was less than 4 this expert proposed an alternative wording and the procedure was repeated until agreement was reached, on each question and each statement, with an average rating equal to or greater than 4. The findings were also validated through cumulative validation. Cumulative validation refers to the ability of the findings to be supported by other studies (Sarantakos, 2005). Actually, the main findings of both quantitative and qualitative surveys are in almost complete agreement with the results of a recent PhD thesis in Northern Greece (Kountios, 2016).

2.3 Reliability analysis

The concept of reliability is also very important in survey analysis especially in case of multivariate statistical analysis. According to Neuman (2011) and Sarantakos (2005), reliability or consistency is the minimization process of errors and biases of research instruments in order to produce the same results whenever repeated research conditions or respondents involved. **To ensure reliability in this report, the crobach's alpha test was used to determine the consistency, precision, stability and objectivity of the research tools.** In this report 114 variables were included and analysed in order to get an overall index of the internal consistency of the scale as a whole, to determine the extent to which these variables are related to each other and to identify questionnaires that had to be excluded. The value of Cronbach's alpha coefficient was found equal to 0.944 (SPSS, 2018), indicating a reliable scale. Moreover, Friedman's analysis of variance (two-way), indicated important significance in differences of item means with x^2=2.68 (α=0.00) and Hotelling's T^2=1.24 (F=28.12 and α=0.00). It's worth noting that none of the 536 questionnaires (Fig. 5) were excluded from the analysis.

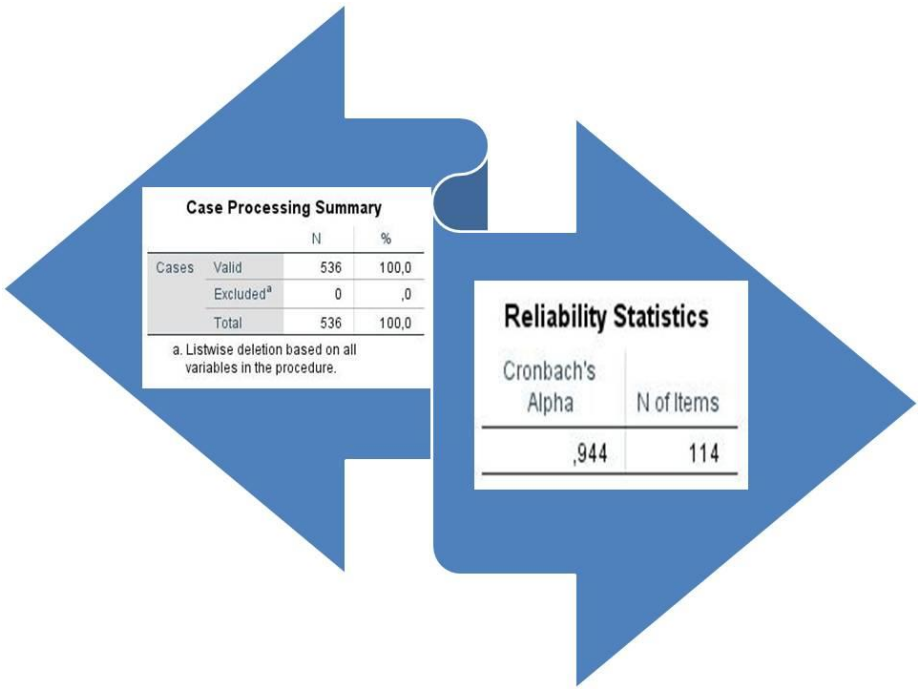


Figure 5. Reliability analysis (Crobach's alpha)

2.4 Methodological framework

From a methodological point of view this report includes an interesting innovative methodological mix employing both descriptive statistics (frequencies, percents and mean values) and multivariable analyses (using Statistical Package for Social Sciences - Ver. 25). In particular special emphasis has been given to validity and reliability issues of the dataset while a Categorical Regression Model (CATREG) has been employed to explain differences in the PA familiriarity of the respondents and a Two-Step Cluster Analysis (TSCA) in order to segment the respondents in a separate number of discrete clusters according to their levels of PA familiarity (Fig.6). The selected methodological framework allows to define students having different perception and knowledge levels of PA and to explain the factors that affect these levels.

Although the methodology of the chosen empirical techniques is rather unusual, it has been selected due to its ability to optimally handle categorical variables. Indeed, much of the data that social and political scientists deal with are qualitative in nature and most other data are at best ordinal (Berry and Lewis-Beck, 1986).

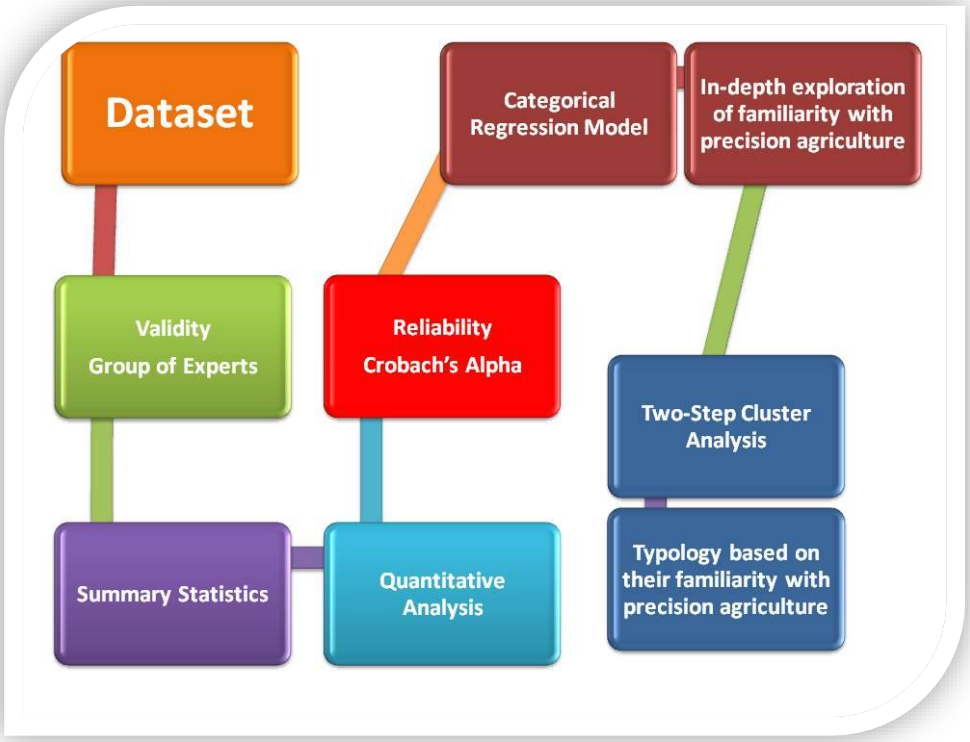


Figure 6. Methodological framework

In order to explore the different levels of students' familiarity with PA and to classify respondents in discernible clusters, with similar PA perceptions and attitudes, the TSCA was employed as a scalable cluster analysis algorithm designed to handle large data sets, revealing natural groupings within a data set that would otherwise not be apparent (Siardos, 2002). Traditional clustering models are considered accurate on small datasets while cannot optimally handle categorical variables most commonly found in a survey research (Zhang et al., 1996).

On the other hand, a CATREG model (Van der Kooij and Meulman, 1997) has been employed to highlight possible relations between PA familiarity of students and a group of independent variables (most of them categorical). Comparing with the most commonly used models (logit-probit or multiple regression analysis) CATREG is much more holistic and effective especially when both qualitative and quantitative data used. According to the Pratt (1987) and Siardos (2002) the relative importance measures are much more useful than the commonly usual standardized beta weights. In particular, relative importance measures can be employed to predict the future values of the dependent variable while also indicates the percentage of explanation of the dependent one.

3. Results

This section presents the main results of the statistical analysis as described in the previous section 2. In particular, the first sub-section includes the summary statistics and the second sub-section includes the multivariate statistical analysis by employing the selected regression and clustering models for categorical data.

3.1 Descriptive statistics analysis

Altogether, 536 students, 19 PA researchers and 21 farmers participated in the survey. In particular, a) 100 students, 4 PA researchers and 7 farmers from Greece, b) 100 students, 5 PA researchers and 7 farmers from Italy, c) 144 students, 6 PA researchers and 7 farmers from Portugal and d) 192 students, 4 PA researchers and 7 farmers from Spain. Survey elements (both questions and scales) have been validated and found suitable for generalisations of the results.

Table 1 presents a short description of the research sample. According to the table data, the representative participant of the study is male, undergraduate student, from Spain or Portugal (Fig. 7).

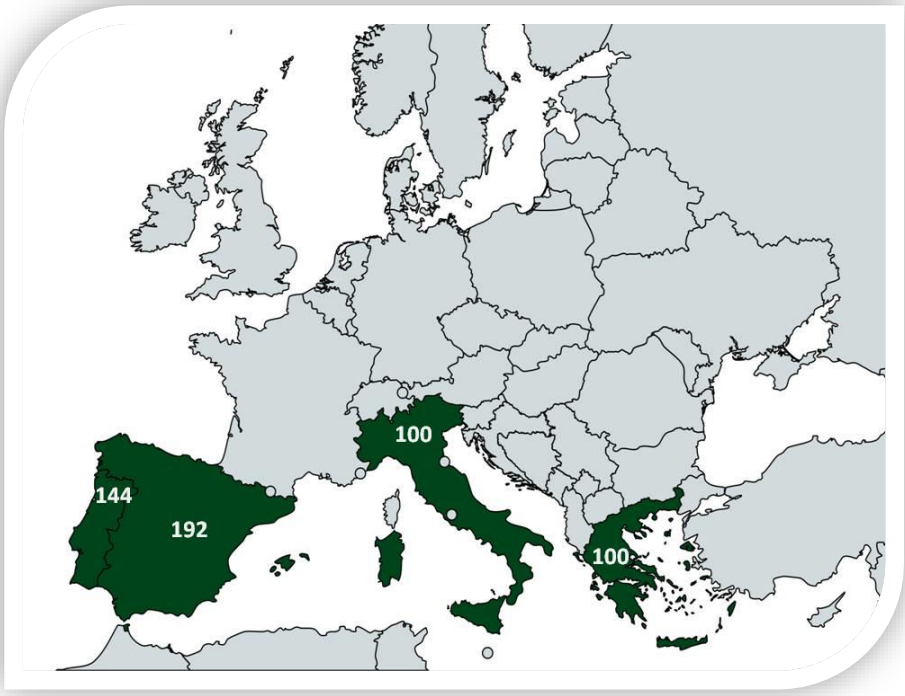


Figure 7. Distribution of the sample by country

Table 1. Description of the sample

Distribution of the sample by country	
Greece (100 questionnaires)	18.7%
Italy (100 questionnaires)	18.7%
Spain (192 questionnaires)	35.8%
Portugal (144 questionnaires)	26.9%
Socioeconomic characteristics	
Male (324 questionnaires)	60.4%
Female (209 questionnaires)	39.0%
Undergraduate students (352 questionnaires)	65.7%
Postgraduate students (167 questionnaires)	31.2%
PhD students (14 questionnaires)	2.6%

According to all groups of participants, future needs in PA training should target the gain of agronomical and environmental skills. Subsequently, training in managerial and environmental skills is important for PA researchers/experts. Tables 2-5 present the mean values per participant category and per country, while the next figure summarizes the averages of those mean values. It is worth mentioning that there is an absolute agreement in all countries as the average values among the students and the total average values in all countries follow the hierarchy of Fig. 8: Environmental, Agronomical, Managerial and Technological skills.

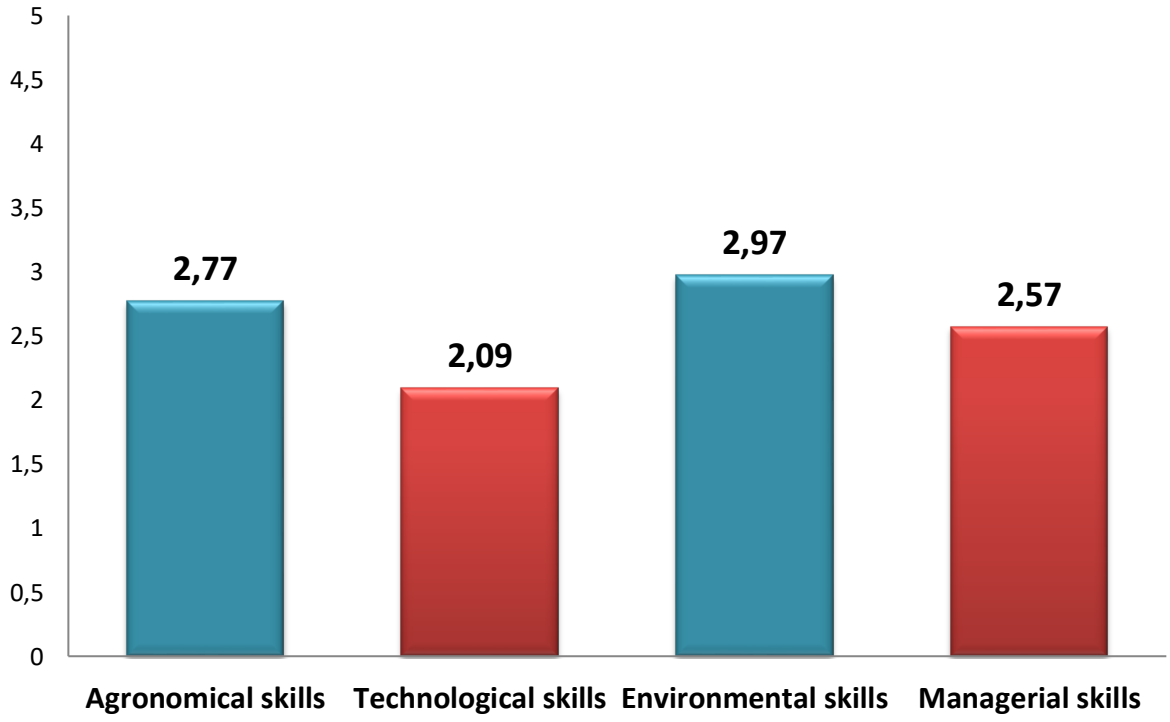


Figure 8. Future needs in PA skills (Average Mean Values)

Table 2. Future needs in PA Agronomical skills

Agronomical skills	Mean value				
	Italy	Greece	Spain	Portugal	Average
Experts	1.20	2.25	-	1.33	**1.59**
Students	3.93	4.07	4.14	4.24	**4.10**
Farmers	3.40	2.75	2.60	1.75	**2.63**
Average	**2.84**	**3.02**	**2.24**	**2.44**	**2.77**

(1=strongly disagree & 5=strongly agree)

Table 3. Future needs in PA Technological skills

Technological skills	Mean value				
	Italy	Greece	Spain	Portugal	Average
Experts	1.00	1.75	1.00	1.33	**1.27**
Students	3.79	3.91	1.01	3.81	**3.13**
Farmers	2.60	1.62	1.90	1.38	**1.87**
Average	**2.46**	**2.42**	**1.30**	**2.17**	**2.09**

(1=strongly disagree & 5=strongly agree)

Table 4. Future needs in PA Environmental skills

Environmental skills	Mean value				
	Italy	Greece	Spain	Portugal	Average
Experts	1.80	3.25	2.50	1.50	**2.26**
Students	3.99	3.59	4.07	3.78	**3.86**
Farmers	3.40	2.75	2.80	2.25	**2.80**
Average	**3.06**	**3.19**	**3.12**	**2.51**	**2.97**

(1=strongly disagree & 5=strongly agree)

Table 5. Future needs in PA Managerial skills

Managerial skills	Mean value				
	Italy	Greece	Spain	Portugal	Average
Experts	1.60	2.00	2.00	1.50	**1.77**
Students	3.59	3.59	3.59	3.74	**3.63**
Farmers	3.20	1.87	2.30	1.88	**2.31**
Average	**2.79**	**2.48**	**2.63**	**2.37**	**2.57**

(1=strongly disagree & 5=strongly agree)

The detailed responses of every subcategory within the previously shown skills-categories are presented in both Table 5 and Figure 6. It can be concluded that students and farmers mentioned

as a primary necessity training for the ability to choose right technologies, and solutions and working with processed data, respectively. More specifically, training for working with processed data is the most essential need for farmers, mainly for Spanish and Portuguese ones. For students, it is important to receive training on the reduction of waste production, as this option scored very high with students in Greece and Spain, as well as training on the knowledge of local ecosystems.

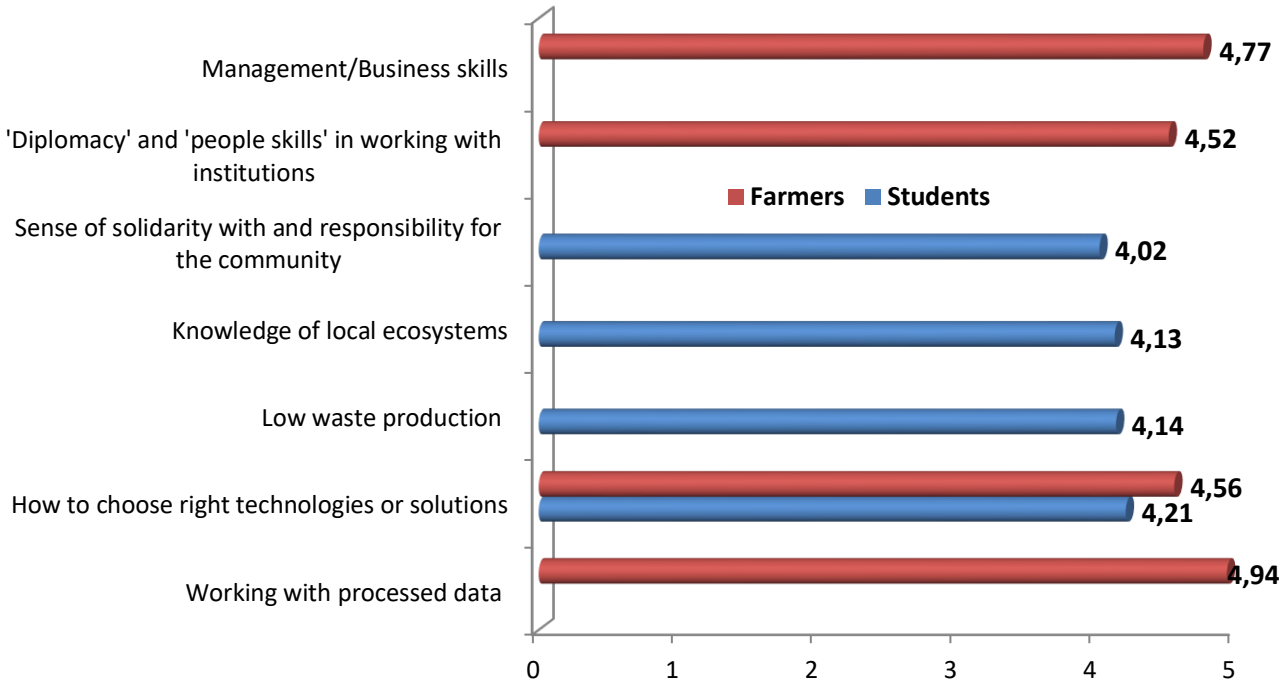


Figure 9. Students/Farmers received training rates

However, the specification and ranking of training needs per country is of greater value. Fig. 10 presents the average response rates (farmers and students) in each country from which the following interesting results are obtained: a) all three major training needs of Greek, Spanish and Portuguese respondents are included in the broader category “Training for Technological expertise –skills”, b) respondents from Italy mentioned in the top three positions hierarchically training needs from “Training for Managerial skills”, “Training for Local community leadership” and “Training for Technological expertise –skills”. Generally, the training needs included in the broader category “Training for Technological expertise –skills” have been ranked in higher positions when compared with the rest of the training needs included in other categories.

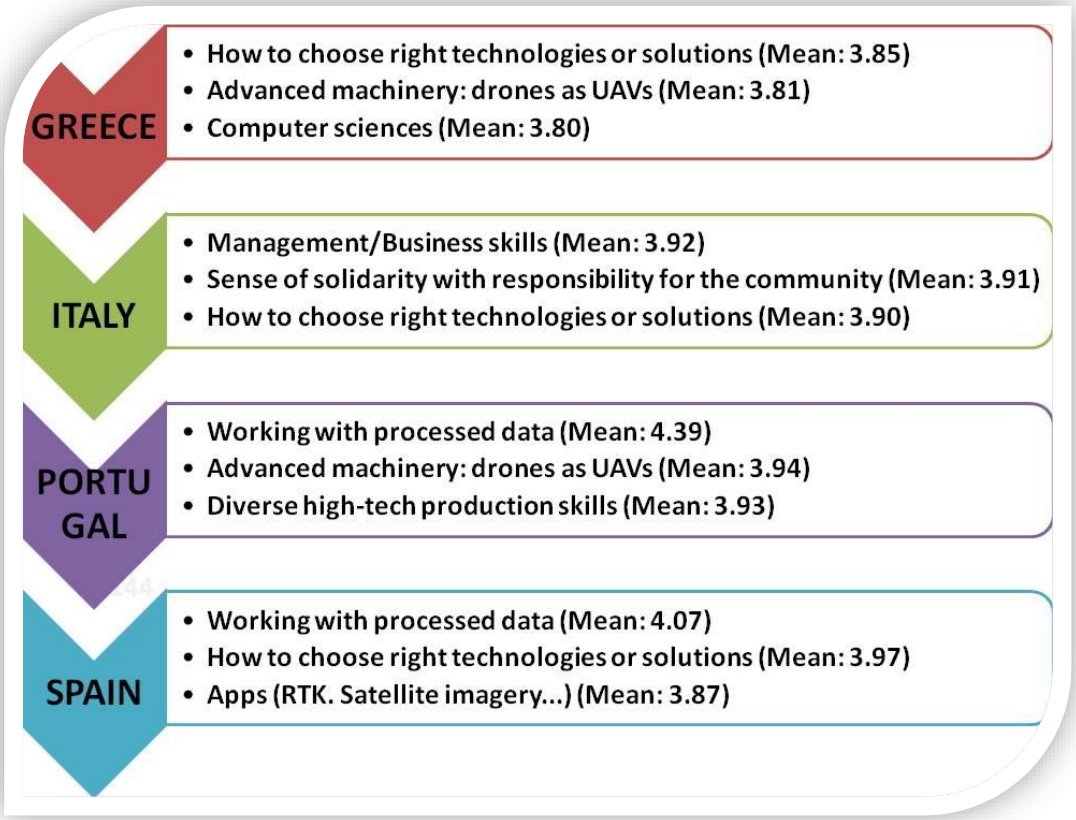


Figure 10. Most important training needs per country (Mean scores of farmers and students)

Table 6. Rate your need for training to the following

	Greece		Italy		Portugal		Spain		Average	
	Students	Farmers	Students	Farmers	Students	Farmers	Students	Farmers	Students	Farmers
Training for Technological expertise -skills										
Aerial and on-ground crop imagery evaluation and analysis	3.64	2.75	3.52	**3.80**	4.07	3.75	3.99	3.43	3.81	4.38
Working with robots	2.98	2.37	3.02	3.50	3.70	4.00	3.58	3.29	3.32	4.17
Working with processed data	3.85	3.75	3.64	3.70	4.15	**4.63**	4.18	**3.96**	3.96	**4.94**
How to choose right technologies or solutions	4.13	3.57	**4.10**	3.70	**4.30**	3.63	**4.32**	3.63	**4.21**	**4.56**
Low waste production	**3.86**	3.12	4.08	3.50	4.24	2.88	**4.38**	3.23	**4.14**	4.06
Diverse high-tech production skills	3.79	3.12	3.59	3.10	4.12	3.75	4.04	3.46	3.89	4.13
Computer sciences	**3.86**	**3.75**	3.52	2.90	3.98	3.75	4.02	3.53	3.85	4.21
Advanced machinery: auto-steered equipment	3.71	2.75	3.44	3.40	3.96	3.63	3.85	3.09	3.74	4.07

Advanced machinery: drones as UAVs	3.75	**3.87**	3.65	3.20	3.88	4.00	3.82	3.76	3.78	4.51
Apps (RTK. Satellite imagery...)	3.77	3.71	3.66	3.40	3.99	3.38	3.92	3.83	3.84	4.43
Training for Legislative /environmental expertise -skills										
Understanding legislation	3.78	3.37	3.61	3.20	3.99	3.00	3.74	3.19	3.78	3.99
Dealing with bureaucracy	4.03	3.50	3.60	3.40	3.68	3.50	3.44	3.47	3.69	4.32
'Diplomacy' and 'people skills' in working with institutions	3.79	3.62	3.54	**3.60**	3.80	**3.63**	3.65	**3.62**	3.70	**4.52**
Expertise in circular agriculture	3.91	2.87	3.76	3.20	3.91	3.38	3.85	3.15	3.86	3.95
Knowledge of local ecosystems	**4.33**	2.75	**4.04**	3.40	**4.13**	3.25	**4.03**	3.13	**4.13**	3.98
Training for Local community leadership										
Knowledge of regional potential and regional growth	3.71	3.12	3.88	3.10	4.02	3.50	3.82	3.24	3.86	4.02
Insight into local needs	3.69	3.50	3.91	3.20	**4.13**	3.25	3.97	3.32	3.93	4.12
Communication	4.00	3.12	3.97	**3.80**	3.96	3.38	3.97	**3.43**	3.98	**4.38**
People management	4.02	3.25	3.73	3.60	3.96	3.38	3.84	3.41	3.89	4.31
Sense of solidarity with and responsibility for the community	**4.11**	2.62	**4.01**	**3.80**	3.99	**3.63**	**3.98**	3.35	**4.02**	4.30
Training for Managerial skills										
Marketing skills	**3.81**	**3.50**	3.53	3.40	3.61	3.00	3.55	3.17	3.63	4.12
Management/Business skills	3.80	3.12	**3.64**	**4.20**	**4.01**	**3.75**	**3.81**	**3.82**	**3.82**	**4.77**

(1=not efficient & 5=extremely efficient)

As shown in Fig. 11 and Table 7, knowledge sharing mechanisms are evaluated as extremely important by students and farmers in total. Especially Italian farmers and Portuguese students rate this option as very high. The respondent group of experts regards the experienced farmers who are treated as mentors as a prevailing form of learning/training.

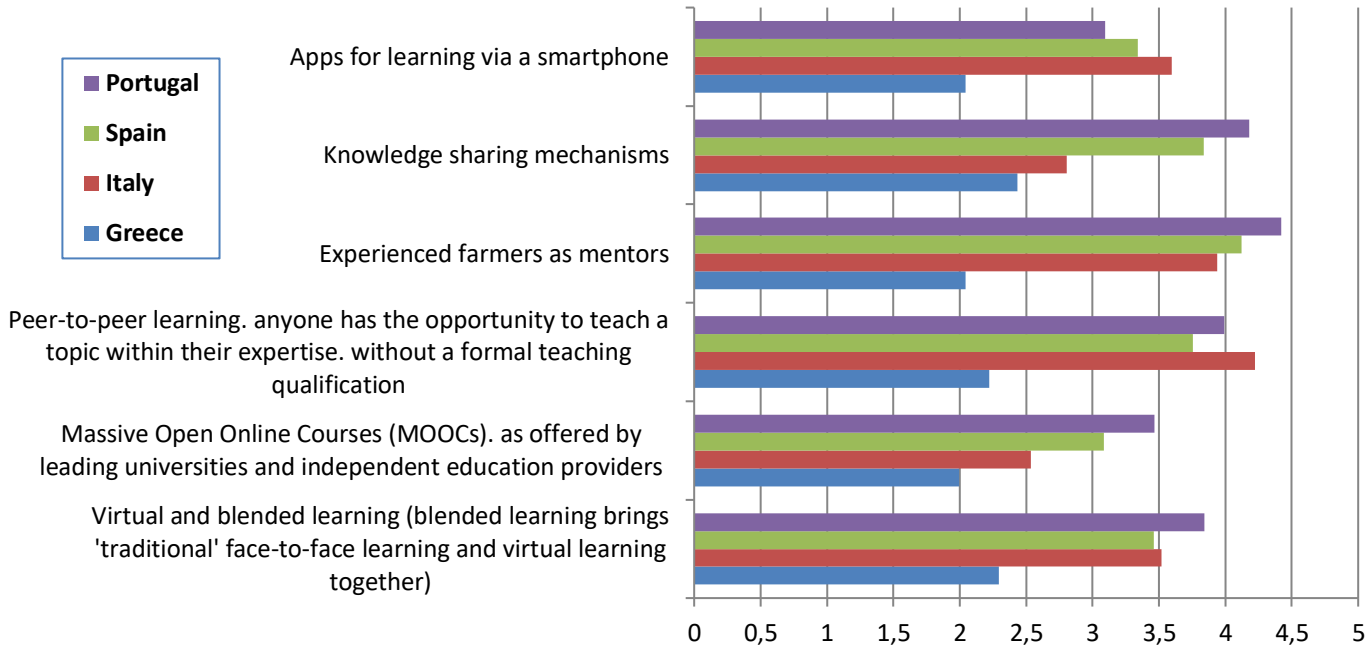


Figure 11. Forms of learning-training needed the most (Mean scores of farmers, experts and students)

Table 7. Forms of learning-training needed the most

Forms of learning/training	Group	Italy	Greece	Spain	Portugal	Average
Virtual and blended learning (blended learning brings 'traditional' face-to-face learning and virtual learning together)	Experts	1.70	3.75	3.50	**4.67**	3.83
	Students	1.69	3.44	3.52	3.61	3.49
	Farmers	**3.50**	3.37	3.37	3.25	4.25
Massive Open Online Courses, as offered by leading universities & independent education providers	Experts	1.20	1.75	2.75	4.17	2.77
	Students	1.79	3.49	3.83	3.60	3.63
	Farmers	3.00	2.37	2.67	2.63	3.42
Peer-to-peer learning. anyone has the opportunity to teach within their expertise, without a formal teaching qualification	Experts	1.70	**5.00**	**4.00**	4.33	4.18
	Students	1.66	3.55	3.54	3.89	3.57
	Farmers	3.30	4.12	3.72	3.75	4.55
Experienced farmers as mentors	Experts	2.20	4.25	**4.25**	**4.67**	**4.39**
	Students	1.89	3.63	3.99	4.17	**3.89**
	Farmers	-	-	-	-	-
Knowledge sharing mechanisms	Experts	1.90	1.00	3.75	4.50	3.26
	Students	1.80	3.80	4.06	4.16	**3.90**
	Farmers	**3.60**	3.62	3.70	3.88	**4.60**
Apps for learning via a Smartphone	Experts	1.50	3.25	3.00	2.50	2.94
	Students	1.53	3.34	3.59	3.78	3.44
	Farmers	3.10	4.20	3.43	3.00	4.21

(1=not efficient & 5=extremely efficient)

According to students and farmers the most efficient training methods are the practical courses and exercises, as well as the agriculturalist's visits to farms, with the latter highlighted by Greek and Italian participants. **The views of all categories of participants also converge in importance of field demonstrations as a training need**, which is mainly indicated by Spainish and Portuguese farmers and experts. Educational excursions were, also, evaluated high by students and farmers mainly in Italy, followed by the need of education training at the individual level/individual contact and the short-term seminars attending.

Table 8. Efficiency ranking of training methods (Mean scores)

Training methods	Group	Italy	Greece	Spain	Portugal	Average
Agriculturalist's visit in farms	Experts	3.60	5.00	4.00	4.00	4.15
	Students	**4.33**	**4.70**	4.31	4.44	**4.45**
	Farmers	**3.40**	**4.28**	2.02	4.38	**4.37**
Field demonstrations	Experts	4.40	4.75	4.25	4.83	**4.56**
	Students	4.26	3.75	**4.51**	**4.57**	**4.27**
	Farmers	3.70	4.33	**4.05**	**4.13**	**4.98**
Practical courses/exercise	Experts	2.80	4.50	4.25	5.00	4.14
	Students	4.22	4.28	4.14	4.42	**4.27**
	Farmers	3.50	4.33	4.11	4.50	**4.99**
Educational excursions	Experts	4.60	2.25	4.00	4.17	3.76
	Students	4.18	3.98	4.17	4.26	4.15
	Farmers	3.30	4.40	3.94	4.13	4.77
Farmer's visits to the agriculturalist's Office	Experts	3.40	3.00	3.50	3.50	3.35
	Students	3.79	3.74	4.01	4.03	3.89
	Farmers	2.80	3.00	3.06	3.38	3.76
Broadcasts on radio	Experts	2.20	2.00	3.00	3.33	2.63
	Students	2.72	2.79	2.94	2.97	2.86
	Farmers	2.60	2.14	2.29	2.13	2.94
Education at the individual level/individual contact	Experts	4.00	4.00	4.25	4.67	4.23
	Students	3.75	3.94	3.78	3.75	3.81
	Farmers	3.10	4.30	3.81	4.13	4.61
Short-term seminars	Experts	3.80	2.75	4.25	4.33	3.78
	Students	3.62	3.69	3.51	3.87	3.67
	Farmers	3.30	4.16	3.74	3.75	4.56
Lectures at physical meetings	Experts	2.20	1.75	3.25	3.67	2.72
	Students	3.39	3.75	3.44	3.85	3.61
	Farmers	2.70	4.00	3.23	3.00	3.91
Agricultural journals	Experts	3.20	2.25	3.25	4.17	3.22
	Students	3.57	3.39	3.64	3.81	3.60
	Farmers	3.00	2.57	3.27	4.25	4.02
On-line communication with agriculturalist	Experts	3.40	4.00	3.25	4.17	3.71
	Students	3.28	3.77	3.65	3.66	3.59
	Farmers	2.70	4.00	3.32	3.00	3.93

Creating newsgroups	Experts	3.20	2.50	2.75	3.83	3.07
	Students	3.37	3.72	3.35	3.50	3.49
	Farmers	3.20	3.71	3.43	3.38	4.23
On-line courses/E-learning	Experts	2.20	1.50	2.75	3.83	2.57
	Students	3.19	3.45	3.27	3.42	3.33
	Farmers	2.70	3.00	2.80	3.00	3.55
Helpline Instructions	Experts	2.80	3.25	2.75	3.50	3.08
	Students	3.14	3.13	3.21	3.29	3.19
	Farmers	3.00	3.00	3.13	3.38	3.88
Articles in newspapers	Experts	2.40	2.50	3.00	3.83	2.93
	Students	3.11	2.90	3.25	3.34	3.15
	Farmers	3.10	2.28	2.92	3.38	3.70
Television broadcasts	Experts	3.00	1.75	3.50	3.33	2.90
	Students	2.94	2.79	3.21	3.48	3.11
	Farmers	2.50	2.14	2.63	3.25	3.26
Information in the form of forms-brochures	Experts	2.40	1.75	3.00	3.50	2.66
	Students	2.75	2.83	2.88	3.14	2.90
	Farmers	2.40	1.85	2.33	2.75	2.93
DVD	Experts	1.80	1.50	2.25	3.33	2.22
	Students	2.52	2.64	3.32	2.95	2.86
	Farmers	2.10	1.86	2.40	3.25	2.93

(1=not efficient & 5=extremely efficient)

As shown in Fig. 12 **"Field demonstrations", "Practical courses/exercises" and "Agriculturalist's visits in farms" are evaluated as the most efficient training methods.** More specifically, a) respondents from Greece mentioned as most efficient the "Practical courses/exercises", b) respondents form Portugal and Italy mentioned as most efficient the "Field demonstrations" and c) respondents form Spain mentioned as most efficient the "Agriculturalist's visits in farms".

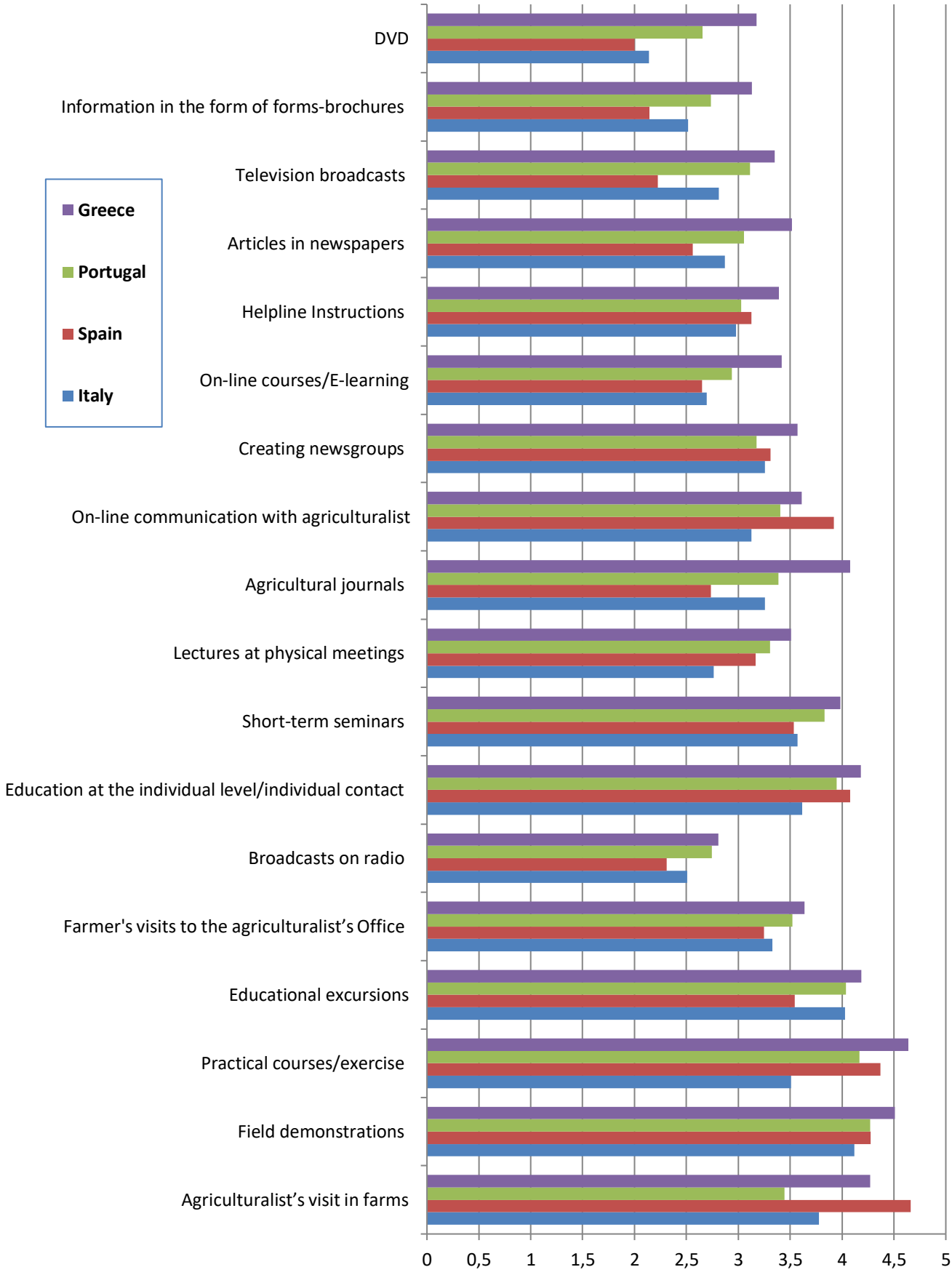


Figure 12. Efficiency of training methods (Mean scores of farmers, experts and students)

Regarding the appropriate time for getting training in PA, the majority of respondents consider it is before the implementation of the PA, with the sole exception of the Portuguese farmers. They regard that the best time is during the implementation of the PA. Students agree, to a very low percentage, that it is also possible to get training in PA even after a short period of trial and error on their own. The results are summarized in Table 9.

Table 9. Best moment for training in PA

Best time to get training in PA	Group	Greece	Italy	Portugal	Spain
Before the implementation of the PA	Experts	-	-	-	-
	Students	**54%**	**72%**	**62%**	**60%**
	Farmers	**62.50%**	**60%**	37%	**57%**
During the implementation of the PA	Experts	-	-	-	-
	Students	43%	21%	25%	35%
	Farmers	12.50%	40%	**63%**	37%
After a short period of trial and error on my own	Experts	-	-	-	-
	Students	3%	7%	1%	2%
	Farmers	12.50%	-	-	3%
Not answered	Experts	-	-	-	-
	Students	-	-	12%	3%
	Farmers		-	-	-
Before and during the implementation of the PA	Experts	-	-	-	-
	Students	-	-	-	-
	Farmers	12.50%	-	-	3%

As it is shown in Table 10, almost half of the Greek, Portuguese and Spanish students are willing to pay a fee for Massive Open Online Courses (MOOCs), offered by leading universities and independent education providers, while 40% of the Italian ones expressed relative neutral willingness.

Farmers mostly consider it likely that they would be willing to pay for MOOCs (44.2%), with a percentage as high as 58% for Spanish farmers. Subsequently, 39.5% of farmers regard it as extremely unlikely to pay for online courses, where the Italian farmers reach the highest percentage with 77.8%. On quite the contrary, one out of four Greek farmers express an absolute probability for paying for Massive Open Online Courses.

Table 10. Willingness to pay (WTP) for MOOCs offered by leading universities and independent education providers

WTP for MOOCs	Group	Greece	Italy	Portugal	Spain	Total
Extremely unlikely	Students	9.0%	8.0%	4.0%	6.0%	6.8%
	Farmers	25.0%	77.8%	37.0%	18.0%	39.5%
Unlikely	Students	6.0%	20.0%	17.0%	16.0%	14.8%
	Farmers					
Neutral	Students	27.0%	**40.0%**	33.0%	29.0%	32.3%
	Farmers					
Likely	Students	**41.0%**	29.0%	**38.0%**	**42.0%**	37.5%
	Farmers	37.5%	-	37.0%	58.0%	44.2%
Extremely likely	Students	17.0%	3.0%	4.0%	6.0%	7.5%
	Farmers	25.0%	11.1%	13.0%	12.0%	15.3%
Not answered/I do not know	Students	-	-	4.0%	1.0%	2.5%
	Farmers	12.5%	11.1%	13.0%	12.0%	12.2%

3.2 Multivariate statistical analysis

Having accepted the consistency of the 14 items of Table 11, the average scores for each respondent were used as the numerical values of the dependent variable "Subjective indicator of familiarity with PA" which along with the categories of fourteen independent variables are shown in Table 11. This is a very important variable, created from the data of Table 11, which expresses the level of interest and knowledge of each respondent in sustainable precision farming issues.

Investigating further the "Subjective indicator of familiarity with PA" a CATREG model was employed in order to find out how "Subjective indicator of familiarity with PA" influenced by a set of personal characteristics of the respondents and other variables (Table 12). The employed CATREG model yielded a R^2 value equal to 0.866 indicating significant relation between the "Subjective indicator of familiarity with PA" and the group of selected predictors (86.6% of the variance in the "Subjective indicator of familiarity with PA" rankings is explained by the regression of the optimally transformed variables used). The F statistic value 3.430 with α=0.00 indicating an always performing well model.

Table 11. Subjective indicator of familiarity with PA

Independent variables
1. Level of knowledge towards PA
2. Level of current Technological expertise (knowledge on new technology and equipment)
3. Level of current Legislative expertise (knowledge on laws, regulations and provisions)
4. Level of current Local community leadership (knowledge on opinion leadership/detection of the influencers in a local community)
5. Level of current Business management skills (do you have skills/expertise in Business Management?)
6. Level of current Innovation management (do you have skills/expertise in Innovation Management?)
7. Level of current Marketing skills (do you have skills/expertise in Marketing?)
8. Level of current Sustainability (Knowledge on sustainability issues and circular agriculture)
9. Level of current Local ecosystems (knowledge of local ecosystems)
10. Level of knowledge towards Soft PA
11. Level of knowledge towards Hard PA
12. Level of Interest towards Hard PA
13. Level of Interest towards Soft PA
14. Level of knowledge about Intelligent machinery (precision seeding, section control for sprayers)

Type: Ordinal, where: 1=none, 2=small, 3=medium, 4=high, 5=very high

The relative importance measures (Pratt, 1987) of the independent variables show that the most influential factors predicting "Subjective indicator of familiarity with PA" correspond to socioeconomic characteristics and particularly to the following in hierarchical order: a) country (17.1%), b) educational lever (11.5%) and c) gender (11.0%). However, the additive importance of estimated independent variables accounts for not more than 40%.

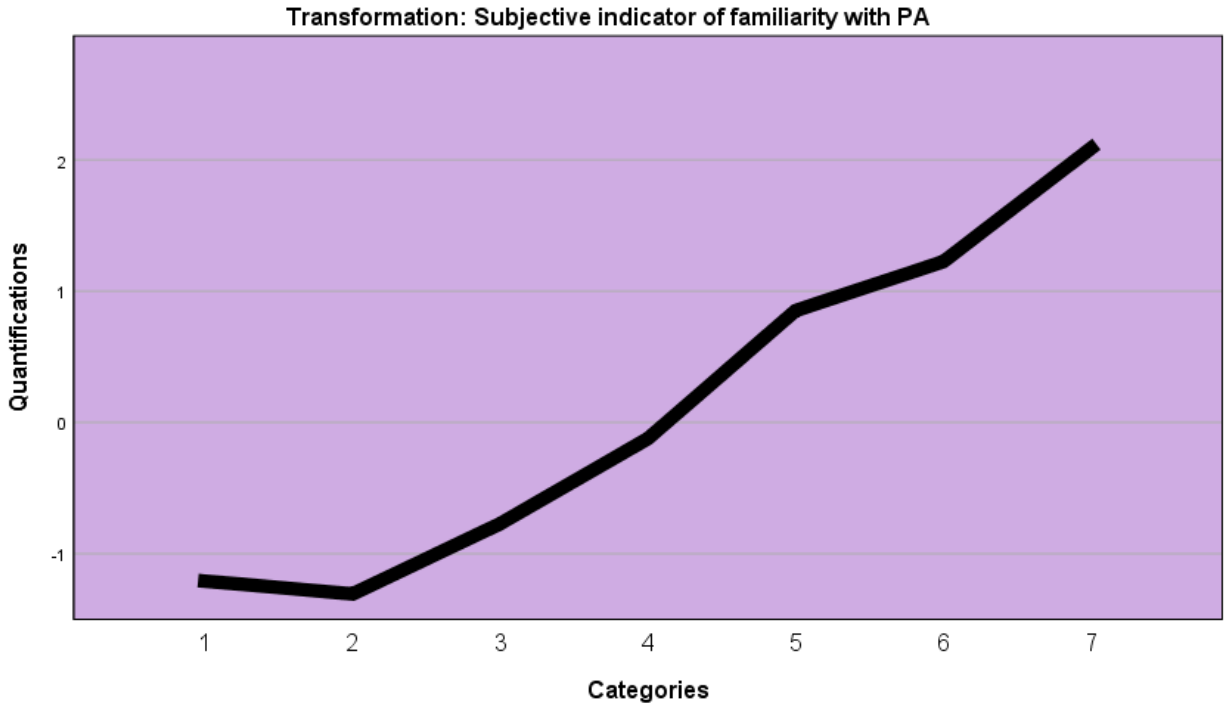
Table 12. Relative Importance Measures

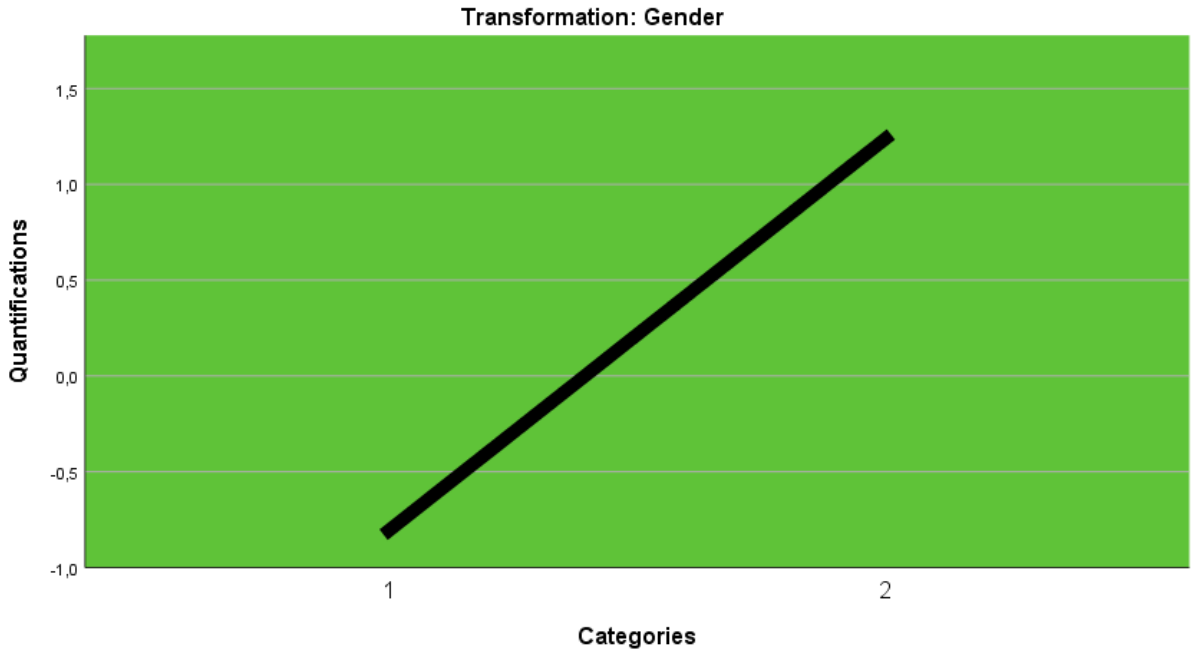
	Correlations				Tolerance	
	Zero-Order	Partial	Part	Importance	After Transformation	Before Transformation
1. Gender	-,200	-,209	-,174	**,110 *****	,895	,880
2. Age	,146	,133	,110	,052 **	,853	,756
3. Educational level	,198	,216	,180	**,115 *****	,873	,742
4. Country	,205	,273	,232	**,171 *****	,695	,682
5. Willing to pay a cost for a MOOCs	,152	,070	,057	,028	,837	,842
6. When do you think is the best time to get training in PA?	-,067	-,099	-,081	,017	,938	,923
7. PA increases productivity	,211	,066	,054	,044 **	,614	,591
8. Life-long learning would be necessary to keep up with the speed of PA	,175	,043	,035	,022	,718	,624
9. PA contributes to lower production costs	,224	,082	,067	,073 **	,384	,478
10. PA results in improved income	,162	-,065	-,053	-,040 *	,425	,488
11. PA requires high investment	,039	-,065	-,053	-,007	,766	,577
12. PA requires great economical risk	,045	,038	,031	,005	,655	,673
13. PA primary products are safe	,152	,144	,119	,062 **	,777	,642

14. PA products are safe	-,033	-,078	-,064	,007	,865	,583
15. PA primary products are of high nutritional value	,091	-,104	-,086	-,031	,581	,467
16. PA protects the environment	,190	,087	,071	,055 **	,537	,410
17. PA improves the sustainable management of land parcels	,010	,138	,114	,004	,732	,741
18. I prefer conventional farming methods	,038	-,152	-,126	-,018	,635	,565
19. PA requires relevant information	,131	,041	,034	,016	,687	,502
20. PA requires relevant education/training	,104	,106	,087	,031	,775	,750
21. PA requires young age	-,142	-,196	-,163	,081 **	,728	,724
22. I cannot familiarize myself with PA methods	,154	,172	,142	,098 **	,448	,356
23. Successful examples of other farmers influence my adoption of PA methods	,046	-,114	-,094	-,020	,430	,353
24. PA requires innovativeness by farmers	,066	,059	,048	,012	,682	,704
25. Business consultants influence my adoption of PA methods	,122	,104	,085	,041 *	,578	,592
26. Government/public incentives influence my adoption of PA techniques	,132	,095	,078	,037 *	,677	,658
27. PA is now necessary	,132	,129	,106	,048 **	,761	,639
28. PA would improve my social position	,041	-,124	-,102	-,015	,727	,662

Dependent Variable: Subjective indicator of familiarity with PA

However, the relative importance measures cannot indicate the direction of the above mentioned dependence although they can predict the contribution of each independent variable on the dependent one. A better prediction of “Subjective indicator of familiarity with PA” can be given by the transformed plots (Fig. 13) of the main independent variables that present the higher relative importance measures (more than 0.100). In these plots the original category values are displayed on the x-axis, and the obtained category quantifications on the y-axis. The higher quantification received by the original category, the greater the contribution of this category in the interpretation of the dependent variable (Subjective indicator of familiarity with PA). The most influential factors predicting the “Subjective indicator of familiarity with PA” are “Gender” (1=Male & 2=Female), “Country” (1=Greece, 2=Spain, 3=Italy & 4=Portugal), and “Educational Level” (1=Undergraduate students, 2=Postgraduate students & 3=PhD students). That means that the most familiar students with PA are the female PhD candidates from Portugal.


Transformation: Subjective indicator of familiarity with PA
Quantifications
2
1
0
-1
1
2
3
4
5
6
7
Categories


Transformation: Gender
Quantifications
1,5
1,0
0,5
0,0
-0,5
-1,0
1
2
Categories

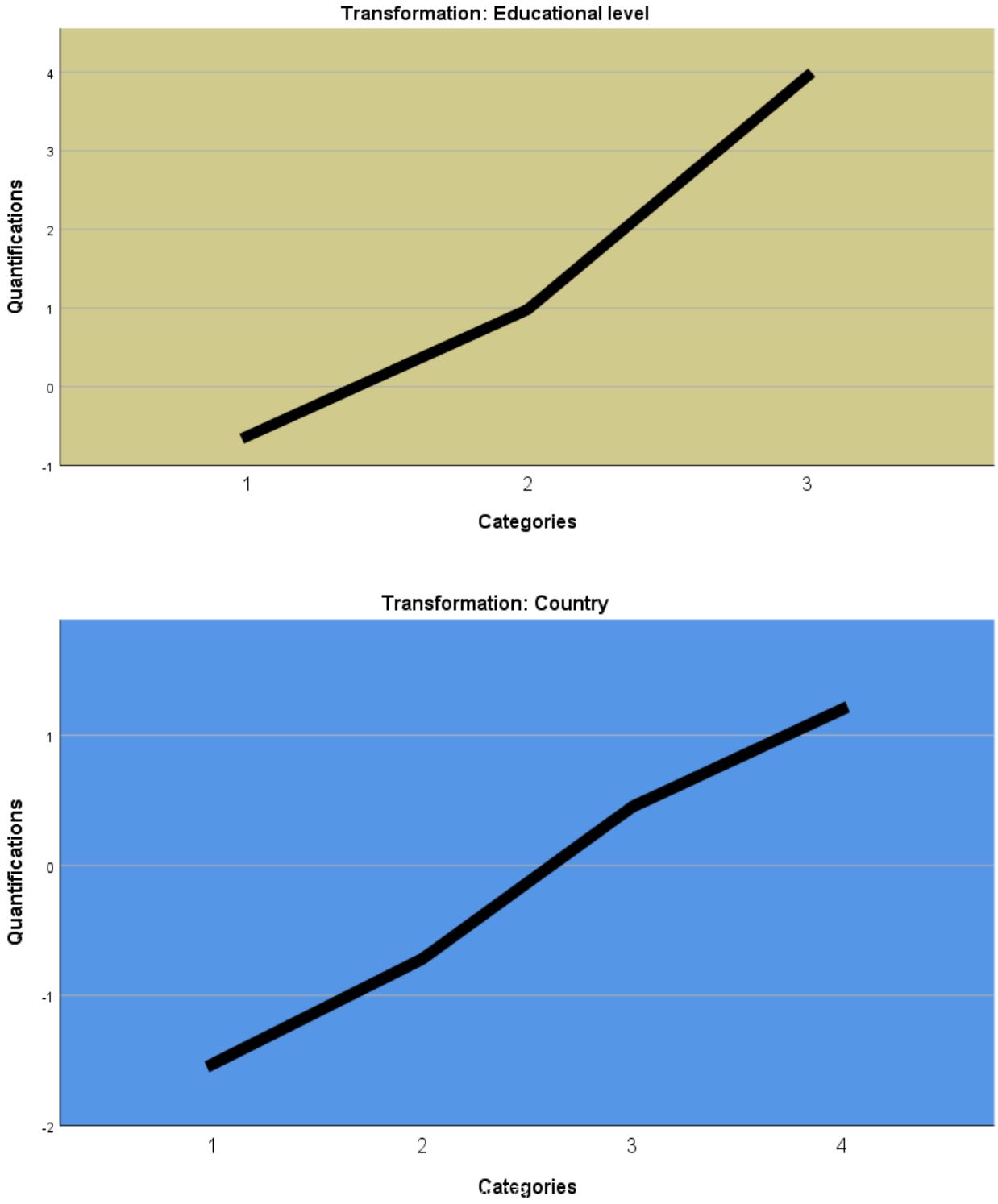


Figure 13. Transformed Plots

In order to segment the sample in several clusters of respondents and to explore the different levels of their "familiarity with PA" a TSCA was used, based upon the scales of all variables. This methodology allows verifying or rejecting the generalizations of Rogers' Diffusion Theory (Rogers, 1995). In this case the TSCA method extracted automatically the optimal solution of five clusters

supporting the Rogers theory. In particular, the majority of respondents (138 or 27.9%) were included in the fourth cluster, 114 (23.1%) were included in the second cluster, 84 (17.0%) were included in the third cluster, 80 (16.2%) were included in the fifth cluster, 78 (15.8%) were included in the first one and 42 respondents are not included in any cluster as they exhibit individual behavior and they are not grouped together (Fig. 14).

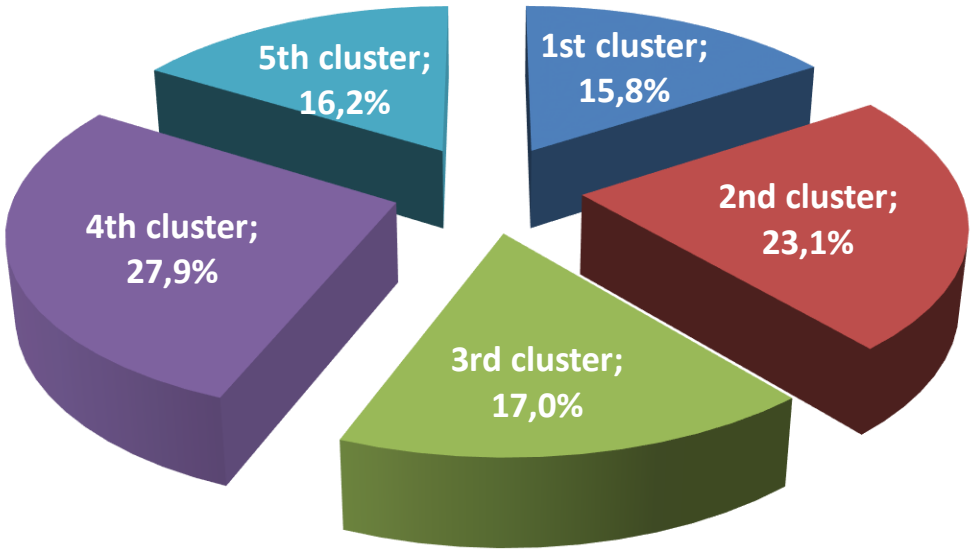


Figure 14. Distribution of respondents by cluster

Regarding the distribution of observations in the clusters above, depending on the predictors of "familiarity with PA", it is shown that the first cluster constitutes mainly "laggards" (mean value of familiarity with PA=1.94). On the other hand, the second cluster constitutes the "innovators" (mean value of familiarity with PA=3.10), the third cluster is constitutes the "early adopters" (mean value of familiarity with PA=2.91), the fourth cluster constitutes the "early majority" (mean value of familiarity with PA=2.44). Finally, the fifth cluster constitutes the "late majority" (mean value of familiarity with PA=1.99).

In particular, Table 13 presents the paramount socioeconomic characteristics of the members of each cluster. According to the analysis the "Innovators" are male, postgraduate students, from Italy, almost 26 years old. The "Early adopters" are male, undergraduate students, from Portugal, almost 25 years old. The "Early majority" are male, undergraduate students, from Spain, almost 23 years old. The "Late majority" are male, undergraduate students, from Greece, almost 23 years old and the "Laggards" are Female, undergraduate students, from Spain, almost 23 years old. It's obvious that there is a very strong relation between "Age" and "Familiarity with PA" and between "Country"

and “Familiarity with PA”. Indeed, the older students from Italy and Portugal are more familiar with the PA issues.

Table 13. Respondents’ characteristics in each cluster

Variables	“innovators” second cluster (23.1%)	“early adopters” third cluster (17.0%)	“early majority” fourth cluster (27.9%)	“late majority” fifth cluster (16.2%)	“laggards” first cluster (15.8%)
Gender	Male	Male	Male	Male	Female
Mean Age	25.89	24.75	22.90	23.34	22.74
Country	Italy	Portugal	Spain	Greece	Spain
Education	Postgraduate	Undergraduate	Undergraduate	Undergraduate	Undergraduate
Familiarity with PA	3.10	2.91	2.41	1.99	1.94

4. CONCLUSIONS

This section presents the policy implications of the analysis results as well as answers to the main questions which were initially set as important in the introduction section. In particular, this section presents the clustering characteristics of the sample according to the generalisations of Rogers' Diffusion Theory which are important tools for designing specialized training programs for each cluster. This methodology creates more efficient training programs tailored to the needs of each cluster, as opposed to a general program for the whole population.

This report provides important insights in the PA research from both methodological and content viewpoint. In particular methodologically it provides a novel framework for survey analysis which allows in-depth analysis, typology of the sample based on the dominant theories and interpretation of the results. From content point of view this report helps make PA closer to agripreuners, researchers, farmers and students helping to reduce their training gap. More specifically, using the results of this report a common training framework can be designed that can cope with the potential threats from precision farming and autonomy of individual European farmers in a pragmatic, inclusive and dynamic manner. Moreover, it answers the following fundamental questions for the effective implementation of the SPARKLE project:

1. **"Why is training needed"?** An important knowledge/skills gap is detected, especially between students and PA researchers/farmers. In addition, almost all of the survey participants recognize the importance of PA training, especially in agronomical and environmental skills.
2. **"How will training cure the problems identified"?** According to the students' data analysis, the major problem is "How to choose the right technologies or solutions". On the other hand, farmers mentioned a major problem for "Work of the processed data". This report reveals and suggests some knowledge mechanisms and training methods to overcome these problems and to design effective and efficient training material.
3. **"What is the best way to get the best results"?** Practical courses/exercises, field demonstrations and agriculturalists' visits to farms yield the best results according to farmers, students, and PA researchers/experts, respectively. It iss also worth noting that

almost half of the Greek, Portuguese and Spanish students are willing to pay a fee for Massive Open Online Courses (MOOCs).

4. **"When should training take place"?** The results show that "before the implementation of the PA" is the preferred moment.

According to students and farmers the most efficient training methods are the practical courses and exercises, as well as the agriculturalist's visit in farms. The last option was highlighted by Greek and Italian participants. The views of all categories of participants also converge in the importance of field demonstrations as a training need, which is mainly indicated by Spanish and Portuguese farmers and experts. Educational excursions were also evaluated high by students and farmers mainly in Italy, followed by the need of education training at the individual level/individual contact and the short-term seminars attending.

Having accepted the validity and reliability of all items of this report, statistical analysis offered the potential to discover statistical relations that are not obvious through descriptive statistical analysis. For this purpose, a new numeric variable was created "Subjective indicator of familiarity with PA", which was the dependent variable in the multivariate analysis. Firstly, a CATREG Model has been employed in order to explain the nature and characteristics of this new important variable. According to the empirical modelling the most influential factors predicting the "Subjective indicator of familiarity with PA" are "Gender" (2=Female), "Country" (4=Portugal), and "Educational Level" (3=PhD students). That means that female PhD students from Portugal are the most familiar ones [having a very strong statistical relation] with the PA issues (knowledge and interest).

On the other hand, the TSCA results of this report support the generalizations of Rogers' Diffusion Theory (Rogers, 1995). More specifically the TSCA extracts automatically the five clusters of Rogers' Theory with the following characteristics:

- The "**Innovators**" (23.1%) are male, postgraduate students, from Italy, almost 26 years old. Most important training needs: a) Management/Business skills, b) Sense of solidarity with responsibility for the community and c) How to choose right technologies or solutions.
- The "**Early adopters**" are male, undergraduate students, from Portugal, almost 25 years old. Most important training needs: a) Working with processed data, b) Advanced machinery: drones as UAVs and c) Diverse high-tech production skills.

- The "**Early majority**" are male, undergraduate students, from Spain, almost 23 years old. Most important training needs: a) Working with processed data, b How to choose right technologies or solutions and c) Apps (RTK. Satellite imagery...).
- The "**Late majority**" are male, undergraduate students, from Greece, almost 23 years old. Most important training needs: a) How to choose right technologies or solutions, b) Advanced machinery: drones as UAVs and c) Computer sciences.
- The "**Laggards**" are Female, undergraduate students, from Spain, almost 23 years old. Most important training needs: a) Working with processed data, b How to choose right technologies or solutions and c) Apps (RTK. Satellite imagery...).

From a practical point of view the compatibility of this report results with the Rogers' Theory regarding the diffusion of innovations (or changes in general including training) recommends the creation of separate training programs for each cluster as the generalized treatment will cost a great deal and little benefit. **This report clarifies the specific training needs in each cluster and country where the training material should be focused.** Moreover, it is very important that **there are no great differences among the answers of students, experts and farmers in each country but mainly among countries**. This finding confirms and increases the value of the proposed methodology and suggests a behavior' concord of the stakeholders involved in this report. Thus, **any generalitasion effort of the results is more than acceptable and will lead to useful policies** although it should be done in a very cautious way.

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