



18-21 June 2019, Acireale (Italy)

Factors pertaining the gap between research and practice: The case of innovative spraying equipment

Alex Koutsouris¹, Emilio Gil², Paolo Balsari³, Sebastien Codis⁴, David Nuyttens⁵, Spyros Fountas¹, Vassiliki Kanaki¹

¹ Agricultural University of Athens, Greece, koutsouris@aua.gr

² Universitat Politècnica de Catalunya, Spain, Emilio.gil@upc.edu

³ Università degli Studi di Torino, Italy, paolo.balsari@unito.it

⁴ Institut Français de la Vigne et du Vin, France, sebastien.codis@vignevin.com

⁵ Instituut voor landbouw en visserijonderzoek, Belgium, david.nuyttens@ilvo.vlaanderen.be

Abstract

Purpose: This work in progress aims at identifying groups of farmers with similar characteristics that relate to farmers' perceptions and adoption of innovative spraying equipment.

Design/Methodology/approach: Data were drawn from farmers' survey in seven EU hubs in the framework of INNOSETA project; Multiple Correspondence Analysis (MCA) and Cluster Analysis were utilized for data analysis.

Findings: Five groups of farmers have been identified showing differences in farms' and farmers' characteristics and general perceptions focusing on their perceptions and the adoption of innovative spraying equipment.

Practical/Theoretical/Political Implications: Agricultural stakeholders need to gain deeper knowledge of farmers' characteristics and needs in order to bridge the gap between research developments and the actual use of the available equipment by farmers.

Keywords: Innovative spraying equipment, adoption, farmers' groups, INNOSETA project, Multiple Correspondence Analysis



18-21 June 2019, Acireale (Italy)

Introduction¹

Plant Protection Products (PPP) industry and research have been developing more sustainable, novel PPPs; at the same time, spraying technologies have experienced important improvements in terms of efficiency and safety, including in their development the latest advances in electronics, data management and safety aspects. But unfortunately, there is still an important gap between research developments and the actual use of the available equipment by farmers, especially the large number of small and medium producers with limited access to relevant information. If this gap closes, then European agriculture could become more sustainable with minimum environmental, socioeconomic and human health impact. Therefore the need for agricultural stakeholders to gain knowledge of existing and future technological advancements in spraying technology as well as of adequate training in all of the European territory which will allow for the implementation of the EU legal framework and thus the production of food in a better and more sustainable way.

The H2020 project INNOSETA is organized to explore spraying application needs in the most commonly used crops (cereals, vegetables, orchards, vineyards and greenhouses) in seven European hubs (see below). The aim of INNOSETA is to set-up a Thematic Network on “Innovative Spraying Equipment, Training and Advising” designed for the effective exchange between researchers, industry, extension services and farming community. This network will link directly applicable research and commercial solutions and grassroots level needs and innovative ideas thus contributing to close the research and innovation divide in this area.

¹ See INNOSETA project proposal.



18-21 June 2019, Acireale (Italy)

Among others, the INNOSETA project aims at assessing end-users' needs and interests and at identifying the factors that influence farmers' generation shift, adoption and diffusion of SETA. In this paper some of the results of the on-going data analysis, collected through farmers' survey (see below) are presented particularly concerning the identification of farmers' groups with similar characteristics.

Methodology

Our study covered 7 different European hubs: France, Greece, Italy, The Netherlands and Belgium, Poland, Spain, and Sweden. Five cropping systems were selected throughout all regions, i.e. arable crops, open field vegetables, orchards, greenhouses and vineyards (Table 1).

Table 1. Cropping systems per hub.

Spain	Orchards, Vineyards, Greenhouses
Italy	Orchards, Vineyards, Cereals
France	Orchards, Vineyards, Cereals
Greece	Orchards, Vineyards, Greenhouses
The Netherlands & Belgium	Cereals, Vegetables, Greenhouses
Sweden	Cereals, Vegetables, Orchards
Poland	Cereals, Vegetables, Orchards

Source: INNOSETA Grant Agreement

According to the project's Grant Agreement a) attention should be given to the fact that both adopters and non-adopters are included in the sample; b) the objective is to account and grasp the different needs and priorities of farmers in relation to their different socio-economic characteristics; and c) up to 50 interviews with farmers from the pre-classified groups should be conducted by the national partners, either personal or telephonic, using the specifically designed for this project questionnaire. Therefore, in the first place, it was decided to interview 50 farmers in each hub, comprising 25 adopters and 25 non-adopters per hub. Following, based on the contribution (%), in terms of utilized agricultural area (UAA), of each of the selected cropping systems per country a

first estimation of the sample (no of farms/farmers per cropping system per country) was made. In order to grasp differences, we categorized the population (total number of farms/farmers) in each cropping system into size classes (ha.) following EUROSTAT 2013 data sets. Thus, based on the EUROSTAT 2013 data concerning the farm size classes for each of the cropping systems per country, a detailed sampling schedule (no of farms/farmers per size per cropping system per country) was put together. Finally, in order to have enough farms/farmers in the least represented cropping systems (ca 10 farms/farmers in each hub and around 30 farms/farmers in total with respect to each of greenhouses, open field vegetables and vineyards), with a view to data analysis, the sample was adjusted as shown in Table 2 (following again the farm size classes rationale in order to select farms/farmers).

Table 2. INNOSETA sampling (farmers' survey)

	Initial sampling	Adjusted sampling	Collected questionnaires
Cereals	200	144	142
Open field vegetables	18	34	29
Orchards	104	102	101
Greenhouses	10	32	32
Vineyards	24	40	44
TOTAL	356	352	348

For data analysis the packages SPSS for Windows (ver 23.0) and SPAD (ver5.5) were used. Analysis was at both univariate (frequencies) and multivariate level. For the latter Multiple Correspondence Analysis (MCA) and Cluster Analysis were utilized. For MCA 50 variables (nominal and ordinal) were used comprising 163 classes or modalities; 32 of them (112 classes) are considered as active variables, that is, variables from which the factorial axes were extracted. The



18-21 June 2019, Acireale (Italy)

remaining 18 variables (51 classes) were not taken into account in the calculation of the inertia (variance) comprising the supplementary variables. Furthermore, Cluster Analysis on the coordinates of the 10 factorial axes resulted in five (5) groups of farms. The description of the 5 (five) groups is based on a mathematical criterion concerning the modalities characterizing each group, i.e. the modalities whose frequency is significantly larger in the group than the (average) frequency in the total sample (Lebart et al., 2002; Behrakis, 1999; Morineau and Morin, 2006). Moreover, it is possible to use the modalities with percentage larger than 60% in the group to characterize the group (Morineau and Morin, 2006); these modalities are presented as group characteristics in the Tables concerning the Groups (Results section).

Results

Sample features

As aforementioned the sample comprises 142 farmers cultivating cereals, 29 farmers with open field vegetables, 101 farmers with orchards, 44 farmers with vineyards and 32 farmers with greenhouses. Farming is the primary occupation for 81.3% of the interviewees. The interviewed farmers are mainly located in flat areas (68.7%) as compared to the ones located in hilly and mountainous areas (29.9% and 1.4% respectively).

The majority of the interviewed farmers operate their own family farm (83%). Companies represent 16% and cooperative farms 1% of the sample. In terms of the contribution of income from agricultural activities to the total family income, the majority of the interviewees depends on agriculture (54.3% between 91% and 100%) while 28.4% earn up to 50% of their family income from agriculture and 17.3% between 51% and 90%.



18-21 June 2019, Acireale (Italy)

The majority of the interviewees fall in the age category 40-59 years old (55%); farmers up to 40 years old account for 28% of the sample with farmers aged 60 years old and over being the 17% of the sample. Up to 10 years of experience in farming have 24% of the sample farmers with 29% having more than 30 years in farming. All other classes of experience (11-20 and 21-30) account, each, for 19-28% of the farmers.

Farmers said they were engaged with farming because they chose to (48%) or due to tradition – family tradition and/or farm inherited (42%). Most farmers (54.8%) have identified a successor who will inherit and/or take over the farm.

In general, the interviewed farmers have good (secondary 26% and technical 42%) to high educational level (university 22%). This, as expected, differs between the countries involved in the survey. Furthermore, 93.6% hold the Training Certificate on PPP use according to the Directive 2009/128/EC while 61% have attended training courses in spraying machinery.

Among the interviewees 20% declared that they are engaged with on-farm non-agricultural activities. The most popular on-farm activities found on these farms are (agri-)tourism (27%), direct sales (23%), processing, packaging and storage (17%) and machinery subcontracting (10%).

The majority of the interviewed farmers (55.5%) participate in a certification scheme. Most of the farmers participate in Global GAP and/or Integrated Production schemes (65.7%), followed by farmers engaged in PDO/PGI schemes (19.7%) and farmers engaged in organic farming (14.6%).

The majority of the farmers in the sample receive direct payments (85.5%) while 45.4% receive other subsidies (Pillar 2 of the CAP). The latter mainly concern environmental schemes



18-21 June 2019, Acireale (Italy)

(36%) and organic farming (11%), modernization/investment schemes (25%), and the young farmers' measure (13%).

The majority of the farmers are satisfied (57%) or very satisfied (29%) with farming. On the contrary, 14% are dissatisfied (with 4% being very unsatisfied).

The vast majority of the farmers own the spraying equipment they use (93%). In 20 out of the 348 cases farmers use a subcontractor (in 15 cases along with the use of their own equipment by themselves).

Concerning the criteria which affect farmers' decisions on buying/choosing spraying equipment (Figure 1) 'spraying efficacy' (96%), 'ease of use' (88%) and 'operator safety' (87%) predominate followed by 'compliance with EU Regulations' (82%), 'reduction of PPP inputs' (80%), 'environmental protection' (77%) and 'farm size' (75%). 'Economic considerations' (66%) appear to be an important criterion (although less important than the aforementioned ones) with 'reputation (of the manufacturer)' (49%) and the fact that 'other farmers use it' (35%) being least important. Some farmers further added reliability (14 cases) and technical support/service (13 cases).

Figure 1: Farmers' criteria for buying spraying equipment

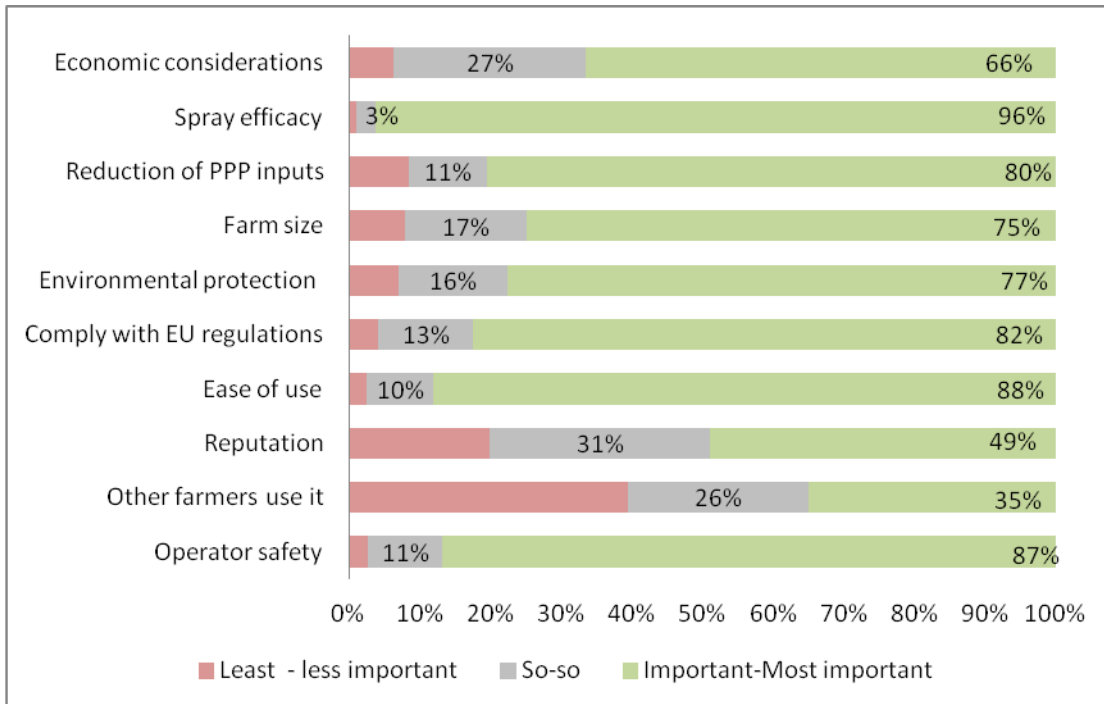
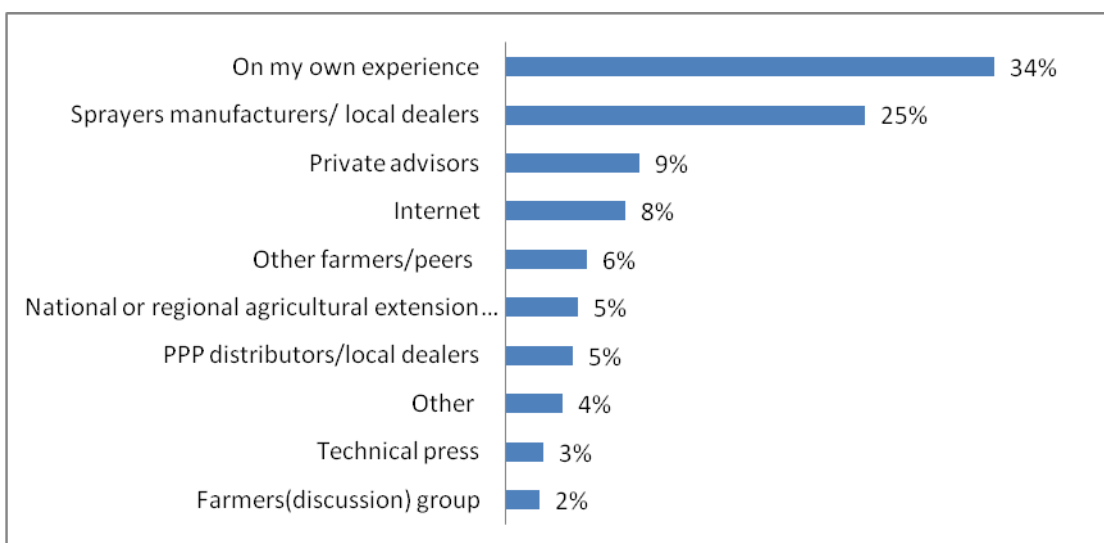


Figure 2: Most important source of knowledge/know-how on the use and operation of spraying equipment

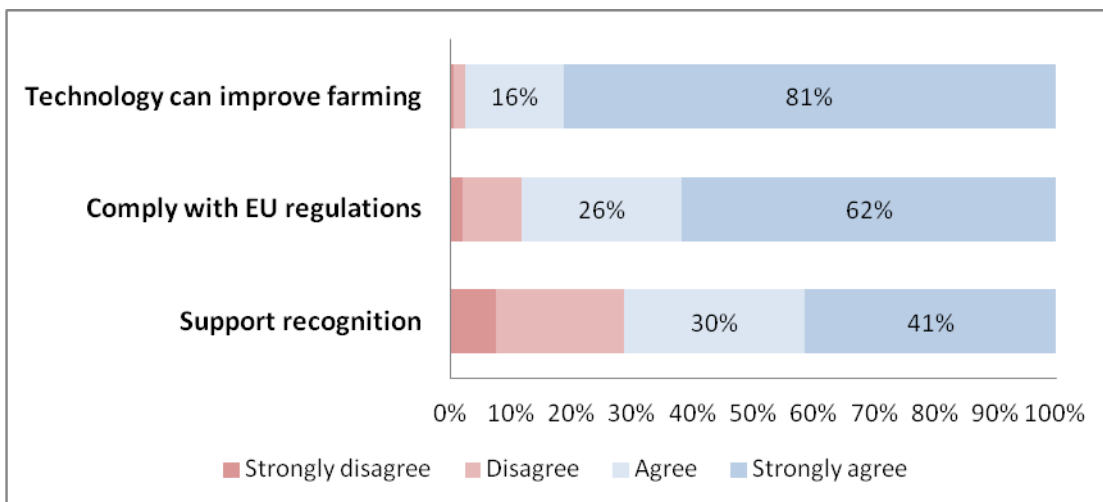


As far as farmers' most important source of knowledge/know-how on the use and operation of their spraying equipment is concerned (Figure 2) farmers said that they rely on their own

experience (34%) followed by information/advice from equipment manufacturers and dealers (25%) and advisors (private: 9% and public/cooperative: 5%).

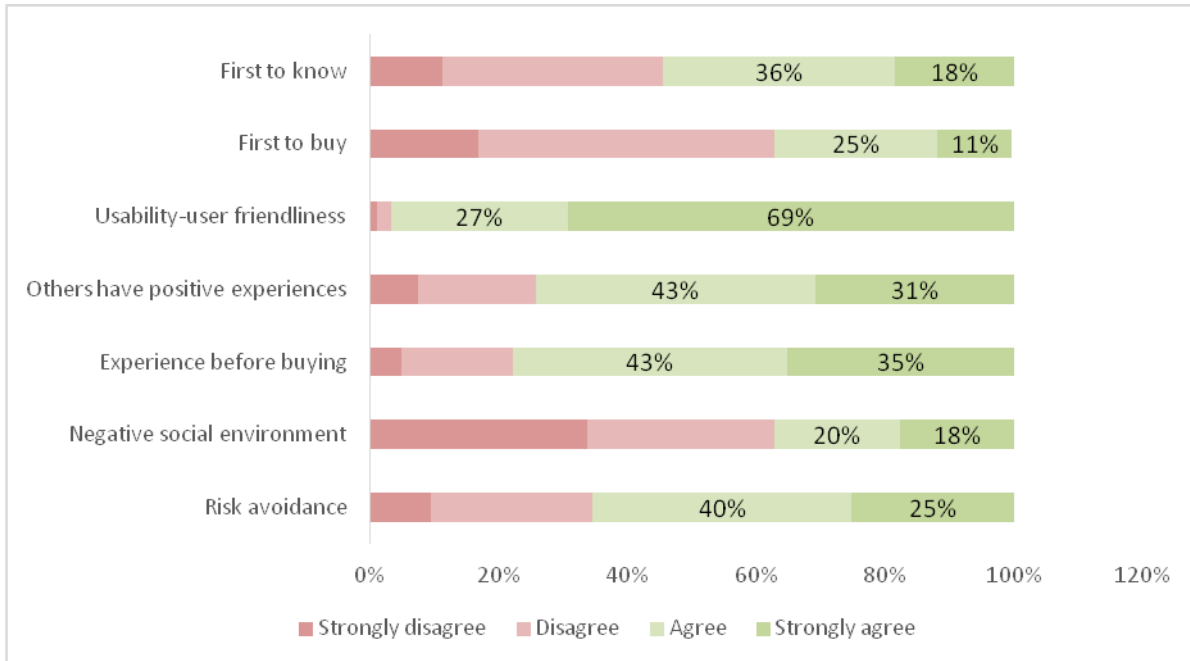
Technology, according to the farmers can contribute to improve farming as well as to assist them in complying with the EU Regulations and to a lesser degree to support their recognition of their work by the wider public (Figure 3).

Figure 3: Farmers' attitudes towards technology



The interviewed farmers claim that usability and user-friendliness are very important to them when they buy new things (97%) thus that they prefer to have some experience with something before they buy them (78%) and wait to buy new things, until they know that others have positive experiences with it (74%). Therefore, although they are the first to know about new machinery/technology in their social circles (54%) they are not the first to buy (63%). In general, they don't like taking risks (risk avoidance) with their farming business (65%). Finally, if interested, they would buy new equipment even if their (social) environment would be negative on it (63%).

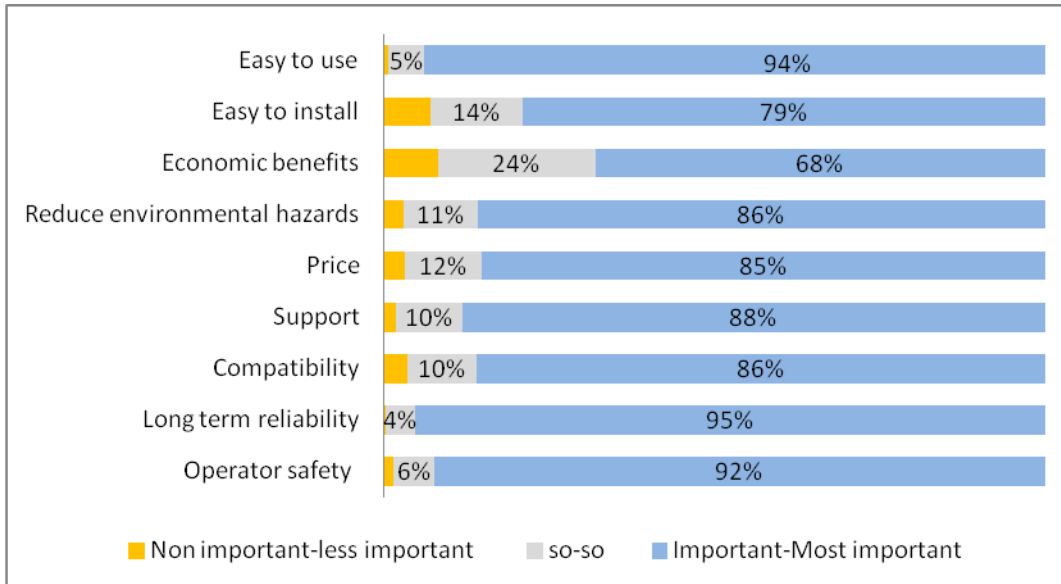
Figure 4: Farmer's innovativeness



The majority of the interviewed farmers claim that they experiment on their farms either by themselves (38%), with advisors and/or researchers (32%) or with their peers (12%). On the other hand, 18% said that they do not experiment on their farms.

According to the interviewed farmers the most important spraying equipment characteristics that would make spraying equipment more relevant to farmers' needs are long term reliability (95%), ease of use (94%) and operator safety (92%), followed by the availability of technical support (88%), compatibility with the existing machinery (86%), the reduction of environmental hazards (86%) and price (85%). Finally, easiness to install the equipment (79%) and economic benefits (68%) are important equipment characteristics for the majority of the farmers.

Figure 5: Characteristics that would make spraying equipment more relevant to farmers' needs



The adopters of one of the innovative spraying equipment (selected by the project experts) are 204 (58.6% of the sample). Adopters and non-adopters do not show any statistically significant difference in terms of age, gender, education and farm size (both owned and rented land) as well as years in farming and the existence of a successor - or not.

Farmers' groups

As shown in Table 3 and Diagram 1, the inertia (significance) of the first axis is 21.82%, of the second is 13.41%, of the third 12.44%, of the fourth 10.23% and of the fifth axis is 8.56%. The information provided by the first five axes amounts to 66.46% which is considered satisfactory (Volle, 1985; Behrakis, 1999, Karapistolis, 2001, Morineau and Morin, 2006).

Table 3: Eigenvalues and inertia percentages

Number	Total (Eigenvalue)	Inertia	Percentage	Cummulative percentage
F1	3,8310	0,120	21,82%	21,82%
F2	3,0030	0,094	13,41%	35,22%
F3	2,8930	0,090	12,44%	47,67%
F4	2,6230	0,082	10,23%	57,89%
F5	2,4000	0,075	8,56%	66,46%
F6	2,3420	0,073	8,15%	74,61%
F7	2,3040	0,072	7,89%	82,50%
F8	2,0860	0,065	6,47%	88,97%
F9	1,9680	0,062	5,76%	94,73%
F10	1,8830	0,059	5,27%	100,00%

Diagram 1: Histogram of Eigenvalues

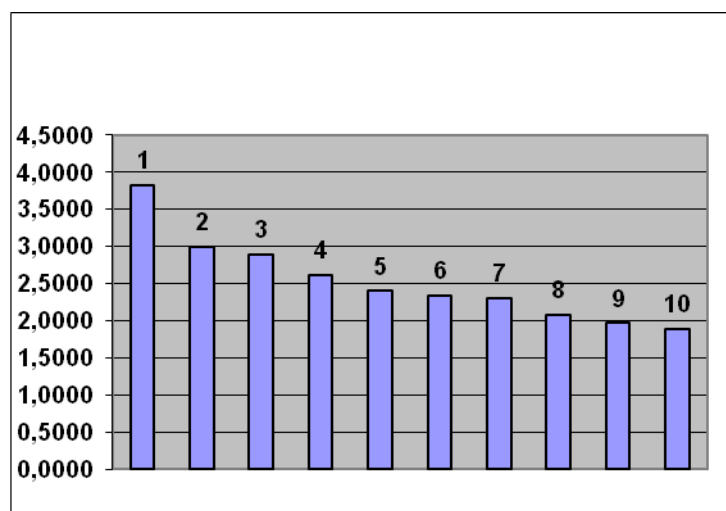


Table 4 Number of farms per Group

Group	No. of farms	Percentage	Cumulative %
Group 1	67	19.25	19.25
Group 2	84	24.14	43.39
Group 3	113	32.47	75.86
Group 4	37	10.63	86.49
Group 5	47	13.51	100.00

Following, using the coordinates of the farms/farmers in the 10 axes, Cluster Analysis produced 5 groups of farms/farmers as shown in Table 4.



18-21 June 2019, Acireale (Italy)

Group 1

Group 1 (Table 5) is characterized by the fact that for half of the interviewees comprising it farming is not their primary occupation; slightly less than one out of three farms are not declared as family farms. Thus for a quarter of the interviewees agricultural income accounts for less than 25% of their overall (family) income. The group is also characterized by the large number of small farms (almost half of them are less than 10 ha. vs. one third of the farms in the sample; sample mean 73 ha.) with one third of the farms enlarged through land rentals (10-60 ha; sample mean 60 ha.). The majority of farmers are active in terms of participation in both certification and Pillar II schemes but not in on-farm diversification. Interviewees have outstanding education: one in three holds university degree. The interviewees believe in technology in terms of supporting the improvement of farming and compliance with regulations. Their majority waits for others to have positive experiences with technology before adopting it; one third is not among the first ones either to know of or/and to buy new technology. On the other hand, they do not depend on the opinion of their social circles in order to adopt new technology. The majority visits events like agricultural fairs, exhibitions and demonstrations more than once per year; however, 10% though never does. Two thirds of the interviewees place usability and user-friendliness of new equipment at the top of their priorities. Almost 60% of 67 farmers in Group 1 (19.25% of the sample) come from Belgium and The Netherlands. The percentage of farmers with open field vegetables growers in the group is double as compared to the sample.

The criteria for buying new spraying equipment and the characteristics of spraying equipment that would, according to the group's farmers, make them more relevant to farmers' needs are (comparatively for all Groups) shown in Tables 10 and 11

Table 5: Group 1 - Active, characteristic and supplementary variables

Variable	Value (modality)	Count Group	% Group	Count Total	% Total	Criterion
ACTIVE VARIABLES						
Farming primary occupation	2 No	33	49,3%	65	18,7%	4,73
Country name	1 Belgium	22	32,8%	27	7,8%	4,24
Country name	6 The Netherlands	18	26,9%	19	5,5%	3,86
I am the first in my social circle of friends and relatives to know about new machinery/technology	1 Strongly disagree	21	31,3%	39	11,2%	3,40
Visits to agricultural fairs, field days/demonstrations, or exhibitions	1 More than once a year	48	71,6%	181	52,0%	3,21
I am among the first of my friends and relatives to buy new machinery/technology	1 Strongly disagree	22	32,8%	59	17,0%	2,61
Even if I am interested, I wouldn't buy if my (social) environment would be negative on it	2 Disagree	30	44,8%	101	29,1%	2,39
Participation in Certification schemes	1 Yes	47	70,1%	193	55,5%	2,37
Farm income % of family income	1 5%-25%	11	25,6%	30	10,8%	2,14
Land owned	1,00 0,4 -10 ha	32	47,8%	116	33,7%	2,12
Participation in Pillar II schemes	1 Yes	39	59,1%	157	45,4%	2,07
Cropping system	2 open field vegetables	12	17,9%	29	8,3%	1,95
Land rented in	2,00 10,01 - 60 ha	21	36,8%	79	23,7%	1,93
Most important Source of knowledge on the use and operation of spraying equipment	6 Technical press-Other	13	21,7%	32	11,0%	1,90
Legal status	2 Other	19	28,4%	62	17,8%	1,79



18-21 June 2019, Acireale (Italy)

Education	4 University	22	32,8%	77	22,1%	1,74
Visits to agricultural fairs, field days/demonstrations, or exhibitions	4 Never	7	10,4%	13	3,7%	1,73
When making farm decisions, I don't like taking risks	3 Agree	34	51,5%	139	40,2%	1,69
CHARACTERISTICS						
Technology can help farmers comply with regulations	3 Strongly agree	46	70,8%			
Technology can improve farming	3 Strongly agree	58	86,6%			
Non agricultural activities on farm	2 No	55	82,1%			
I wait to buy new things, until I know others have positive experiences with it	2 Agree, Strongly agree	51	76,1%			
Region description	1 Flat	47	70,1%			
Usability and user-friendliness are very important to me when I buy new things	4 Strongly agree	43	64,2%			
The majority of the spray equipment used in the farm is owned by Contractor	2 No	62	92,5%			
Certificate in PPP use	1 Yes	57	87,7%			
Legal status	1 Family farm	48	71,6%			



18-21 June 2019, Acireale (Italy)

Group 2

The majority of the farmers comprising Group 2 (Table 6) are family farms, with an identified successor, owning more than 50 ha. (vs. one quarter of the sample; sample average 73 ha.) and renting more than 60 ha. (i.e. over the sample mean), mainly cultivating cereals and open field vegetables; farming is their primary occupation. Farmers are engaged in certification schemes; one third of them have diversified on-farm activities with agricultural income accounting between 50% and 75% of the overall (family) income. Farmers have very strong technical education background. Farmers believe in technology in terms of supporting the improvement of farming and compliance with regulations; thus they buy new technology without taking into account the opinion of their social circles. On the other hand, they wait for others to have positive experiences with technology before adopting it. Usability and user-friendliness are at the top of their priorities when considering new technology. The majority of the 84 farmers in Group 2 (24.14% of the sample) come from Sweden and France.

The criteria for buying new spraying equipment and the characteristics of spraying equipment that would, according to the group's farmers, make them more relevant to farmers' needs are (comparatively for all Groups) shown in Tables 10 and 11. Additionally, more than 40% of the farmers said they are very satisfied from farming.

Group 3

The majority of the interviewees comprising Group 3 (Table 7) operate family farms and have farming as their primary occupation. They have chosen to be involved in farming and half of them are new in farming (up to 17 years in farming; over 45% in the group vs. one third in the sample); the majority has not identified a successor. Half of them are small-scale farmers (own land < 10 ha.)



18-21 June 2019, Acireale (Italy)

and the majority does not rent land; the majority earns their whole income (100%) from agriculture. The group includes a high percentage of farmers with low educational level (double than the sample's average); the majority holds a certificate in PPP use. The majority said that they experiment on their farms by themselves. Their majority participates in certification schemes but not in Pillar II schemes or on-farm diversification activities. Farmers believe in technology in terms of supporting the improvement of farming; on the other hand, the percentages of those who strongly disagree that technology can help with reference to “compliance with regulations” and “public recognition of farmers’ work” are double as compared to the sample’s average (one out of four and four out of ten, respectively). The majority waits for others to have positive experiences with technology before adopting it. Usability and user-friendliness are at the top of their priorities when considering new technology. One third of them shows a strong risk aversion attitude. They rely much more than farmers in other groups on advisors (double than the sample’s average). The majority of the 113 farmers in Group 3 (32.47% of the sample) come from Spain and Greece. The percentage of farmers with vineyards, orchards and greenhouses is almost double as compared to the sample.

The criteria for buying new spraying equipment and the characteristics of spraying equipment that would, according to the group’s farmers, make them more relevant to farmers’ needs are (comparatively for all Groups) shown in Tables 10 and 11. Furthermore, more than 60% of this Group’s farmers own/use innovatory spraying equipment.

Table 6: Group 2 - Active, characteristic and supplementary variables

Variable	Value (modality)	Count Group	% Group	Count Total (Sample)	% Total	Criterion
ACTIVE VARIABLES						
Country name	8 Sweden	48	57,1%	50	14,4%	7,48
Education	3 Technical	61	72,6%	147	42,2%	5,48
Land owned	3,00 > 50 ha	45	55,6%	93	27,0%	4,74
Cropping system	1 cereals	56	66,7%	142	40,8%	4,48
Legal status	1 Family farm	80	95,2%	286	82,2%	4,21
Even if I am interested, I wouldn't buy if my (social) environment would be negative on it	1 Strongly disagree	47	56,0%	117	33,7%	3,72
Land rented in	3,00 > 60 ha	29	35,8%	52	15,6%	3,55
Certificate PPP use	1 Yes	82	98,8%	320	93,6%	2,93
Country name	3 France	24	28,6%	51	14,7%	2,64
Farm sucesor	1 Yes	56	70,0%	183	54,8%	2,62
Non agricultural acitivities on the farm	1 Yes	30	35,7%	74	21,3%	2,55
Region description	1 Flat	67	79,8%	239	68,7%	2,20
Cropping system	2 open field vegetables	15	17,9%	29	8,3%	2,15
Farm income % of family income	3 50%-75%	24	30,8%	57	20,5%	1,78
CHARACTERISTICS						
The majority of the spray equipment used in the farm is owned by Contractor	2 No	83	98,8%			

Usability and user-friendliness are very important to me when I buy new things	4 Strongly agree	65	77,4%
Farming primary occupation	1 Yes	71	85,5%
Participation in Certification schemes	1 Yes	51	60,7%
Training course on spraying machinery	1 Yes	54	64,3%
I wait to buy new things, until I know others have positive experiences with it	2 Agree/ Strongly agree	64	76,2%
Technology can help farmers comply with regulations	3 Strongly agree	52	61,9%
Technology can improve farming	3 Strongly agree	62	73,8%
Non agricultural activities on the farm	2 No	54	64,3%
SUPPLEMENTARY VARIABLES			
Rank satisfaction	3 Very Satisfied	36	42,9%

Table 7: Group 3 - Active, characteristic and supplementary variables

Variable	Value (modality)	Count Group	% Group	Count Total (Sample)	% Total	Criterion
ACTIVE VARIABLES						
Country name	2 Spain	42	37,2%	49	14,1%	4,70
Country name	4 Greece	39	34,5%	52	14,9%	4,02
Farm sucesor	2 No	72	65,5%	151	45,2%	3,83
Land rented in	0	66	59,5%	130	39,0%	3,80
Cropping system	4 vineyards	34	30,1%	44	12,6%	3,74
Cropping system	3 orchards	50	44,2%	101	29,0%	2,89



ESEE2019
24th EUROPEAN SEMINAR ON
EXTENSION (AND) EDUCATION

18-21 June 2019, Acireale (Italy)

Land owned	1,00 0,4 -10 ha	55	49,1%	116	33,7%	2,87
Comply with regulations	1 Strongly disagree/ Disagree	27	24,1%	41	11,9%	2,78
Experiment on farm	1 Yes-by myself	60	53,6%	135	38,9%	2,72
Farming primary occupation	1 Yes	102	90,3%	282	81,3%	2,58
Technology can support farmers' work recognition by the public	1 Strongly disagree/ Disagree	43	42,2%	95	28,7%	2,45
Years in farming	1,00 1-17 years	52	46,4%	117	33,7%	2,37
Technology can improve farming	3 Strongly agree	101	89,4%	283	81,3%	2,26
When making farm decisions, I don't like taking risks	4 Strongly agree	41	36,6%	87	25,1%	2,24
Cropping system	5 greenhouse	20	17,7%	32	9,2%	2,17
Farm income % of family income	5 100%	61	64,9%	146	52,5%	2,15
Education	1 Elementary	17	15,0%	26	7,5%	2,08
Most important Source of knowledge on the use and operation of spraying equipment	2 National or regional agricultural extension services-Private advisors	22	22,7%	43	14,2%	1,81
Participation in Pillar II schemes	2 No	71	63,4%	189	54,6%	1,66
CHARACTERISTICS						
Reasons for becoming a farmer	2 All others	68	62,4%			
Non agricultural activities on the farm	2 No	94	83,2%			
Participation in Certification schemes	1 Yes	69	61,1%			
Certificate in PPP use	1 Yes	105	95,5%			
The majority of the spray equipment used in the farm is owned by Contractor	2 No	110	97,3%			

Legal status	1 Family farm	94	83,2%
Region description	1 Flat	75	66,4%
Usability and user-friendliness are very important to me when I buy new things	4 Strongly agree	73	64,6%
I wait to buy new things, until I know others have positive experiences with it	2 Agree/ Strongly agree	78	69,0%
SUPPLEMENTARY VARIABLES			
Have/Use innovative spray equipment	1 Yes	70	61,9%

Table 8: Group 4 - Active, characteristic and supplementary variables

Variable	Value (modality)	Count Group	% Group	Count Total (Sample)	% Total	Criterion
ACTIVE VARIABLES						
Country name	7 Poland	30	81,1%	50	14,4%	9,95
Participation in Certification schemes	2 No	32	86,5%	155	44,5%	6,74
Visits to agricultural fairs, field days/demonstrations, or exhibitions	2 Once a year	28	75,7%	117	33,6%	5,61
Reasons for becoming a farmer	1 Tradition	27	75,0%	152	45,9%	3,77
Non agricultural activities on the farm	2 No	35	94,6%	274	78,7%	3,67
Even if I am interested, I wouldn't buy if my (social) environment would be negative on it	4 Strongly agree	16	43,2%	61	17,6%	3,06
Education	2 Secondary	19	51,4%	89	25,6%	3,02
Cropping system	1 cereals	24	64,9%	142	40,8%	2,91

Region description	2 Hilly	20	54,1%	104	29,9%	2,83
Even if I am interested, I wouldn't buy if my (social) environment would be negative on it	3 Agree	16	43,2%	68	19,6%	2,81
Land owned	2,00 10,01 - 50 ha	21	56,8%	114	33,1%	2,77
I wait to buy new things, until I know others have positive experiences with it	2 Agree/ Strongly agree	33	89,2%	258	74,1%	2,68
I am the first in my social circle of friends and relatives to know about new machinery/technology	2 Disagree	21	56,8%	119	34,3%	2,63
Most important Source of knowledge on the use and operation of spraying equipment	2 National or regional agricultural extension services-Private advisors	8	47,1%	46	15,8%	2,54
Participation in Pillar II schemes	1 Yes	24	64,9%	157	45,4%	2,35
Certificate in PPP use	2 No	8	21,6%	22	6,4%	2,20
Technology can improve farming	2 Agree	12	32,4%	56	16,1%	2,06
Most important Source of knowledge on the use and operation of spraying equipment	1 On my own experience-	10	58,8%	103	34,0%	2,03
Technology can help farmers comply with Regulations	2 Agree	16	43,2%	91	26,4%	1,99
Farm income % of family income	5 100%	21	70,0%	146	52,5%	1,97
Training course on spraying machinery	1 Yes	28	75,7%	199	61,0%	1,94
When making farm decisions, I don't like taking risks	3 Agree	21	56,8%	139	40,2%	1,94
Farm successor	1 Yes	26	70,3%	183	54,8%	1,94
Experiment on farm	1 Yes-by myself	20	54,1%	135	38,9%	1,76
CHARACTERISTICS						
Farming primary occupation	1 Yes	33	89,2%			
Legal status	1 Family farm	31	83,8%			



18-21 June 2019, Acireale (Italy)

The majority of the spray equipment used in the farm is owned by Contractor	2 No	35	94,6%
Technology can improve farming	3 Strongly agree	25	67,6%
Certificate in PPP use	1 Yes	29	78,4%
SUPPLEMENTARY VARIABLES			
Rank satisfaction	2 Satisfied	29	80,6%



18-21 June 2019, Acireale (Italy)

Group 4

The majority of the interviewees comprising Group 4 (Table 8) operate family farms and became farmers due to tradition; they have identified a successor. They own farms between 10 and 50 ha. (small-medium vs. sample mean 73 ha.) and earn their whole income (100%) from agriculture; they are involved in Pillar II schemes but not in certification schemes or on-farm diversification. Slightly over 50% have secondary education with the majority having attended courses on both PPP use and spraying machinery. Their majority certainly waits for others to have positive experiences with technology before adopting it; most of them said that they are not among the first ones to know of new technology. Furthermore, they strongly depend on the opinion of their social circles in order to adopt new technology. Concerning the use and operation of spraying equipment, most of them declared that they rely on their own experience; the second important source of knowledge are advisors. Most of the farmers said that they experiment on their farms by themselves. The majority claims that they pay visits to agricultural fairs, field days/demonstrations, or exhibitions once a year. The majority of the 37 farmers in Group 4 (10.63% of the sample) come from Poland and/or cultivates cereals; the percentage of farms in hilly areas is almost double as compared to the sample.

The criteria for buying new spraying equipment and the characteristics of spraying equipment that would, according to the group's farmers, make them more relevant to farmers' needs are (comparatively for all Groups) shown in Tables 10 and 11. Additionally, 80% maintained that they are satisfied from farming.

Group 5



18-21 June 2019, Acireale (Italy)

The majority of the interviewees comprising Group 5 (Table 9) operate family farms with farming being their primary occupation, but the groups includes a higher percentage of non-family farms (three out of ten) as compared to the sample. Two thirds have identified a successor. They do not participate in Pillar II schemes. The majority have had technical education background and were trained in both PPP use and spraying machinery. They percentage of those who experiment on their farms with other farmers is more than double as compared to the sample; they also experiment with advisors and researchers to a percentage higher than that of the sample. For the majority the most important source of knowledge on the use and operation of spraying equipment are manufactures and their dealers; they also use the Internet to a much higher degree (more than double) as compared to the sample. They strongly believe that technology can help in terms of farming improvement and compliance with Regulations. They claim that they are the first in their social circles to know of new technologies. On the other hand, they prefer to have some experience with technology before adopting it and/or see others having positive experiences with it. The majority of the 47 farmers in Group 5 (13.51% of the sample) come from Italy.

Table 9: Group 5 - Active, characteristic and supplementary variables

Variable	Value (modality)	Count Group	% Group	Count Total (Sample)	% Total	Criterion
ACTIVE VARIABLES						
Country name	5 Italy	44	93,6%	50	14,4%	19,66
Participation in Pillar II schemes	2 No	40	85,1%	189	54,6%	5,22
Certificate in PPP use	1 Yes	47	100,0%	320	93,6%	4,85
Education	3 Technical	32	68,1%	147	42,2%	3,54
Technology can help farmers comply with Regulations	3 Strongly agree	39	83,0%	213	61,7%	3,50
I am the first in my social circle of friends and relatives to <i>know</i> about new machinery/technology	3 Agree	28	59,6%	125	36,0%	3,10
Most important Source of knowledge on the use and operation of spraying equipment	3 PPP & Sprayers manufacturers/ local dealers	24	52,2%	89	29,4%	2,92
I prefer to have some experience with something before I buy it	4 Strongly agree	27	57,4%	122	35,2%	2,91
Farm sucesor	1 Yes	35	74,5%	183	54,8%	2,84
Most important Source of knowledge on the use and operation of spraying equipment	4 Internet	11	23,9%	25	8,3%	2,42
Experiment on farm	2 Yes-with other farmers	13	27,7%	40	11,5%	2,39
Usability and user-friendliness are very important to me when I buy new things	4 Strongly agree	39	83,0%	241	69,3%	2,28



18-21 June 2019, Acireale (Italy)

Land rented in	1,00 0,4 -10 ha	17	36,2%	72	21,6%	1,98
Experiment on farm	3 Yes-with advisers or researchers	22	46,8%	110	31,7%	1,96
Most important Source of knowledge on the use and operation of spraying equipment	4 Internet	11	23,9%	34	11,7%	1,86
Second Most important Source of knowledge on the use and operation of spraying equipment	3 PPP & Sprayers manufacturers/ local dealers	19	41,3%	80	27,5%	1,79
Visits to agricultural fairs, field days/demonstrations, or exhibitions	3 Less than once a year	10	21,3%	37	10,6%	1,72
Legal status	2 Other	14	29,8%	62	17,8%	1,72
CHARACTERISTICS						
Farming primary occupation	1 Yes	42	89,4%			
Training course on spraying machinery	1 Yes	30	63,8%			
Region description	1 Flat	33	70,2%			
The majority of the spray equipment used in the farm is owned by Contractor	2 No	45	95,7%			
Non agricultural activities on the farm	2 No	36	76,6%			
Technology can improve farming	3 Strongly agree	37	78,7%			
I wait to buy new things, until I know others have positive experiences with it	2 Agree/ Strongly agree	32	68,1%			
Legal status	1 Family farm	33	70,2%			
Usability and user-friendliness are very important to me when I buy new things	3 Agree	8	17,0%			



SUPPLEMENTARY VARIABLES			
Rank satisfaction	2 Satisfied	28	60,9%
Have/Use innovative spray equipment	1 Yes	29	61,7%

The criteria for buying new spraying equipment and the characteristics of spraying equipment that would, according to the group’s farmers, make them more relevant to farmers’ needs are (comparatively for all Groups) shown in Tables 10 and 11. Furthermore, more than 60% of the group’s farmers declare satisfied from farming and/or are adopters of innovatory spraying machinery.

Table 10: Criteria for buying/choosing spraying equipment per Group

Criteria for buying/choosing spraying equipment (important)	G1	G2	G3	G4	G5
Economic considerations	X	X		XXX+	XX
Spray efficacy	XXX	XXX	XXX	XXX	XXX+
Reduction of PPP inputs	X	X	XX	XX	XXX
Farm size	X	X	X	XX	XXX
Environmental protection	X	X	X	XX	XXX+
Comply with EU/other regulations	XX	XX	X	XXX+	XXX
Ease of use	XXX	XX	XX	XXX	XX
Reputation (company, brand name)				XX	
Other farmers, friends etc. use it		X-			
Operator safety	X	XX	XX	XXX	XXX+
Other (Please specify):					

Legend

	%
X-	50 - 60
X	60.1 - 75
XX	75.1 - 90
XXX	90.1 - 99.9
XXX+	100

(less/non-important)

Table 11: Characteristics of spraying equipment that would make them more relevant to farmers' needs per Group

Characteristics of spraying equipment that would make them more relevant to farmers' needs (important/most important)	G1	G2	G3	G4	G5
Easy to use	X	X	x	X	
Easy to install on the sprayer	XX	X	X	XXX	XX
Show economic benefits right away	XX		X	XX	X-
Reduction of environmental hazards	XX	XX	XX	XXX	XXX+
Reasonable price			X		X
Technical support					
Compatible with existing machinery/equipment	XX	XX	XX	XXX	XXX
Long-term reliability					
Operator safety					
Other (please specify)					

Discussion and conclusion

According to the preceding data analysis, Group 1 is characterized by the fact that half of the farmers do not have farming as their primary occupation while one third of the farms in Groups 1 and 5 are not family farms. Farms in Groups 1 and 3 are small-scale and this probably relates to their major cultivation systems; the majority of the farmers in Group 3 do not rent land. Group 4 is characterized by the fact that farmers got engaged in agriculture due to tradition. Participation in various schemes (certification and Pillar II) and on-farm diversification differs between the groups, the same is true as far as the existence of an identified successor is concerned. The level and type of education as well as of training in PPP use and spraying equipment also differs between the groups.

While farmers in Groups 1, 2 and 5 believe that technology can help in terms of farming improvement and compliance with Regulations, Group 3 includes a notably high percentage of farmers who strongly disagree that technology can help with reference to “compliance with regulations” and “public recognition of farmers’ work”.

The majority of the farmers in all Groups waits for others to have positive experiences with technology before adopting it. Farmers in Group 5 also prefer to have some experience with technology before adopting it; furthermore, they claim that they are the first ones to know of new technology among the social circles. On the other hand, farmers in Group 4 depend on the opinion of their social circles in order to acquire new technology. One third of the farmers in Group 3 show strong risk aversion attitude.

Concerning the use and operation of spraying equipment, most of the farmers in Group 4 declared that they rely on their own experience; advisors follow as a source of relevant knowledge. Advisors are important for Group 3 while for Group 5 the most important source of knowledge on the use and operation of spraying equipment are manufactures and their dealers followed by the Internet.

The majority of farmers in Groups 3 and 4 experiment on their farms by themselves while Group 5 is characterized by the high percentage of farmers who experiment with other farmers as well as with researchers and advisors. Moreover, farmers in Groups 3 and 5 seem to be keener to adopt innovatory spraying machinery than the rest of the farmers; they have farming as their primary occupation while the first seem to rely more than other farmers on advisory services and the latter on join-experimentation and contacts with manufactures/dealers.

Groups 4 and 5 are characterized by the high percentages of farmers who are satisfied from farming while 4 out of ten of Group's 2 farmers are very satisfied.

Farmers in Group 5 seem to be more sensitive vis-à-vis environmental protection, the reduction of PPP inputs and farm size when making decisions on buying new spraying machinery; farmers in Groups 4 and 5 put emphasis on compliance with EU Regulations, operator safety and economic considerations.

As far as the characteristics of spraying equipment that would make them more relevant to farmers' needs, farmers in Groups 4 and 5 seem to believe that the reduction of environmental hazards and the compatibility of the equipment are more important than their colleagues do. It is also worth noting that the majority of the farmers in Group 5 do not show much interest on whether the new equipment will show economic benefits right away or not.

Innovation adoption and diffusion is undoubtedly multifactorial (Rogers, 2003); the heterogeneity of both farms and farmers affects what is adopted, to what extent, and when. In this piece of on-going work, an attempt to construct farmers' groups with similar characteristics, as regards the adoption of innovative spraying equipment, was undertaken. Despite the particular scope and sampling methodology followed in the INNOSETA project, the importance of exploring the differing features of target-groups has been shown. Further exploration, especially vis-à-vis national/regional AKIS is needed.

Acknowledgements

This paper is based on the conceptual Framework (Deliverable 2.1) and data collected during the INNOSETA project funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773864. The opinions expressed in this paper are not necessarily those of the EU.

References

- Behrakis, T. (1999). *Multidimensional data analysis*. Livanis - Nea Synora, Athens.
- Karapistolis, D. (2001). *Data analysis and market research*. Anikoula, Thessaloniki.
- Lebart, L., Piron, M. et Morineau, A. (2002). *Statistique Exploratoire Multidimensionnelle*, Edition Dunod, Paris.
- Rogers, E. (2003). *Diffusion of Innovations*. New York: Free Press.
- Morineau, A. et Morin, St. (2006). *Pratique du traitement des enquetes (Exemple d'utilisation du logiciel SPAD)*, Edition SPAD, Paris.
- Volle, M. (1985) *Analyse des donnees 3eme edition*, Edition ECONOMICA, Paris.