



Deliverable 2.2: Report on farmers needs, innovative ideas and interests

**Accelerating Innovative practices for
Spraying Equipment, Training and
Advising in European agriculture.**



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Abstract

The aim of this document, i.e. Deliverable 2.2. of the INNOSETA project, is to provide: 1) the methodology used for farmers' survey and expert interviews, aiming at the evaluation of needs and interests regarding innovation processes related to Spraying, Equipment, Training and Advising (SETA), 2) the research tools used (farmers' questionnaire and experts' interview guide); and 3) the research results. The farmers' survey and experts' interviews results are subsequently summarized and discussed with a view to factors that influence the adoption and the contexts in which SETA may be relevant across Europe.



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Preface

The document at hand constitutes Deliverable 2.2 of the INNOSETA (Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture through the mobilization of Agricultural Knowledge and Innovation Systems) project and provides the short report of the project partners' common empirical research on innovation processes related to Spraying, Equipment, Training and Advising (SETA). As referred to in the Grant Agreement (GA), SETA encompasses: (i) Spraying machinery and their components; (ii) Precision electronic technologies (software and hardware) applied in sprayers; and, (iii) Training and Advising.

According to the GA, INNOSETA will strive to assess end-user needs and interests, and identify factors influencing adoption and diffusion of SETA technologies and best practices, taking into account regional specificities. This will be achieved through targeted surveys and interviews with farmers and selected advisory/extension services in all partner countries.

We conducted surveys with farmers in seven hubs: France, Greece, Italy, The Netherlands and Belgium, Poland, Spain, and Sweden. Farmers were selected according to their cropping system (arable crops, open field vegetables, orchards, greenhouses and vineyards) and farm size class. Overall, 348 farmers were interviewed from mid-October 2018 till mid-January 2019. The questionnaire comprised sections on background (farm and farmer's) information, spraying equipment and machinery, innovative spraying equipment, adoption (and non-adoption), best management practices, information seeking and farmers' attitudes towards technology and innovativeness. A combination of multiple-choice questions, Likert-scale data, and open-ended questions was used to shed light on the abovementioned topics with emphasis on how background data, subjective perceptions and/or information sources differ between adopters and non-adopters. Data analysis has been performed at univariate (frequencies) and bivariate level (cross-tabulations; Pearson Chi-Square).

Farmers' background and (some) perceptions towards spraying equipment were found to differ according to cropping system while differences per hub (country) were also detected, as for example in terms of farmers' education, information sources and the rate farmers renew their farming equipment. In general, farmers seem interested and have favourable attitudes towards innovative spraying equipment. The main obstacles vis-à-vis their adoption according to non-adopters are farm size and affordability. Non-adopters claim that a special subsidy would be very welcome although few adopters made use of such a subsidy. Among non-adopters economic reasoning and equipment condition predominate over technological and environmental considerations. According to all the interviewed farmers the three most important spraying equipment characteristics that would make spraying equipment more relevant to farmers' needs

are long term reliability, ease of use and operator safety. Adopters and non-adopters differ in terms of training, information sources, attitudes towards technology and venturesome spirit.

Additionally, experts working on SETA were identified, by the project partners, in each of the INNOSETA hubs and a number of them (representing different institutes/ organizations) were interviewed using the experts' interview guide (aide memoire).

1 Methodology

The rationale as well as the tools (farmers' questionnaire and experts' interview guide) of this study, based on the INNOSETA Grant Agreement, were presented in Deliverable 2.1 (for the tools, see also Appendices B & C).

1.1 Farmers' survey: Sampling rationale and background

With reference to the farmers' survey, based on our literature review (Deliverable 2.1), we hypothesized that by using farm size as the criterion for selecting farmers, we would be able to explore a broad spectrum of farming realities. This, in turn, would allow for the investigation of the adoption (or not) of innovative spraying equipment vis-à-vis the available innovation support systems (advisory/extension services, including training), policy dynamics, environmental limitations, and farmers' sociocultural and economic circumstances, thus to explore the divide between, on the one hand, research and innovation and, on the other hand, farmers.

As far as the experts' interviews are concerned, as mentioned in Deliverable 2.1, the target-group comprises key-persons from research, industry and practice.

1.2 Farmers' survey: Sampling structure

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 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 assessment templates provided in Deliverable 2.1.

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 sets¹. 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 (Appendix A). 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

The detailed account of no of farms/farmers per size per cropping system per country is shown in Appendix A. Data were collected by partners, entered in appropriate EXCEL data basis (built by AUA) and analyzed with the use of SPSS.23.

As far as the experts' (i.e. those who are involved in agricultural technology development and innovation processes) interviews are concerned it was decided to interview 5 officials per hub comprising researchers/ academics, industry representatives, extensionists/advisors and/or farmers (representatives of cooperatives/ associations). The overall aim is to grasp the wider societal environment (and processes) influencing the development, dissemination and use of innovative spraying equipment as well as to explore similarities and differences in the perception(s) of factors affecting such processes. The expert interviews were conducted face-to-face, via telephone or Skype, recorded and transcribed to produce computer-generated documents and analysed per topic (exploratory analysis; Sarantakos, 2005²).

¹ The analytical data concerning the size of all agricultural holdings per country, based on EUROSTAT 2013, were presented in Table 6.3 (Appendix 6) of Deliverable 2.1.

² Sarantakos, S. (2005). Social Research (3rd Edition). Basingstoke: Palgrave Macmillan.

1.3 Experts' interviews

Experts from the partner hubs (countries) were also interviewed, chosen on the basis of their expertise. Overall 35 interviews with experts from 8 European countries were conducted. Emphasis was given to the expert groups *Research* (9), *Industry* (9) and *Advisors* (9) especially vis-à-vis the *Farmers'* group (3) as farmers were specifically targeted through the survey. The distribution of experts per group and per country is illustrated in Table 3.

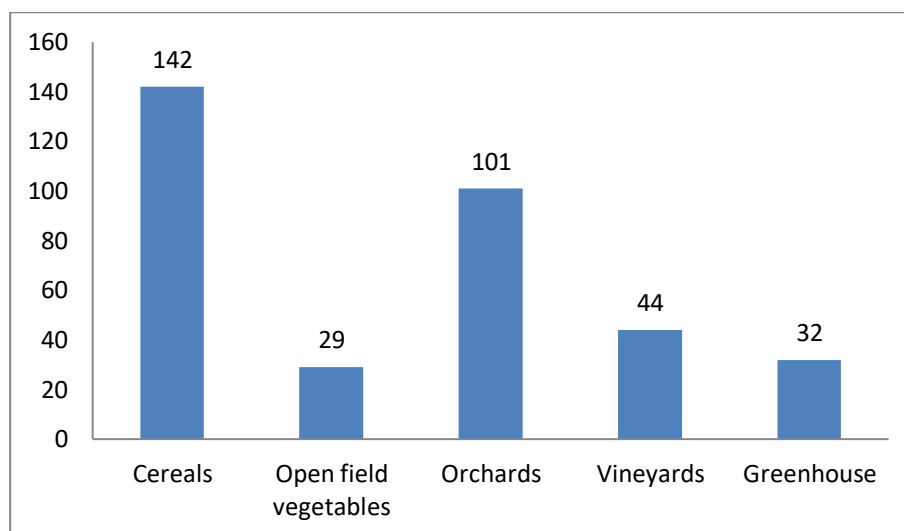
Table 3. Composition of the experts' group

	Belgium/ Netherlands	Spain	France	Greece	Italy	Poland	Sweden
Academia	1	1		1	1	1	
Research	1	1	1	2	1	1	2
Industry	1	2	1	2	2	1	
Advisors	1	1	3			2	2
Farmers	1			1			1

2 Farmers' survey: Data analysis

2.1 Farm and farmer characteristics

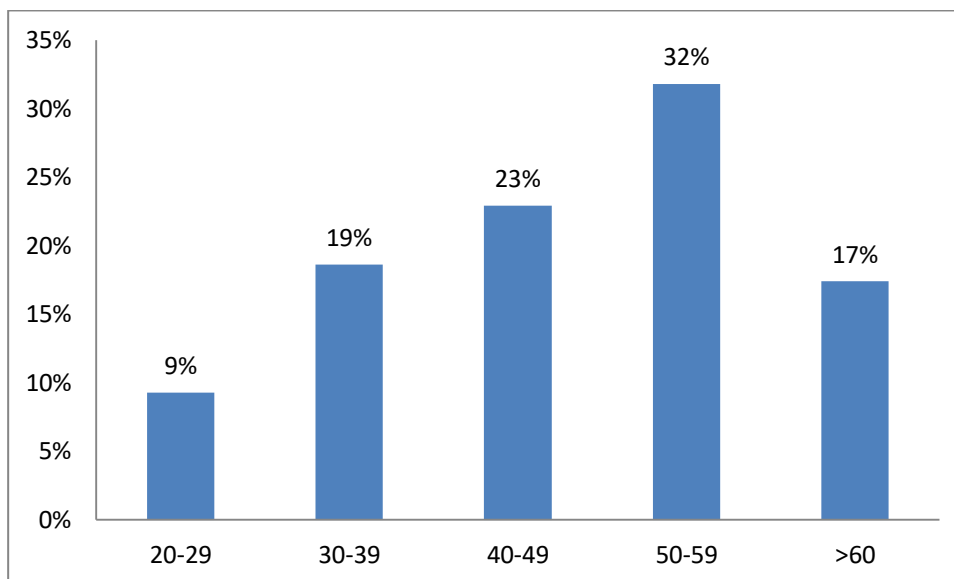
Figure 1: Number of interviewees per cropping system



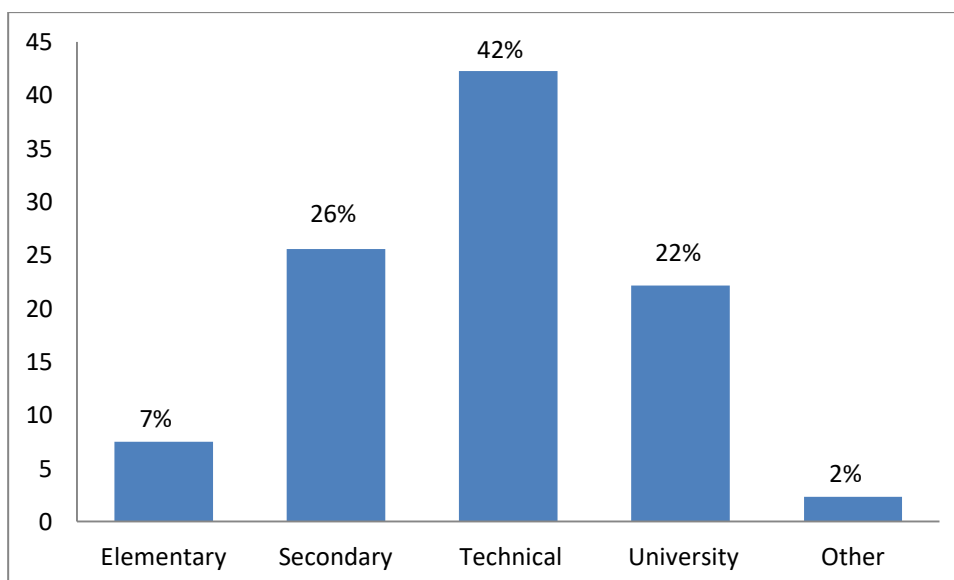
As aforementioned the sample comprises 142 farmers cultivating cereals, 29 farmers with open field vegetables, 101 farmers with orchards, 44 farmers with vineyards and 32 farmers with greenhouses.

Men comprise the great majority of the sample (92%).

Furthermore, women-farmers are less in the case of cereals and open field vegetables as well as in the case of orchards and vineyards as compared to farmers with greenhouses ($P=0.001$)

Figure 2: Farmer's age

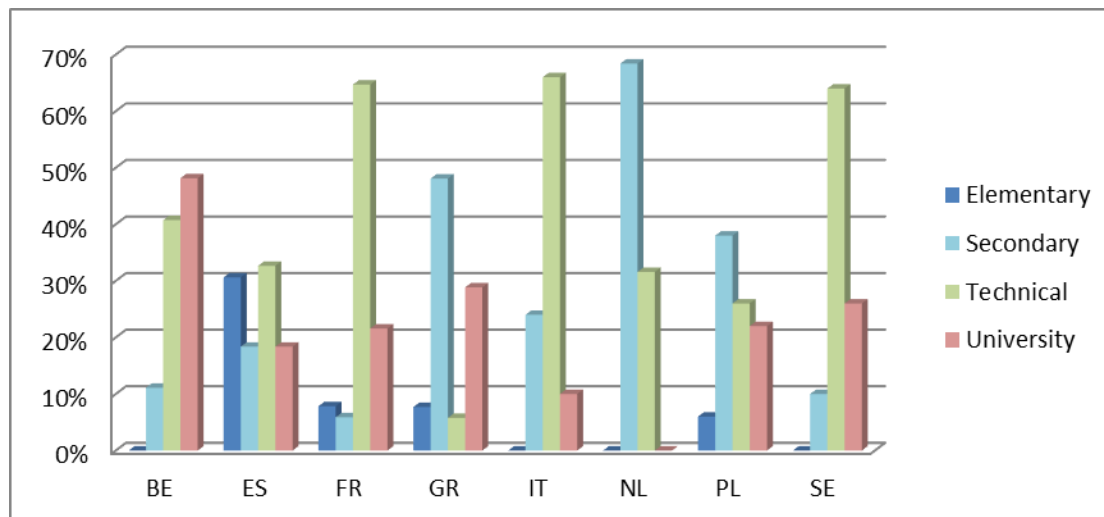
The majority of the interviewees fall in the age category 40-59 years old (55%); farmers up to 40 years old account for 28% of the sample with farmers aged 60 years old and over being the 17% of the sample. Farmers' age is differentiated per cropping systems with orchards and vineyards cultivators being younger (1:3 under 40 years old; $P < 0.05$).

Figure 3: Farmers' education

In general, the interviewed farmers have good (secondary 26% and technical 42%) to high educational level (university 22%) (Figure 3). This, as expected, differs between the countries involved in the survey with Belgium having the highest percentage of university graduates, France, Italy and Sweden having the highest percentages of farmers with technical education, The

Netherlands and Greece the highest percentages of farmers with secondary education, while Spain has the highest percentage of farmers with elementary education (Figure 4).

Figure 4: Farmers' education per country



Furthermore, the majority of the farmers with greenhouses have primary and secondary education while the majority of the farmers with cereals and vegetables have technical education; more farmers (%) with orchards or vineyards have tertiary education as compared to the farmers with other cropping systems ($P=0.000$).

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.

Farmers with cereals or open filed vegetables are the ones who have been mostly trained on both PPP use and spraying machinery with farmers with greenhouses being the least trained in spraying machinery ($P<0.05$).

Farming is the primary occupation for 81.3% of the farmers in 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 (Table 4). Somewhat similar, as might be expected, is the case of farmers' experience with spraying (Table 5).

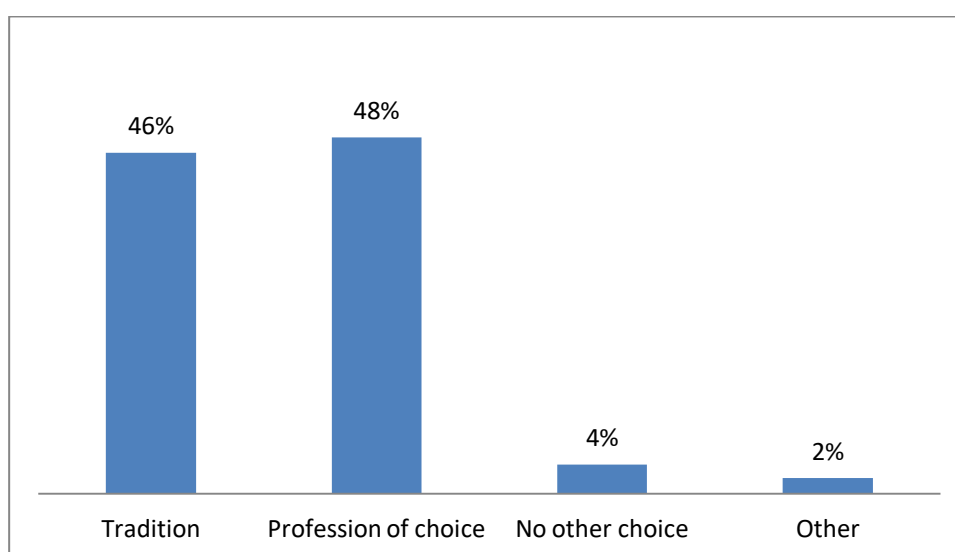
Table 4. Years (experience) in farming

Years	Percentage
1-10	24%
11-20	19%
21-30	28%
>30	29%

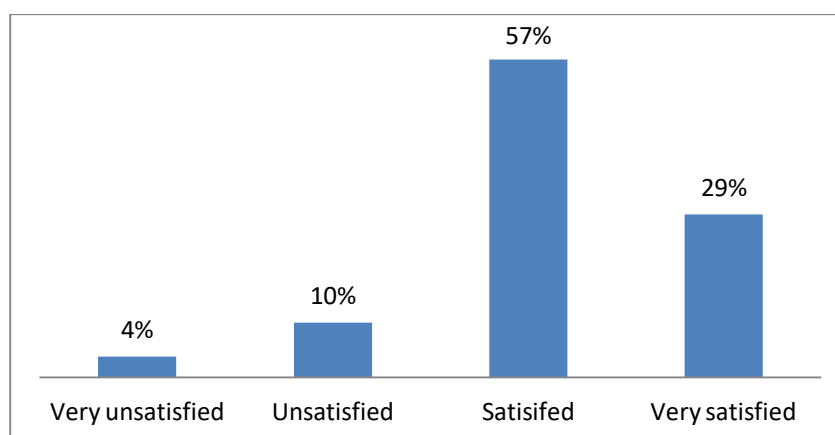
Table 5. Years (experience) in spraying applications

Years	Percentage
1-10	26%
11-20	20%
21-30	28%
>30	26%

Farmers with orchards or vineyards are the least experienced (in farming) ones ($P < 0.10$); the same holds true for experience with spraying applications ($P < 0.05$).

Figure 5: Reasons for becoming a farmer

Farmers said they were engaged with farming because they chose to (48%) or due to tradition – family tradition and/or farm inherited (42%).

Figure 6: Satisfaction with farming

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 main reason for farmers' dissatisfaction, for one out of eight of them, is related to the farm economy, especially low prices for their produce in parallel with high production costs; another 5% refers to instability (of the profession, the markets or the income). Finally, fewer farmers refer to their disappointment from the actions of the state (support, controls, bureaucracy; 9 farmers) and their public image (5 farmers).

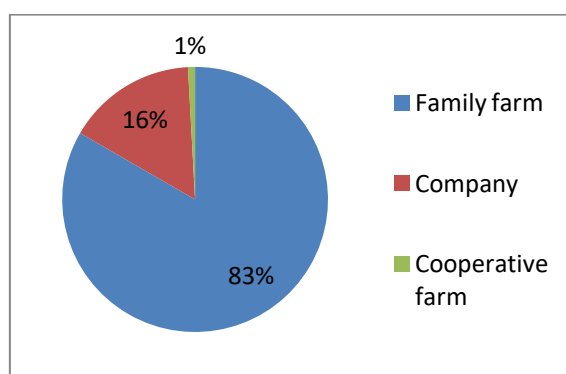
Farmers with orchards or vineyards appear to be the least satisfied ($P < 0.05$).

Most farmers (54.8%) have identified a successor who will inherit and/or take over the farm.

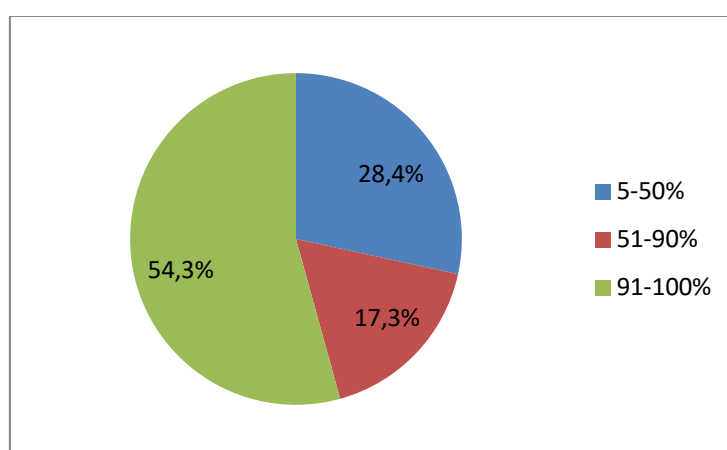
The majority of the farmers with cereals and open field vegetables have identified a successor in comparison to the farmers with other cropping systems - a minority of whom (45%- 48%) has identified a successor ($P < 0.03$).

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).

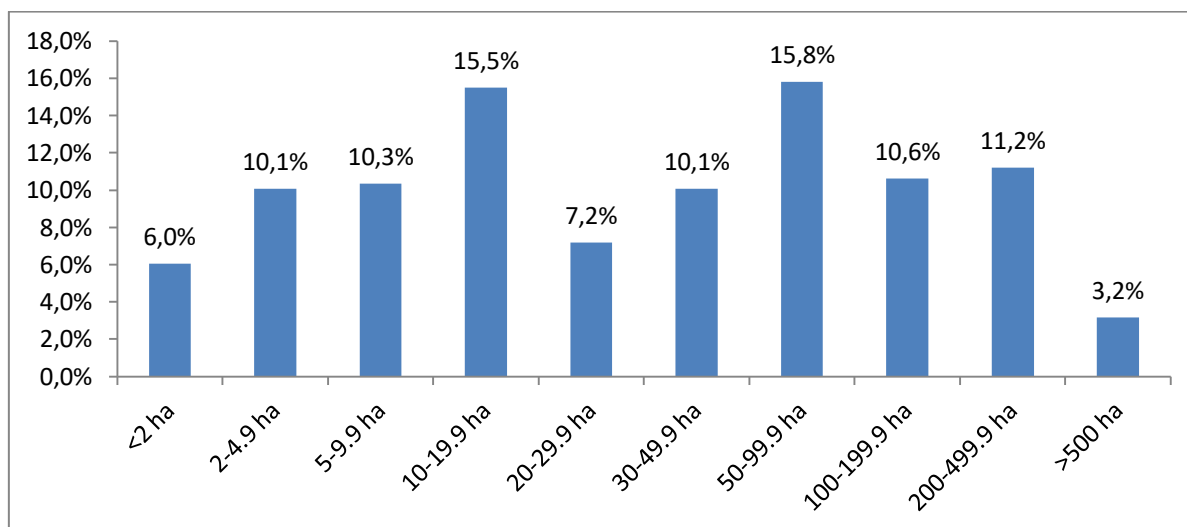
It has to be noted that farmers with greenhouses are found only in flat areas.

Figure 7: Legal status of the farm

The majority of the interviewed farmers operate their own family farm (83%). Companies represent 16% and cooperative farms 1% of the sample.

Figure 8: Percentage of farm income from agricultural activities

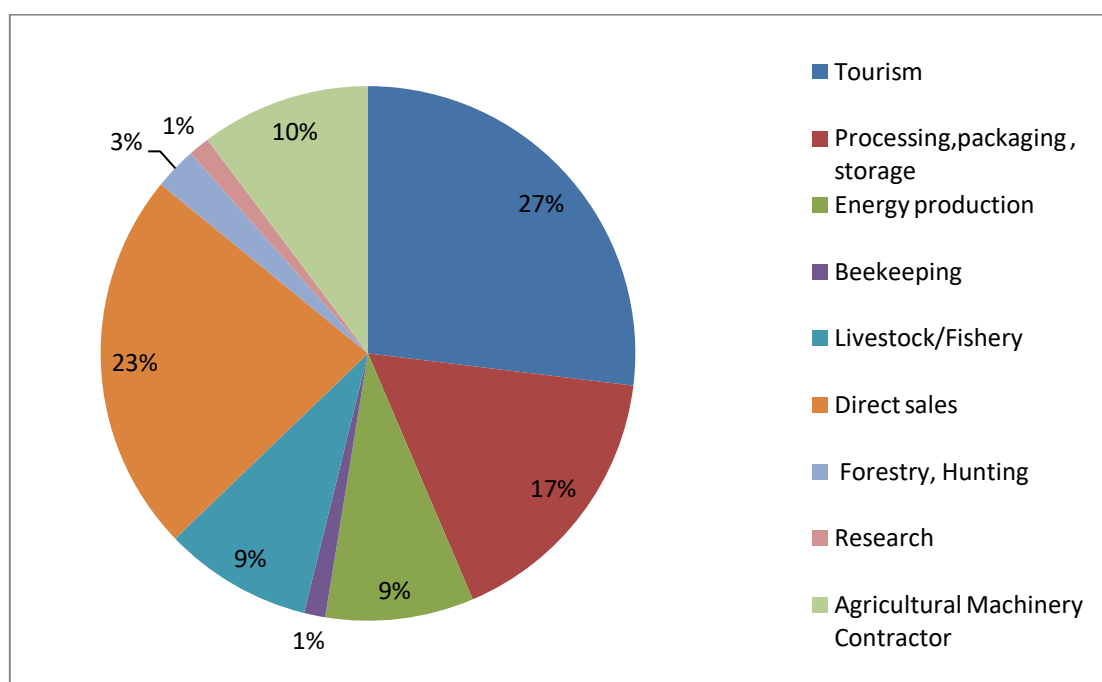
In terms of the contribution of income from agricultural activities to the total family income, as shown in Figure 8, the majority of the interviewees depends on agriculture (54.3% between 91% and 100%) while 28.4% earn up to 50% of their family income from agriculture and 17.3% between 51% and 90%.

Figure 9: Total cultivated area per farm

In Figure 9 the total cultivated area per farm is shown (since although farmers were selected on the basis of the cultivated area of the chosen crops they may also have other cultivations on their farms).

Farmers with cereals and open field vegetables own the largest farms (both with respect to the certain cropping systems examined here as well as irrespectively of crops cultivated in the farm shown in Figure 9) while farmers with greenhouses own the smallest ones ($P=0.000$). The same holds true for the size of rented land ($P=0.000$).

Among the interviewees 20% declared that they are engaged with on-farm non-agricultural activities. Farmers in Sweden (46%), followed by farmers in The Netherlands/Belgium hub (26.1%), Greece (23.1%) and Italy (22%) show the highest percentages of engagement in non-agricultural activities while farmers in Spain (4.1%) and Poland (8%) the least, with French farmers falling in between (19.6%).

Figure 10: Non-agricultural on-farm activities

The most popular on-farm activities found on these farms are (agri-)tourism (27%), direct sales (23%), processing, packaging and storage (17%) and subcontracting (10%).

The majority of the interviewed farmers (55.5%) participate in a certification scheme. This is true for the majority of the farmers in The Netherlands/Belgium hub (85%; and indeed, all the farmers in The Netherlands, Sweden (84%) and Greece (65.4%) while Polish farmers are the ones with the least participation (20%).

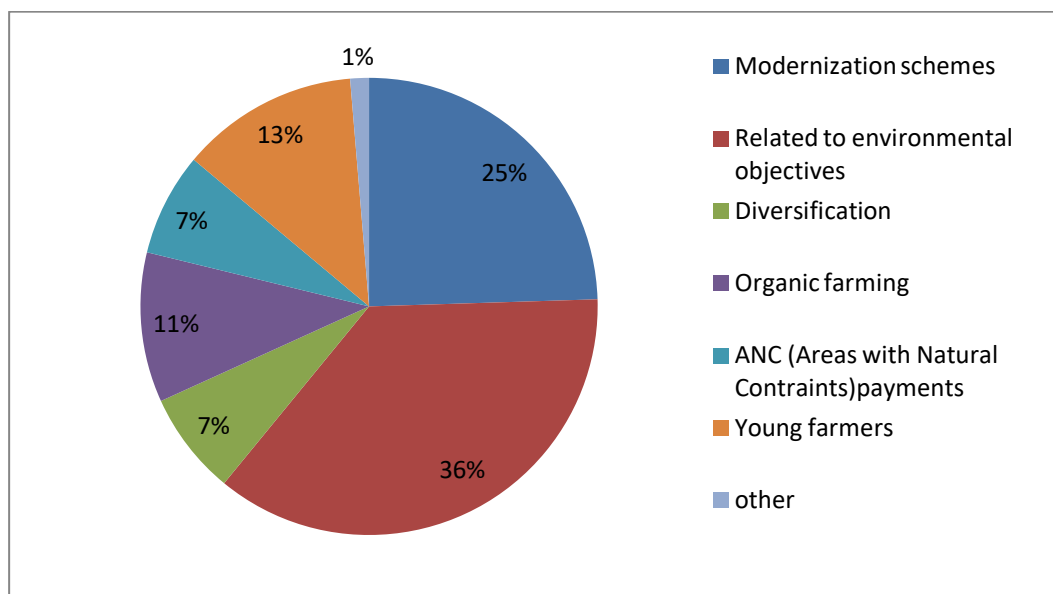
Most of the farmers participate in Global GAP and/or Integrated Production schemes (65.7%), followed by farmers engaged in PDO/PGI schemes (19.7%) and farmers engaged in organic farming (14.6%).

In certification schemes participates the majority of the farmers with orchards and vineyards (68.3%) and half of the farmers with greenhouses but only 45.6% of the farmers with cereals and open field vegetables ($P = 0.000$).

The majority of the farmers in the sample receive direct payments from CAP (85.5%) while 45.4% receive other subsidies (Pillar 2 of the CAP).

Over 90% of the farmers in Sweden, Poland (100%), Italy (94%) and the Belgium/The Netherlands hub (91%) receive direct payments. On the other hand, less farmers in France (60.80%), Spain (77.6%) and Greece (76%) receive direct payment.

Almost all the farmers with cereals/open field vegetables (96.5%) and the majority of the farmers with orchards/vineyards (85.3%) but only a minority of the farmers with greenhouses (23.3%) receive direct payment ($P=0.000$).

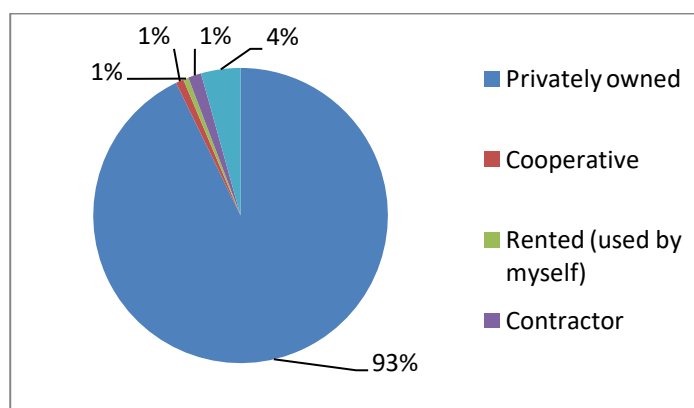
Figure 11: Other subsidies (excl. direct payments)

The 45.4% of the farmers receive other than direct payments subsidies (Figure 11). These mainly concern environmental schemes (36%) and organic farming (11%), modernization/investment schemes (25%), and the young farmers measure (13%).

Other than direct payment subsidies (CAP support Pillar II) receives the majority of the Dutch/Belgian (67%), Polish (58%) and French (57%) farmers as compared with farmers in Spain (49%), Sweden (42%), Greece (29%) and Italy (18%)

The majority of the farmers with cereals/open filed vegetables receive such (Pillar II) subsidies with the farmers with greenhouses being the least involved in relevant schemes ($P=0.000$).

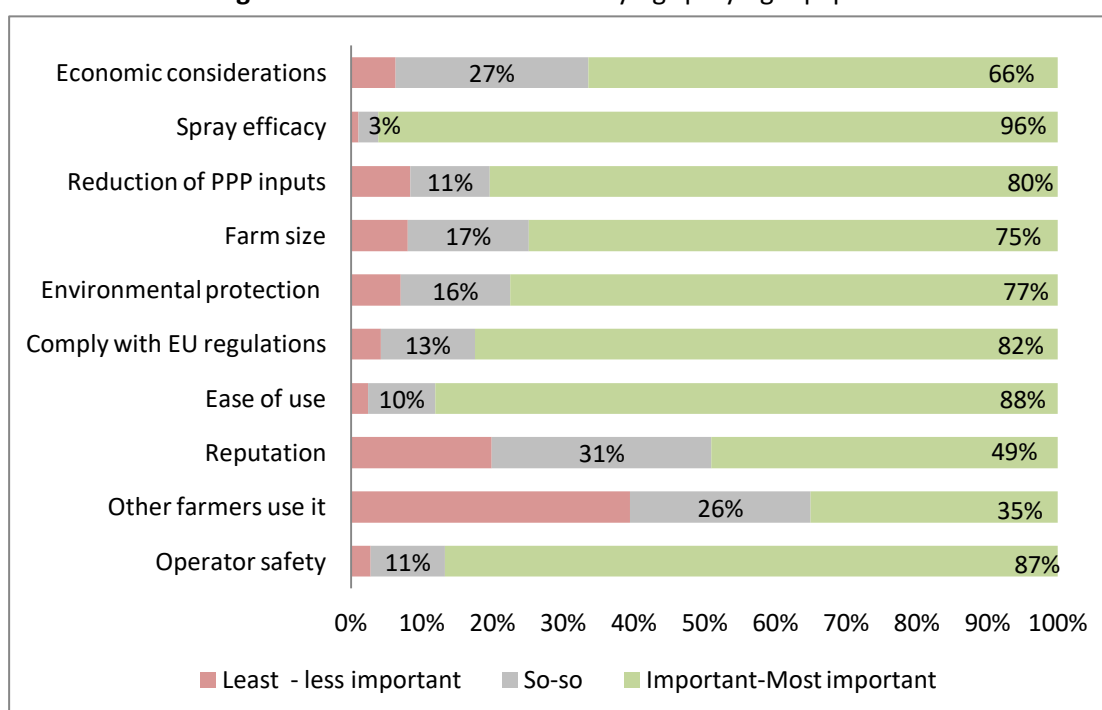
Most of the farms have land parts/parcels that neighbor with inhabited areas (57%) and/or surface waters (51%) while farms neighboring with organic cultivations and protected areas are less but not negligible (25% and 22% respectively).

Figure 12: Ownership of spraying equipment

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).

Subcontractors are chosen mainly due to the long-standing good cooperation with him/her (33.3%), availability (s/he is the only one at the locality) or the advanced equipment s/he uses (26.7% each). When all reasons for choice are considered, then farmers choose a subcontractor on the basis of a long-standing relationship (28%), availability in the area and advanced equipment (20% each) and costs – cheapest in the area – and, for easiness and effectiveness (16%).

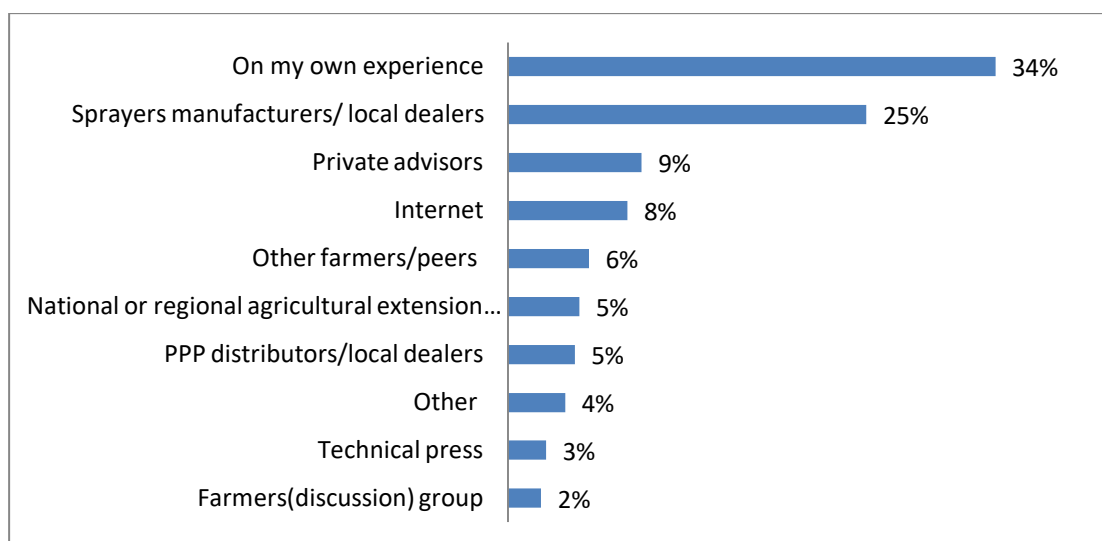
Figure 13: Farmers' criteria for buying spraying equipment



Concerning the criteria which affect farmers' decisions on buying/choosing spraying equipment (Figure 13) '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).

Economic considerations ($P < 0.05$) and farm size ($P < 0.10$) are less important for greenhouse growers; compliance with the EU rules is more important for farmers cultivating cereals and open field vegetables ($P < 0.05$); and the fact that 'other farmers use it' is mostly important for growers with orchards/vineyards ($P = 0.000$). No statistically significant differences occur between farmers with different cropping systems as far as the other criteria are concerned.

Figure 14: Most important source of knowledge/know-how on the use and operation of spraying equipment

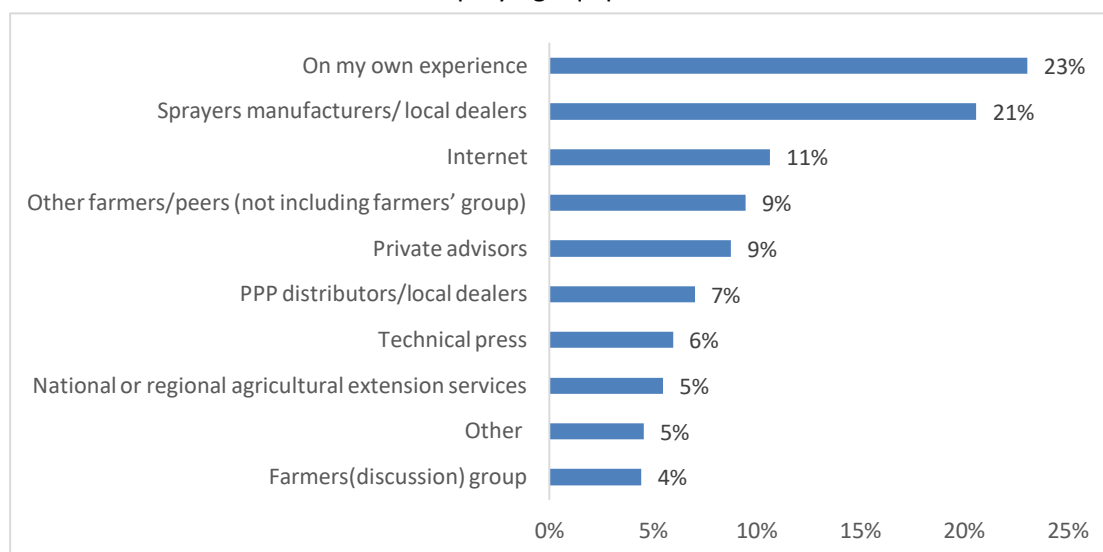


As far as farmers' most important source of knowledge/know-how on the use and operation of their spraying equipment is concerned farmers said that they rely on their own experience (34%) followed by information/advice from equipment manufacturers and dealers (25%) and advisors (private: 9% and public/cooperative: 5%). More specifically, the situation per hub is as follows:

- Belgium/Netherlands: sprayer manufacturers and dealers (28%), own experience (28%), PPP distributor (11%), other farmers/peers (11%)
- Spain: sprayers' manufacturers and dealers (30%), own experience (23.3%), private advisors (16.7%), other peers (13.3%), public advisors (10%)
- France: own experience (45.1%), public extension (15.7%), sprayers' manufacturers and dealers (13.7%)
- Greece: own experience (43.1%), sprayers' manufacturers and dealers (23.5%) and private advisors (9.8%).
- Italy: manufacturers and dealers (46%), own experience (24%), Internet (24%)
- Poland: own experience (44%), PPP distributors and dealers (20%), sprayers' manufacturers and dealers (12%)
- Sweden: own experience (30%), private advisors (18%), sprayers' manufacturers and dealers (16%)

The most important source of knowledge/know-how on the use and operation of their spraying equipment differs between farmers with different cropping systems ($P < 0.10$). Farmers with cereals and open field vegetables mainly mention their own experience closely followed by the industry (sprayers' manufacturers, PPP distributors and their dealers); farmers with orchards/vineyards equally mention the industry and their own experience; and growers with greenhouses their own experience followed away by advisors (private or public).

Figure 15: Three most important sources of knowledge/know-how on the use and operation of spraying equipment



When the three most important sources of information are taken together again farmers' own experience (23% of all the answers to the questions) and equipment manufacturers and dealers (21%) predominate followed by advisors (private: 9% and public/cooperative: 5%), other farmers (9% other peers and 4% farmer groups) and the Internet (11%).

The types of spraying machinery the interviewees use in their farms are shown in Table 6; in addition, their age is shown in Table 7.

Table 6. Type of used spraying machinery

	Number	%
Air-blast sprayer	145	36%
Boom sprayer	197	49%
Greenhouse ³	45	11%
Other	12	3%
Total	399	100

³ Includes machinery/equipment used in greenhouses such as: mainly spray gun (majority of equipment) as well as lances, fixed spraying systems, foggers, robots, irrigation booms, automatic drivers, boom sprayers and knapsack sprayers.

Table 7. Age of machinery

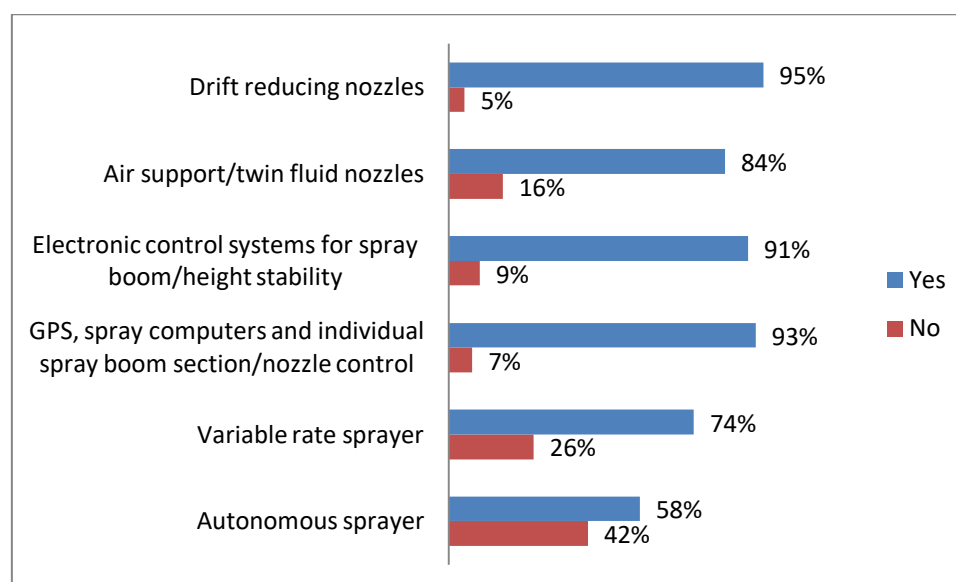
Age class (years)	Percentage
0-5	32%
6-10	26%
11-20	26%
>20	16%

The great majority of the interviewees (92%) declared that their spraying machinery/ equipment have passed the mandatory inspection of sprayers in use according Directive 128/2009/EC. Greece is the country with the smallest inspection percentage⁴.

2.2 Innovative spraying machinery/equipment

Farmers were further asked if they are aware of 6 different Innovative Spraying Equipment, regardless of whether they owned such equipment. The order of technologies is listed from the least to the most technologically advanced equipment for each cropping system (Appendix D).

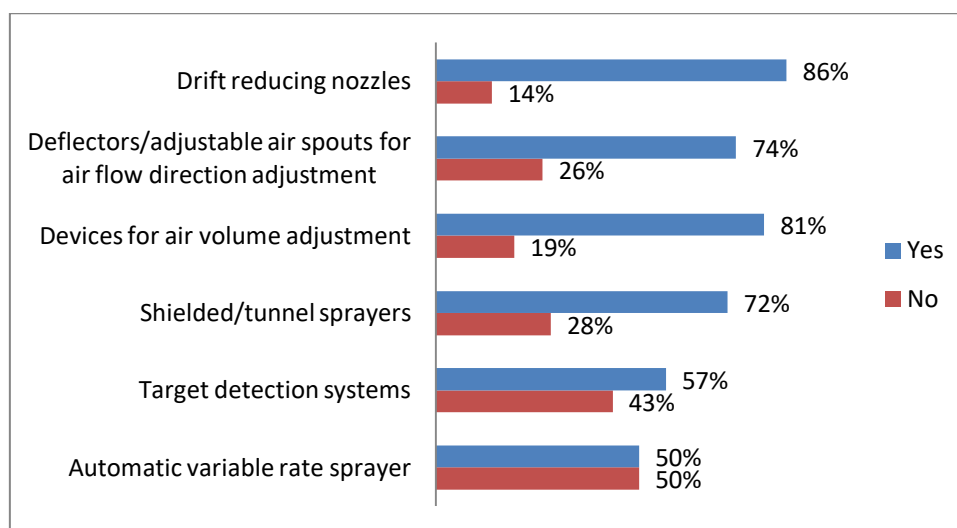
Figure 16: Innovative spraying equipment farmers are aware of (arable/open field vegetables)



⁴ The majority of non-inspected equipment in the sample (38 out of 40) comes from Greece. The reasons for that are either non-compliance with mandatory inspection legislation (boom and orchard sprayers) or the use of gun fixed or semi mobile sprayers which currently are not subject to mandatory inspection.

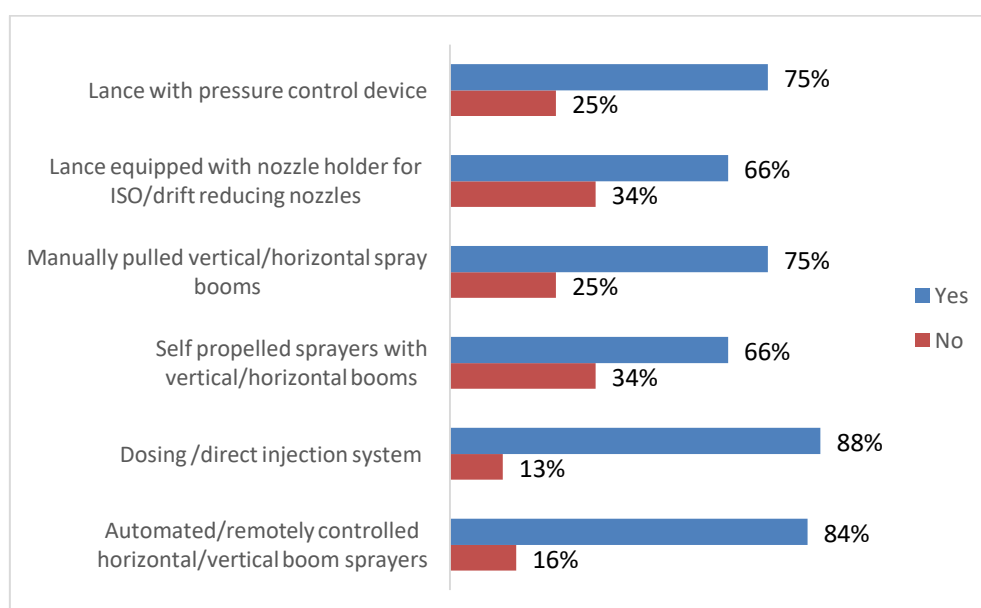
In the case of farmers with arable/open field vegetables cultivations, the most widely known technologies are 'drift reducing nozzles' (95%), 'GPS, spray computers and individual spray boom section/nozzle control' (93%) and 'electronic control systems' for spray boom/height stability (91%) followed by 'air support /twin fluid nozzles' (84%) and 'variable rate sprayers' (74%). The least known, however by most of the farmers, innovative technology is 'autonomous sprayers' (58%).

Figure 17: Innovative spaying equipment farmers are aware of (orchards/vineyards)



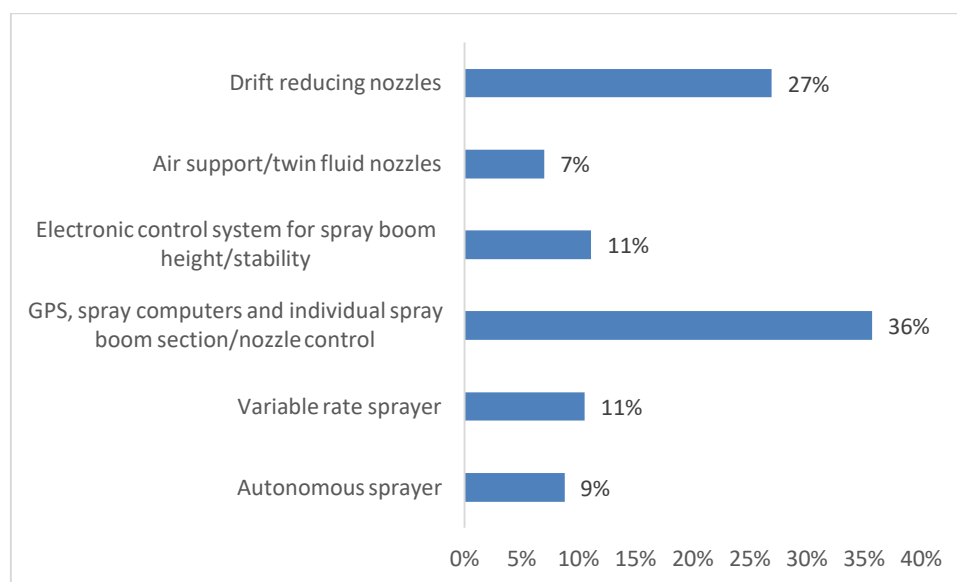
In the case of orchards/vineyards, most farmers are aware of 'drift reducing nozzles' (86%), whereas 81% are aware of 'devices for air volume adjustment'. Farmers are also familiar with 'deflectors/adjustable air spouts for air flow direction adjustment' (74%) and 'shielded/tunnel sprayers' (72%). Awareness is lower with regard to the most advanced equipment, i.e. 'target detection systems' (57%) and 'automatic variable rate sprayers' (50%).

Figure 18: Innovative spaying equipment farmers are aware of (greenhouses)



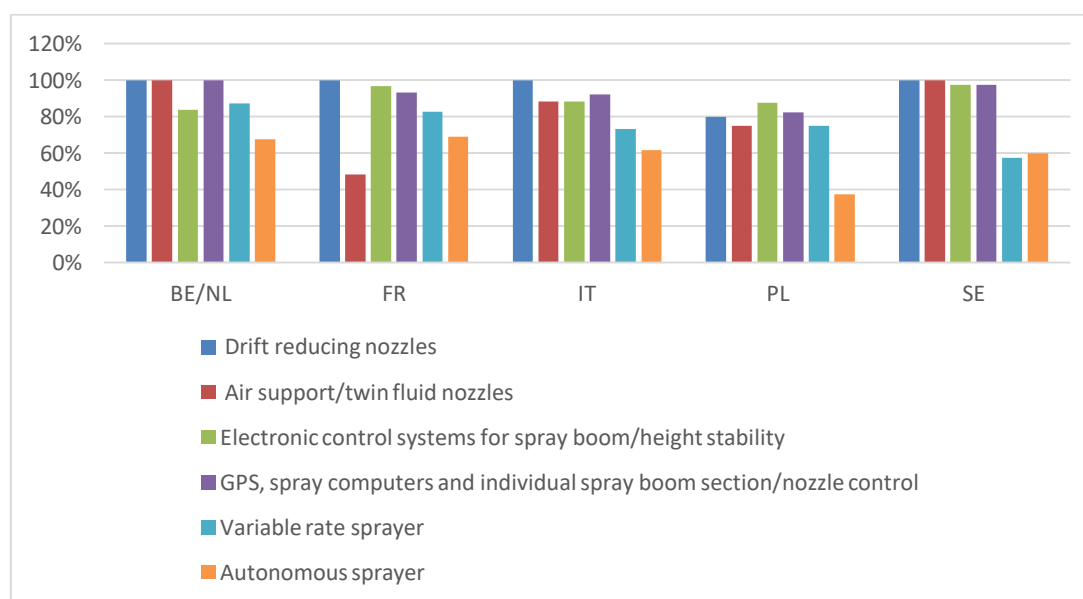
In the case of greenhouses most farmers are aware of 'dosing/direct injection systems' (88%) and 'automated/remotely controlled horizontal/vertical boom sprayers' (88%) followed by 'lance with pressure control devices' and 'manually pulled vertical/horizontal spray booms' (75% each). Two thirds of the farmers are also aware of lance equipped with nozzle holders for ISO/drift reducing nozzles and self-propelled sprayers with vertical/horizontal booms.

Figure 19: Innovative technology the farmer knows better (arable/open field vegetables)



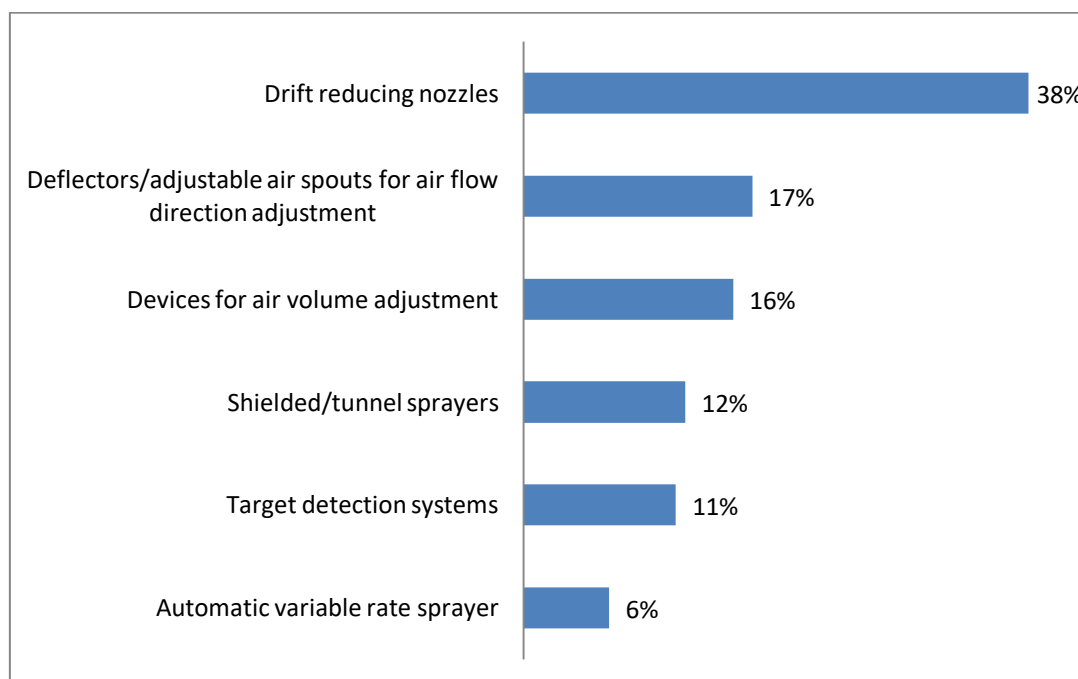
Among the 6 innovative spraying equipment presented to them, farmers cultivating cereals or open field vegetables claimed that they know better 'GPS, spray computers and individual spray boom section/nozzle control' (36%) and 'drift reducing nozzles' (27%) followed by 'electronic control system for spray boom height/stability' and 'variable rate sprayers' (11% each). The least known ones are 'autonomous sprayers' (9%) and 'air support/ twin fluid nozzles' (7%).

Figure 19a: Innovative technology the farmer knows better (arable/open field vegetables) per hub

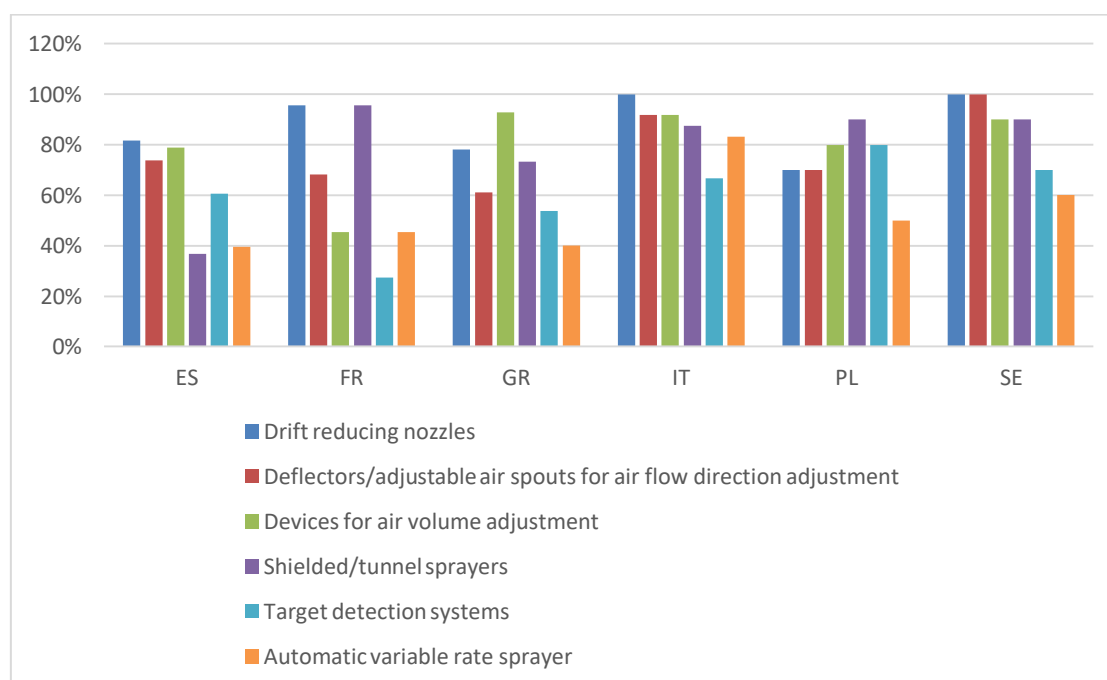


Note: The numbers of farmers are as follows: BE/NL (N=36); FR (N=29); IT (N=26); PL (N=40); SE (N=40)

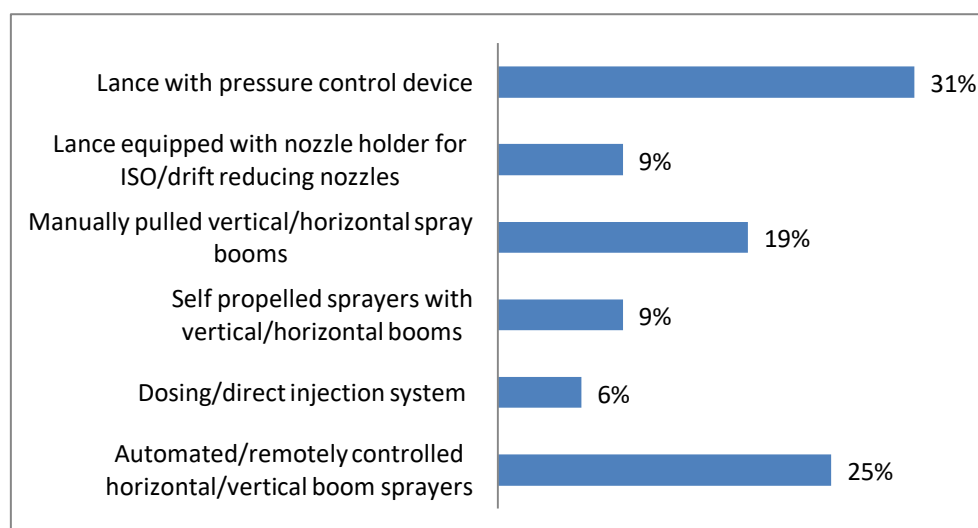
Figure 20: Innovative technology the farmer knows better (orchards/vineyards)



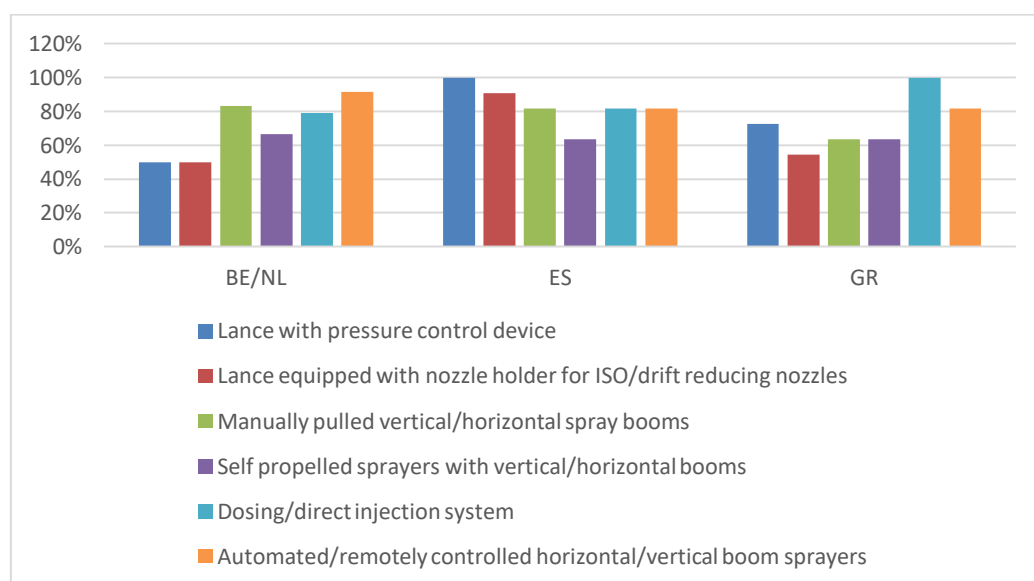
In the case of orchards/vineyards farmers claim that they better know of 'drift reducing nozzles' (38%) followed by the other technologies in descending order in relation to the equipment's innovativeness.

Figure 20a: Innovative technology the farmer knows better (orchards/vineyards) per hub


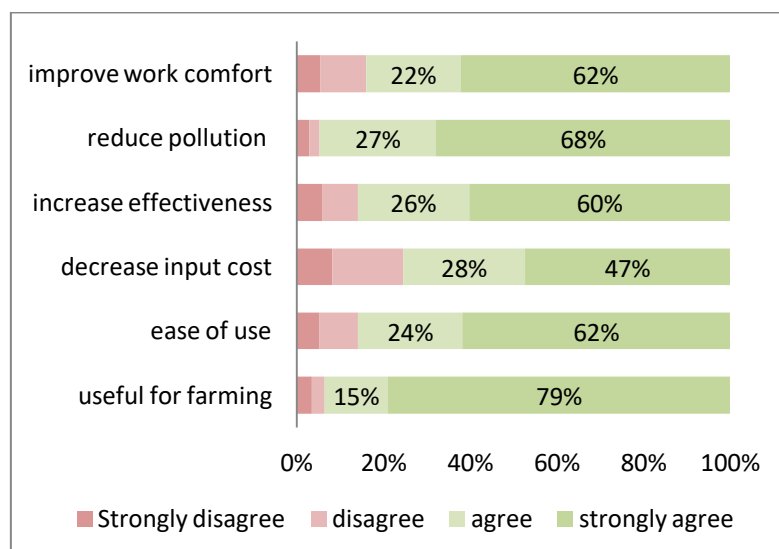
Note: The numbers of farmers are as follows: ES (N=38); FR (N=22); GR (N=41); IT (N=24); PL (N=10); SE (N=10)

Figure 21: Innovative technology the farmer knows better (greenhouses)


In the case of greenhouses farmers claim that among the 6 alternatives presented to them they know better 'lance with pressure control device' (31%) and 'automated/remotely controlled horizontal/vertical boom sprayers' (25%) followed by 'manually pulled vertical/horizontal spray booms' (19%). The rest of the technologies are much less known to farmers (ranging from 9% to 6% each).

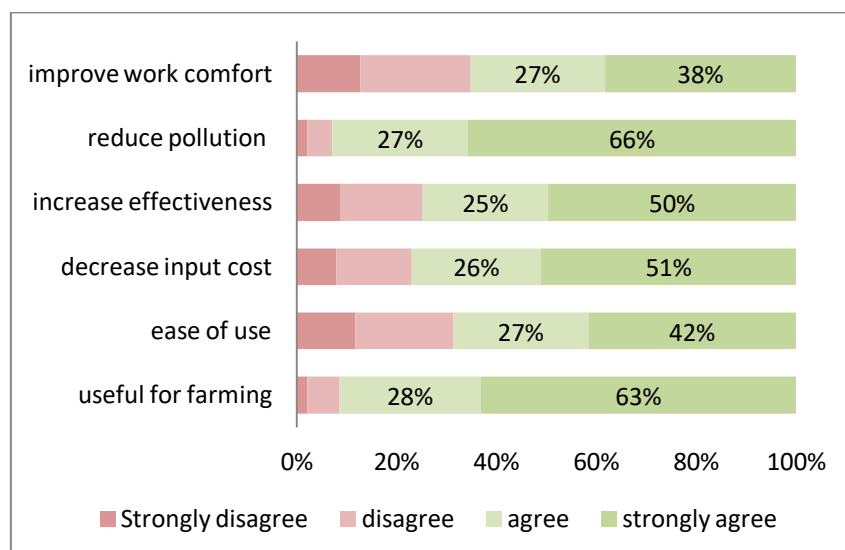
Figure 21a: Innovative technology the farmer knows better (greenhouses) per hub


Note: The numbers of farmers are as follows: BE/NL (N=10); ES (N=11); GR (N=11)

Figure 22: Farmers' opinions on innovative spraying equipment they know best (arable/open field vegetables)


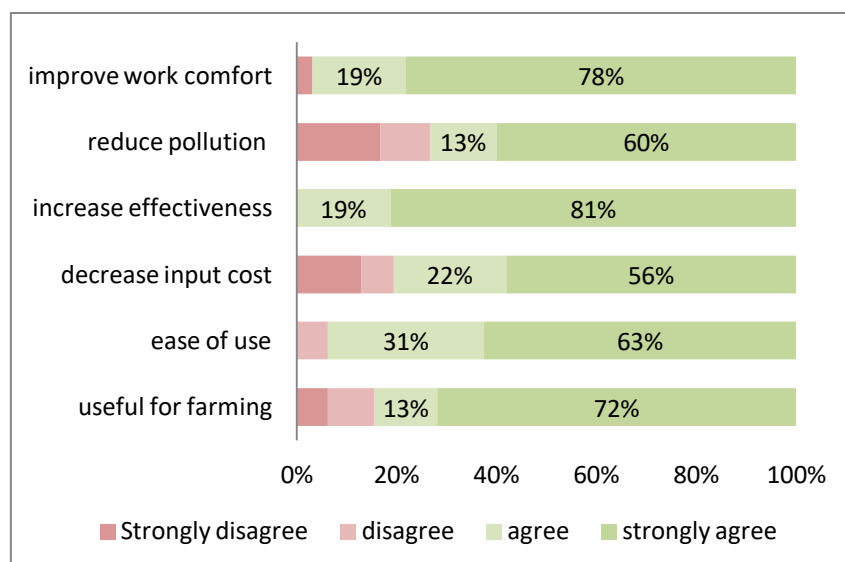
Farmers' opinions concerning the innovative equipment which they know best (among the alternatives presented to them) are, in the case of cereals and open field vegetables, clearly favorable (agree and strongly agree) with respect to the reduction of pollution (95%), usefulness (94%) as well as with respect to work comfort (84%), ease of use - as compared to current equipment (86%), effectiveness (86%) and the reduction of input costs (75%).

Figure 23: Farmers' opinions on innovative spraying equipment they know best (orchards/vineyards)



The opinions of farmers with orchards or vineyards are also favorable, albeit to a lesser degree. These farmers declare that the innovative equipment which they know best are better in terms of the reduction of pollution (93%), usefulness (91%) as well as with respect to the reduction of input costs (77%), effectiveness (75%), ease of use - as compared to current equipment (69%) and work comfort (65%).

Figure 24: Farmers' opinions on innovative spraying equipment they know best (greenhouses)



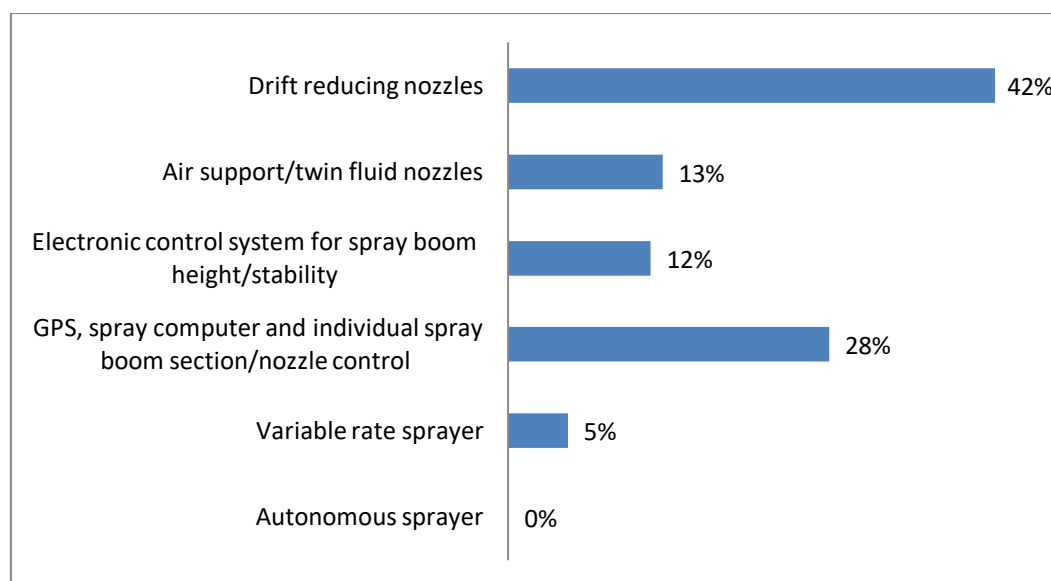
Favorable opinions are also expressed by farmers with greenhouses. In this case farmers find that the innovative equipment which they know best are better in terms of effectiveness (100%), work comfort (97%) and ease of use - as compared to current equipment (94%) as well as with respect to usefulness (85%), the reduction of input costs (78%) and the reduction of pollution (73%).

2.3 Adopters of innovative spraying machinery/equipment

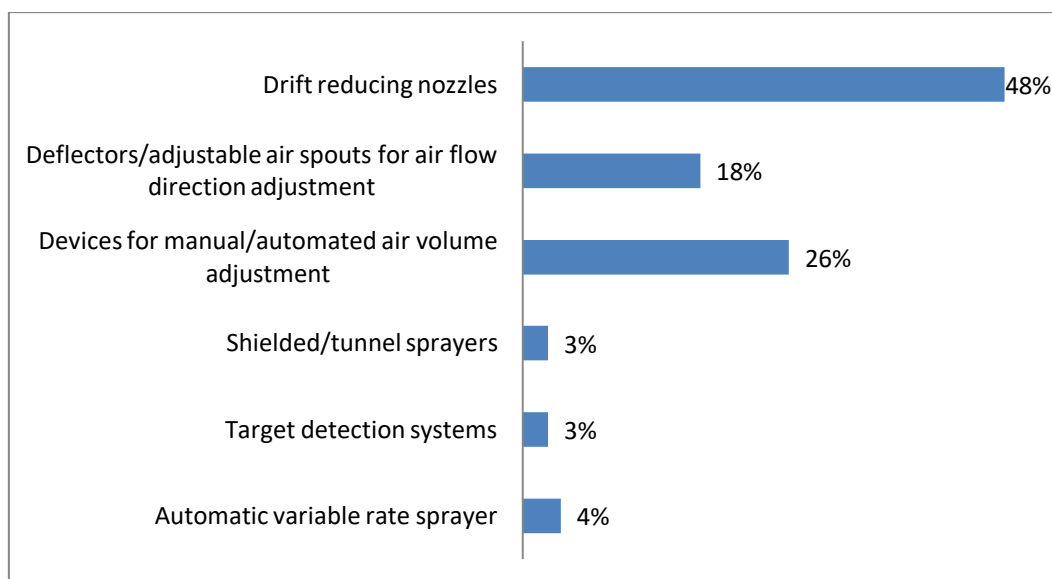
The adopters of one of the innovative spraying equipment are 204 (58.6% of the sample). Per category of cropping system(s) they have adopted (own and use) the following innovative equipment (Figures 25, 26 & 27).

It is important to note here that the definition of adopters is somehow different in the case of Flanders (Belgium) and Sweden than in the rest of the hubs. In Flanders the use of Low Drift Nozzles in a rate of (at least) 50% of the nozzles the farmer uses is mandatory; therefore, farmers who only have 50% drift reducing nozzles (and no other innovative equipment) were classified as a non-adopters. In Sweden farmers who have (in order to comply with legislation) but do not use injection nozzles (and no other innovative equipment) are also classified as non-adopters.

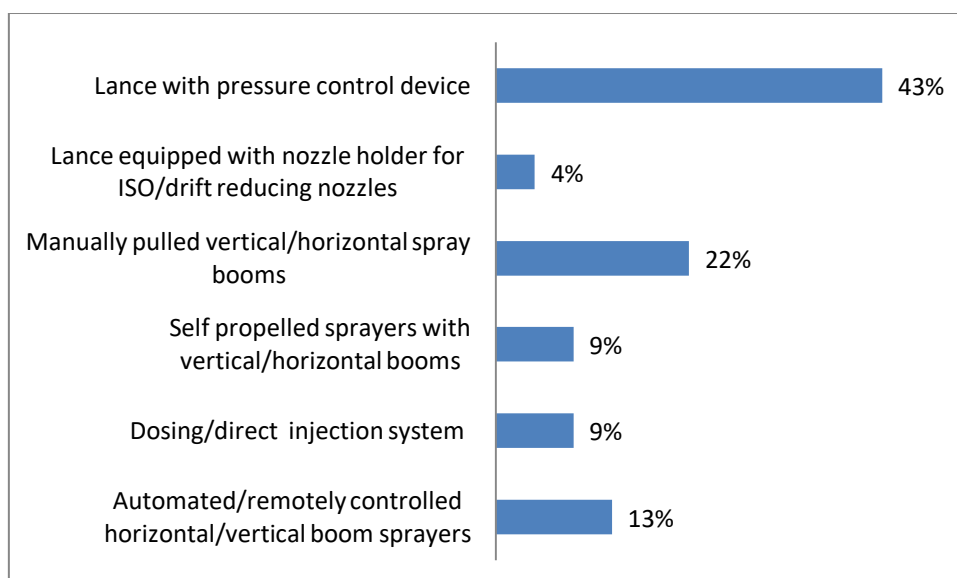
Figure 25: Adoption of innovative spraying equipment (arable and open field vegetables)



In the case of arable and open filed cultivators they mainly own and use 'drift reducing nozzles' (42%) and 'GPS, spray computers and individual spray boom section/nozzle control' (28%). Much lesser farmers have adopted "Air support/twin fluid nozzles' (13%), 'electronic control system for spray boom height/stability' (12%) and 'variable rate sprayers' (5%) while none has got 'autonomous sprayers' (0%).

Figure 26: Adoption of innovative spraying equipment (orchards and vineyards)


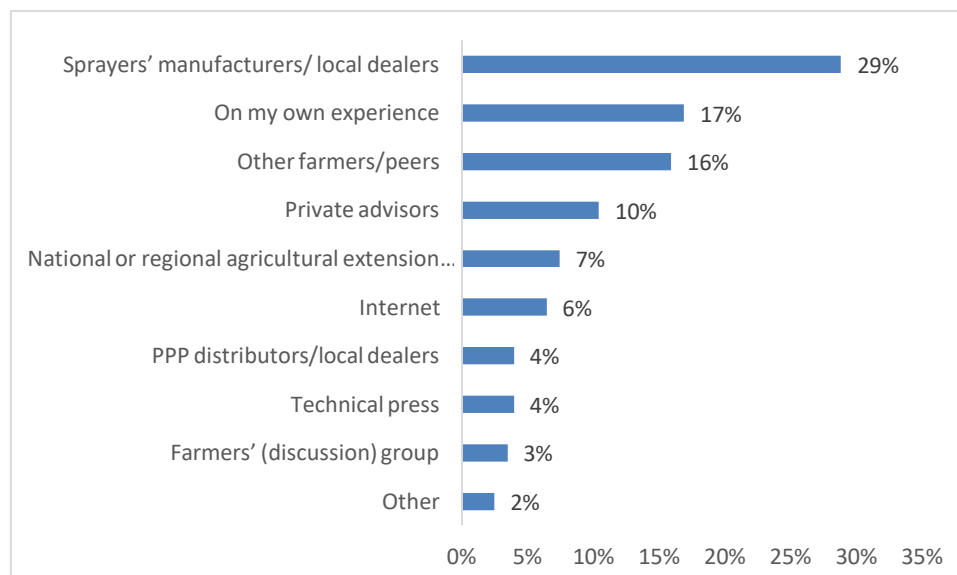
Farmers with orchards or vineyards have mainly adopted ‘drift reducing nozzles’ (48%), ‘devices for air volume adjustment’ (26%) and ‘deflectors/adjustable air spouts for air flow direction adjustment’ (18%). Much fewer farmers use the rest innovative spraying equipment (from 3% to 4% each)

Figure 27: Adoption of innovative spraying equipment (greenhouses)


Farmers with greenhouses have mainly got ‘lances with air pressure control device’ (43%), ‘manually pulled vertical/horizontal spray booms’ (22%) and ‘automated/remotely controlled horizontal /vertical boom sprayers’ (13%). The adoption of the rest spraying equipment is much

lower: 9% for 'self-propelled sprayers' as well as for 'dosing/direct injection systems' and 4% for 'lance equipped with nozzle holder for ISO/drift reducing nozzles'.

Figure 28: Most important farmers' information source on buying innovative spraying equipment

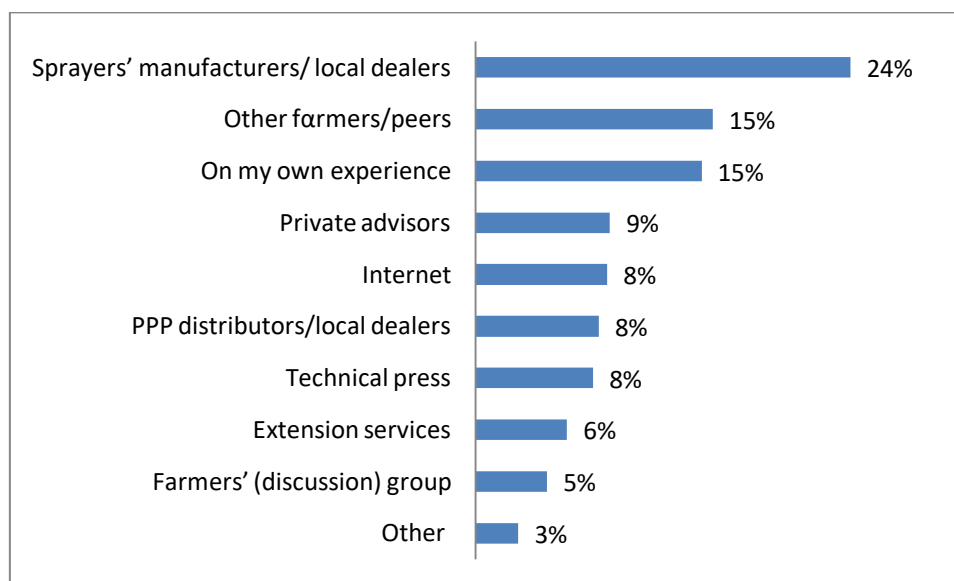


The most important farmers' source of information on buying innovative spraying equipment is sprayers' manufacturers/dealers (29%) followed by farmers' own experience (17%), other farmers (16%) and private advisors (10%). All the other sources of information account for less than 10% each.

More specifically, the situation per hub is as follows:

- Belgium/The Netherlands: sprayers' manufacturers/dealers (32%), own experience (14%), other farmers (14%), private advisors as well as PPP distributors/local dealers (11% each)
- Spain: sprayers' manufacturers/dealers (22.5%), own experience (20%), other farmers (20%), private advisors (17.5%), farmers' group (12.5%)
- France: public advisors (43.8%), own experience (25%), sprayers' manufacturers/dealers (18.8%)
- Greece: sprayers' manufacturers/dealers (33.3%), other farmers (29.2%), internet (16.7%), own experience (12.5%)
- Italy: sprayers' manufacturers/dealers (48.4%), own experience (12.9%), other farmers (9.7%)
- Poland: own experience (28%), internet (20%), technical press (16%), sprayers' manufacturers/dealers (12%), PPP distributors/dealers (12%)
- Sweden: sprayers' manufacturers/dealers (28.6%), other farmers (25%), private advisors (25%), own experience (10.7%)

Figure 29: Three most important farmers' information sources on buying innovative spraying equipment



Farmers said that the three most important sources of information for buying their innovative spray equipment were sprayers' manufacturers/ local dealers (24%) along with other farmers/peers and their own experience (15% each). All the other sources of information account for less than 10% each.

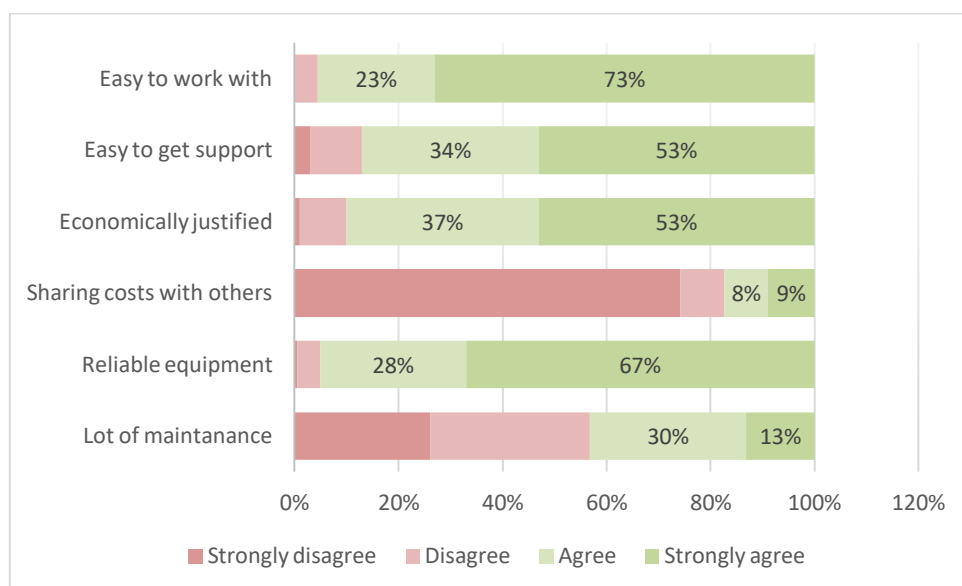
The majority of the adopters did not test the equipment before buying it (70.6%).

This is mostly true for open field cultivations (around 27% of the farmers tested the machinery) while 50% of the farmers with greenhouses said they tested the equipment they were going to buy.

The majority of the adopters (78.6%) assert that the innovative equipment they bought and use has changed the way they do the job (spraying).

In general, adopters state that their innovative spraying equipment are easy to work with (96%), reliable (95%) and economically justified (90%); additionally, it is easy to get technical support for their equipment (87%) and they do not require a lot of maintenance (57%). Farmers also disagree with the statement that "sharing costs with other farmers has allowed you to use this spraying equipment" (83%).

Figure 30: Adopter's opinions on the innovative spraying equipment they have



In Figures 31, 32 & 33 the opinions of the farmers with different cropping systems are presented.

Figure 31: Adopter's opinions on the innovative spraying equipment they have (arable/open field vegetables)

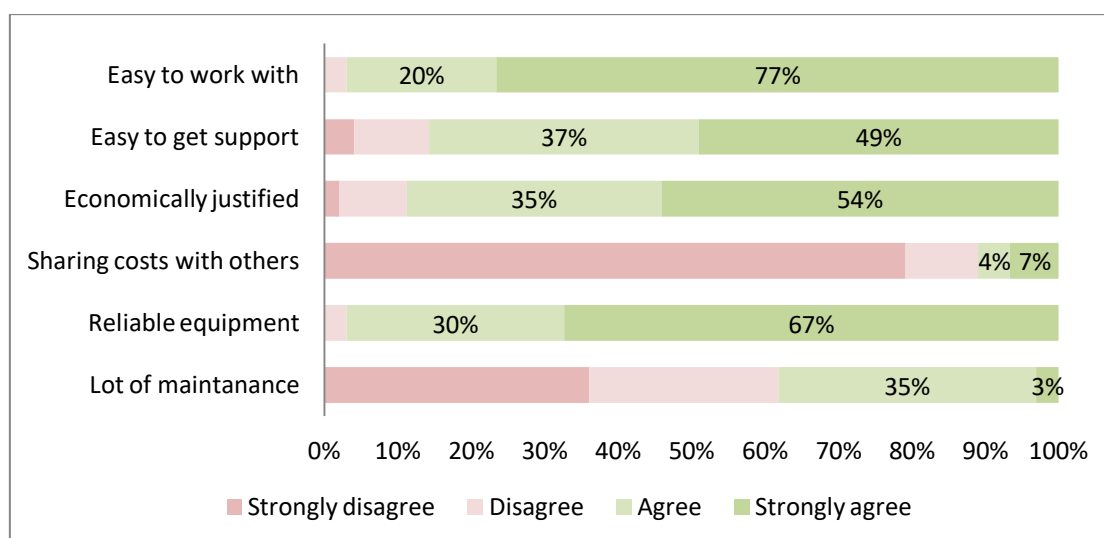
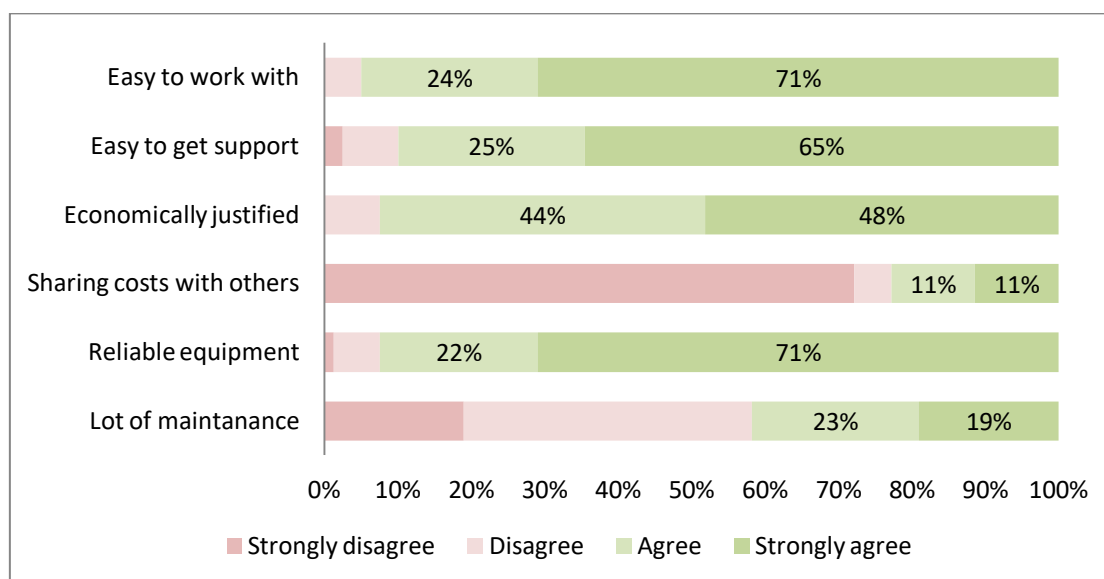
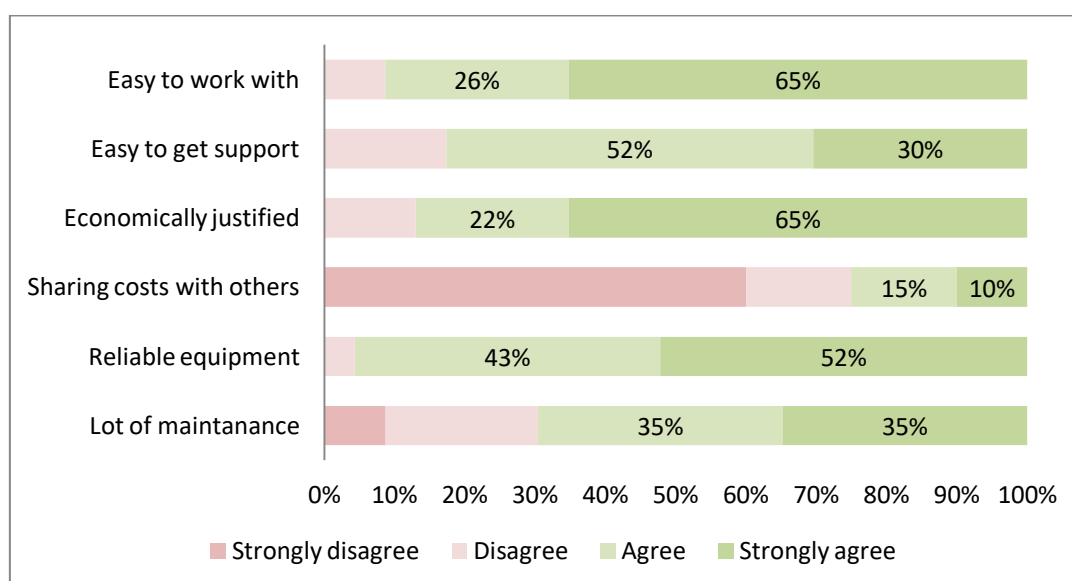


Figure 32: Adopter's opinions on the innovative spraying equipment they have (orchards/vineyards)

Figure 33: Adopter's opinions on the innovative spraying equipment they have (greenhouses)


Interviewees do not show statistically significant differences in their opinions about their innovative spraying equipment with the exception of the statements 'Sharing costs with other farmers has allowed me to use this spraying equipment' and 'This spraying equipment requires a lot of maintenance' with which farmers with greenhouses are more likely to agree ($P < 0.10$ and $P = 0.000$, respectively).

Only 16.7% of the farmers said that a specific subsidy (i.e. a subsidy other than the direct farm payment) gave them the opportunity to invest in their innovative spraying equipment.

As far as the farmers' plans for purchasing new innovative spraying equipment are concerned these are presented in Figures 34, 35 & 36.

Figure 34: Next equipment farmers will potentially purchase (arable and open field vegetables)

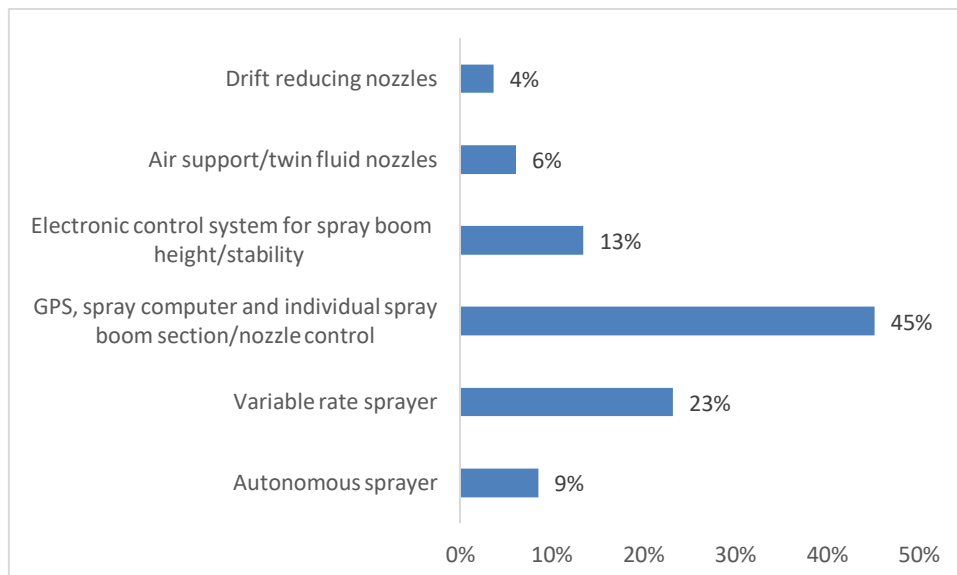


Figure 35: Next equipment farmers will potentially purchase (orchards and vineyards)

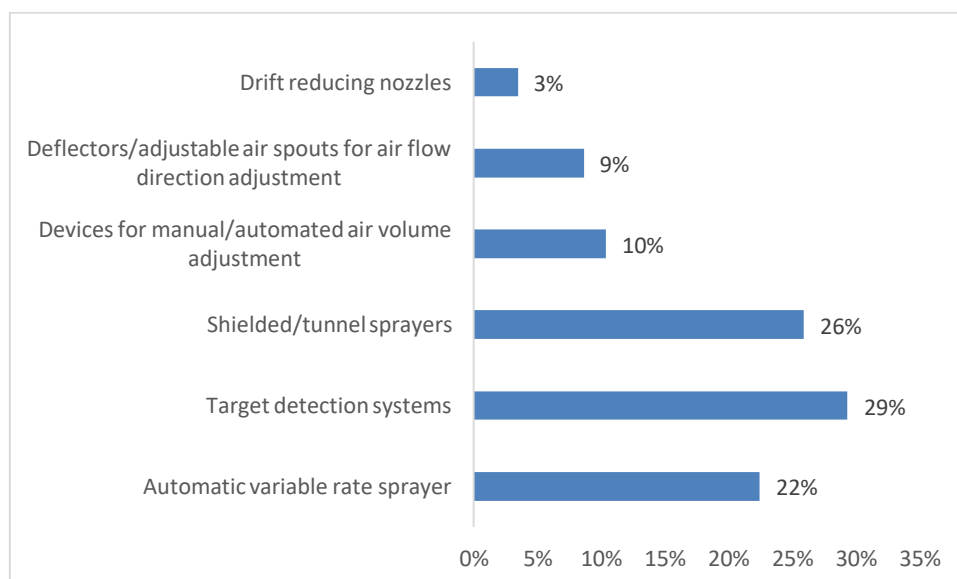
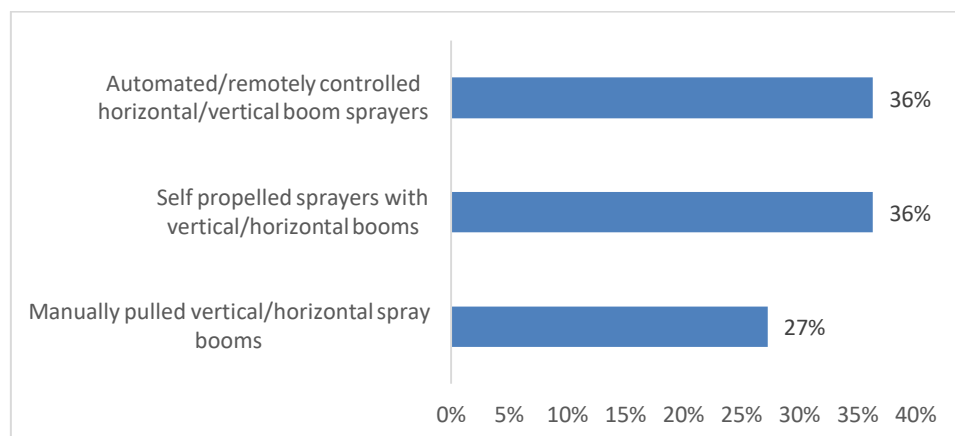


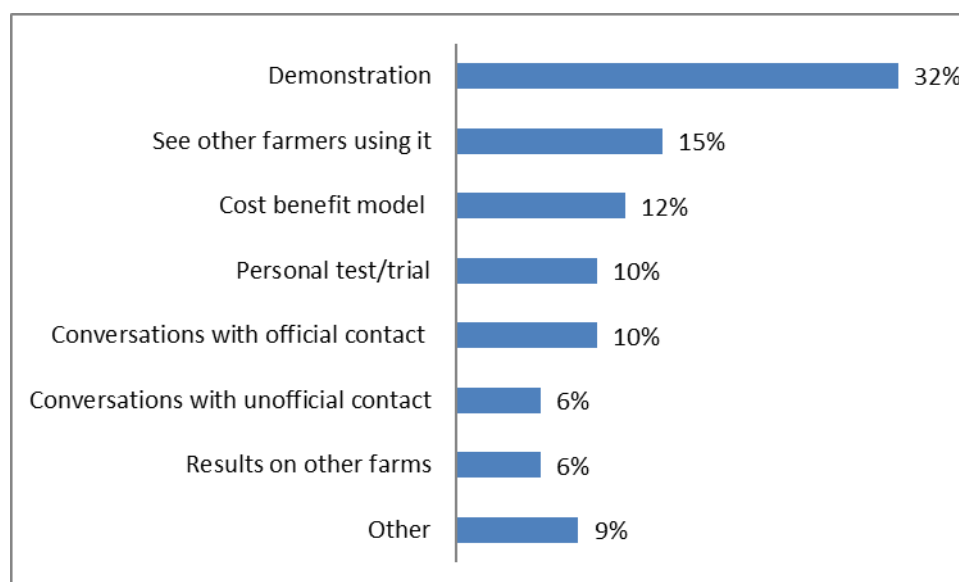
Figure 36: Next equipment farmers will potentially purchase (greenhouses)



2.4 Non-adopters of innovative spraying machinery/equipment

The adopters of none of the innovative spraying equipment they were presented with (i.e. non-adopters) account for 44.1% of the sample (144 farmers)⁵.

Figure 37: Information source farmers trust the most for buying innovative spraying equipment



These farmers declared that the most important source/piece of information/test they would trust before deciding to purchase innovative spraying equipment are demonstrations (32%), other farmers using the equipment (15%), a cost-benefit model tailored to their farm (12%) as well as a

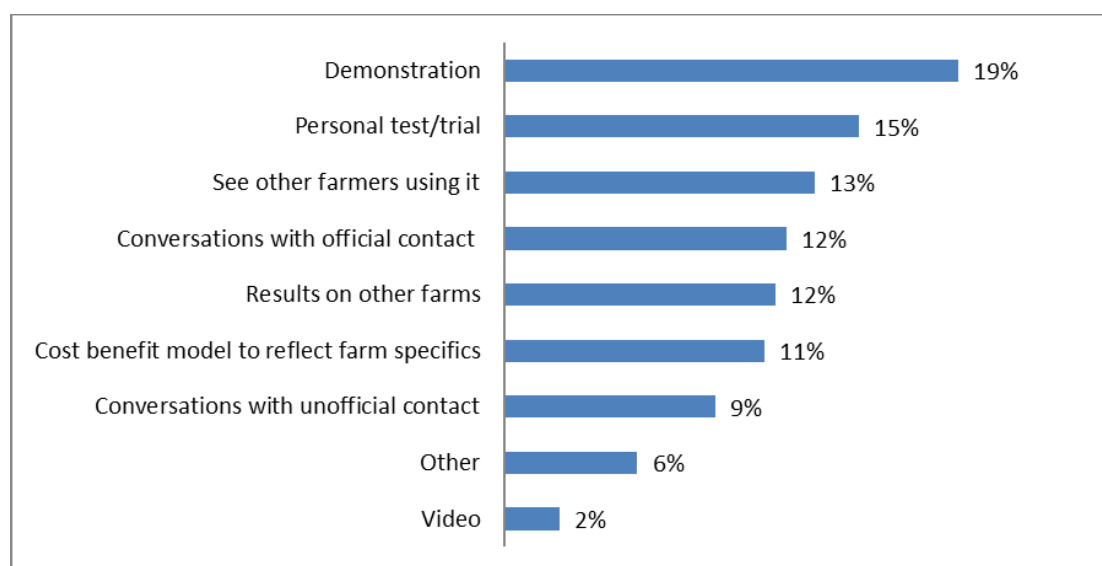
⁵ In The Netherlands the fact that the use of Drift Reducing Nozzles is mandatory (75% of all the nozzles the farmers uses) it has been extremely difficult to locate non-adopters.

personal trial or conversation with someone with advisory capacity (10%). ‘Other’ refers to 13 cases out of which 4 refer to extension/advisory service and another 4 to the Internet.

More specifically, the situation per hub is as follows:

- Belgium/The Netherlands: demonstrations (33%), conversations with unofficial contact (neighbor/other farmer) (22%), personal test/trial, see other farmers use it, results on other farms, or cost/benefit model (11% each)
- Spain: demonstrations (33%), discussion with other farmers (17%), see other farmers use it (17%), results on other farms (17%)
- France: demonstrations (56%), personal trial (12%), other/extension service (12%)
- Greece: demonstrations (26%), see other farmers use it (26%), other/internet (15%)
- Italy: cost-benefit models (36.8%), conversation with advisors (21.1%), personal trial (21.1%), see other farmers use it (15.8%)
- Poland: cost-benefit models (33.3%), demonstrations (29.2%), see other farmers use it (16.7%)
- Sweden: conversation with advisors (34.8%), demonstrations (26.1%), discussion with other farmers (13%)

Figure 38: Information sources farmers trust the most for buying innovative spraying equipment

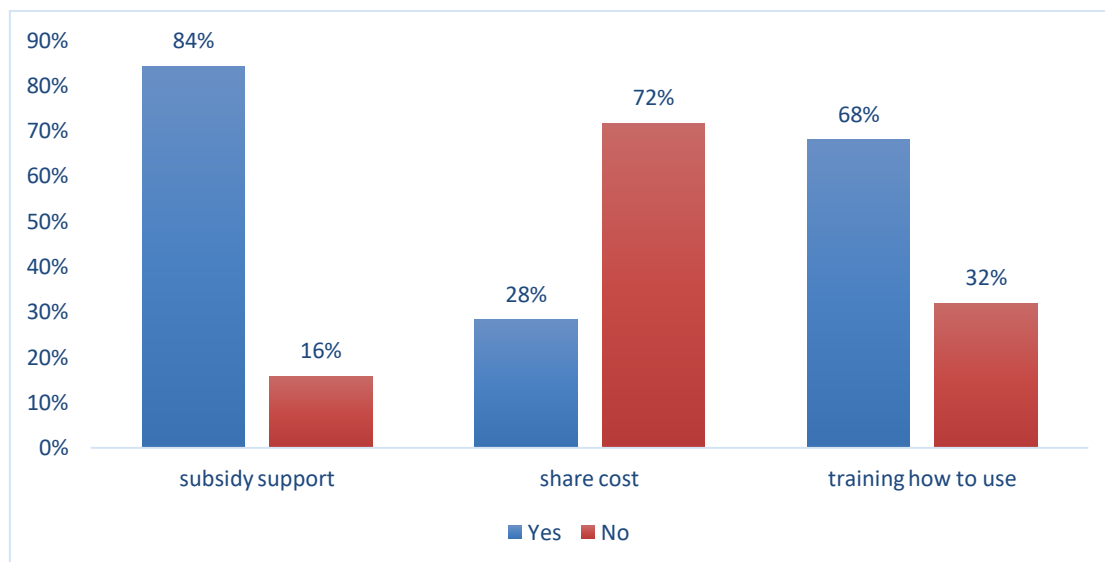


When it comes to the three most important sources/pieces of information/tests they would trust before deciding to purchase innovative spraying equipment demonstrations still lead (19%), followed by personal trials (15%) and other farmers using the equipment (13%). Conversations with someone with advisory capacity as well as results on other farms are equally important at 12% closely followed by a cost-benefit model tailored to their farms (11%) and conversations with peers and neighbors (9%).

In particular, the most important source is ‘demonstrations’ (32% of the answers); the first among the second most important sources is ‘personal test/trial’ (17% of answers of those who declared a second most important source); and the first among the third most important sources is ‘results on

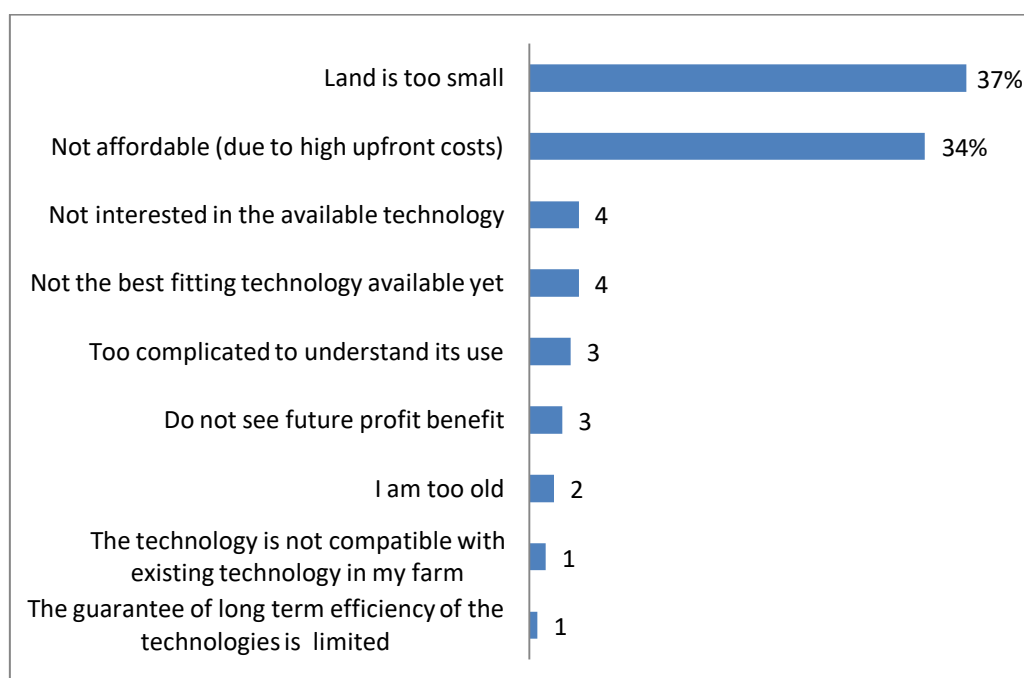
other farms' and 'personal test/trial (19% of answers, respectively, among the ones who declared a third source).

Figure 39: Incentives for buying innovative spraying equipment



Non-adopters claim that they would buy innovative spraying equipment if they would get a subsidy (84%) as well as relevant training (68%) and to a much lesser degree if they could share initial (purchase) costs (28%).

Figure 40: Most important reason for non-adopting innovatory spraying equipment



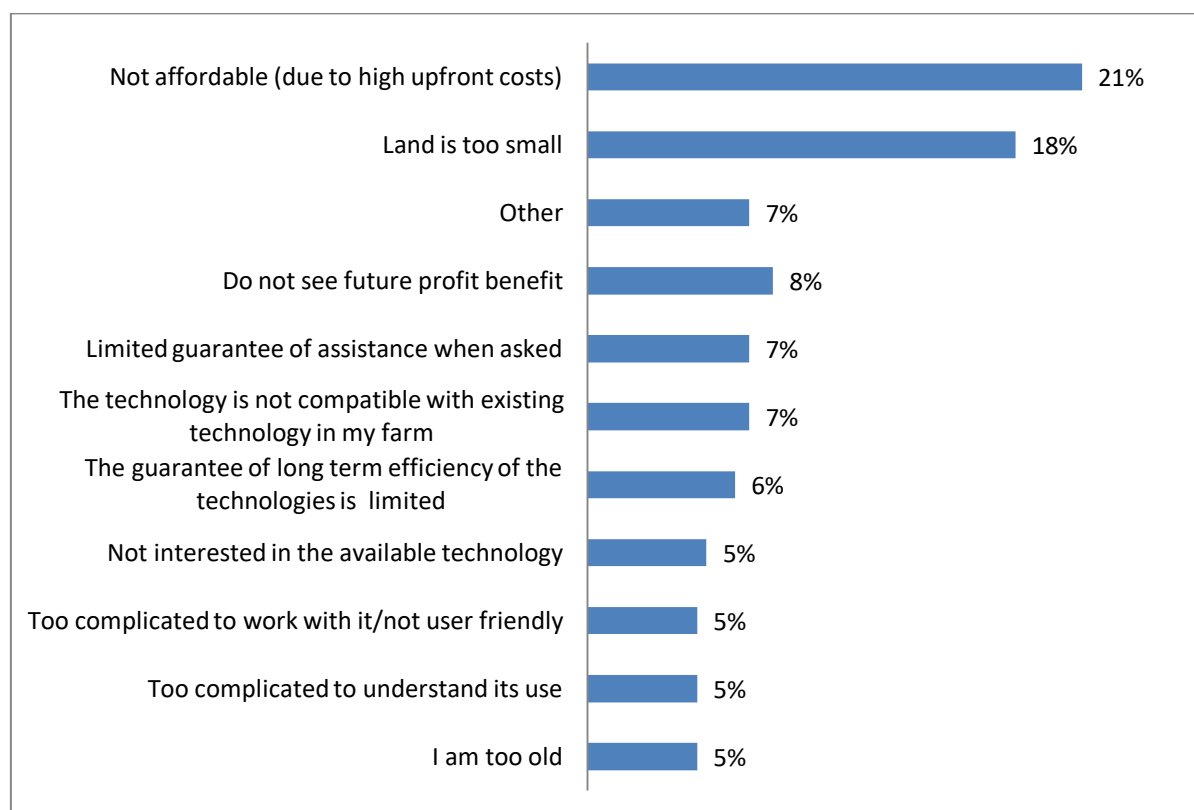
According to non-adopters the main reason for not having innovatory spraying equipment owes to their small sized farms (37%) and that they cannot afford it (34%).

More specifically, the situation per hub is as follows:

- Belgium/The Netherlands: small size (56%; 100% The Netherlands), no best fit (11%), not affordable (33%)
- Spain: small size (60%), affordability (20%), no best fit (10%), compatibility (10%)
- France: small size (36%), affordability (26%), no future profit (10%), no interest (10%)
- Greece: affordability (41%), small size (19%), do not need it (15%), not suitable for land morphology (11%).
- Italy: small size (68%), affordability (21%),
- Poland: affordability (46%), small size (25%)
- Sweden: affordability (39%), small size (30%), too complicated (13%).

The main reason per cropping system is as follows:

- Cereals and open field vegetables: not affordable (19%), small size (17%), do not see future profit/benefit (12%)
- Orchards and vineyards: not affordable (25%), small size (19%)
- Greenhouses: small size (24%), technical assistance not guaranteed (13%), not affordable (10%)

Figure 41: Reasons for non-adopting innovatory spraying equipment

When all five reasons for non-adoption are aggregated again the issues of affordability and small farms prevail (21% and 18% respectively) with all other reasons ranging between 5% and 8%⁶.

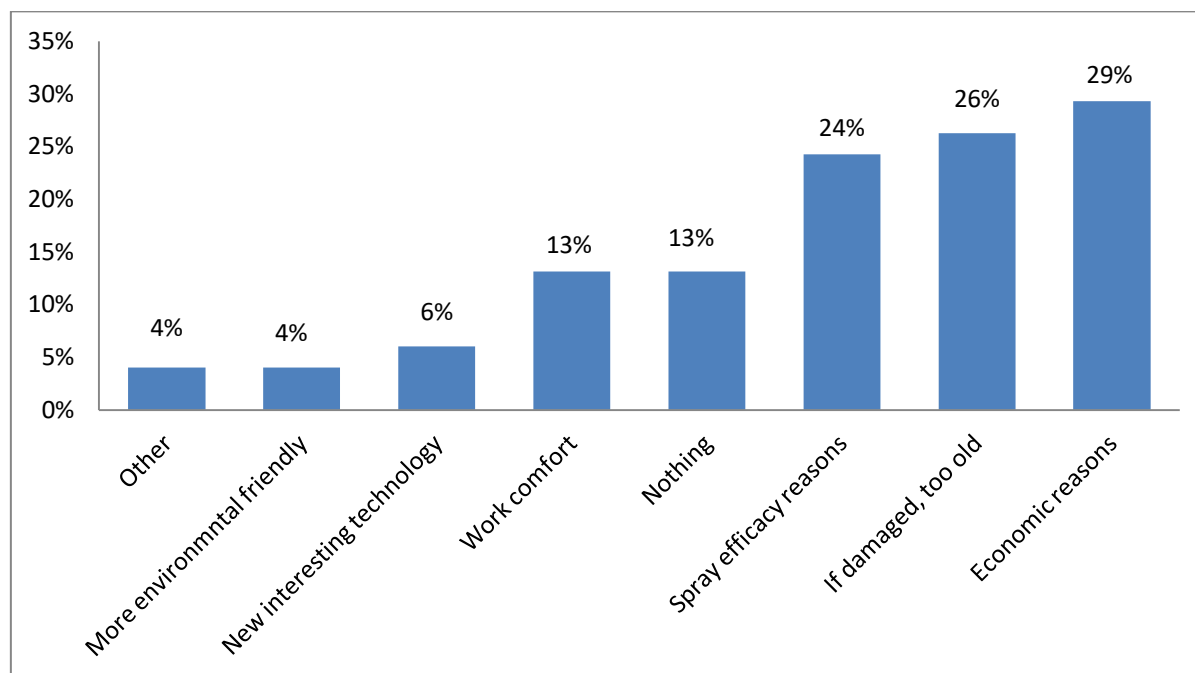
Furthermore, most of these farmers (61%) said that they do not renew their farm equipment frequently.

The percentages of farmers who stated that they frequently renew their farm equipment per hub are as follows:

- Belgium/The Netherlands: 44%
- Spain: 18%
- France: 44%
- Greece: 19%
- Italy: 16%
- Poland: 67%
- Sweden: 52%

⁶ Other refers to 30 answers among which the most important are: 'do not need it/my old machine works well' (11), 'not handy' (3) and 'not suitable for the morphology of the farm' (3).

Figure 42: Reasons for investing in something new

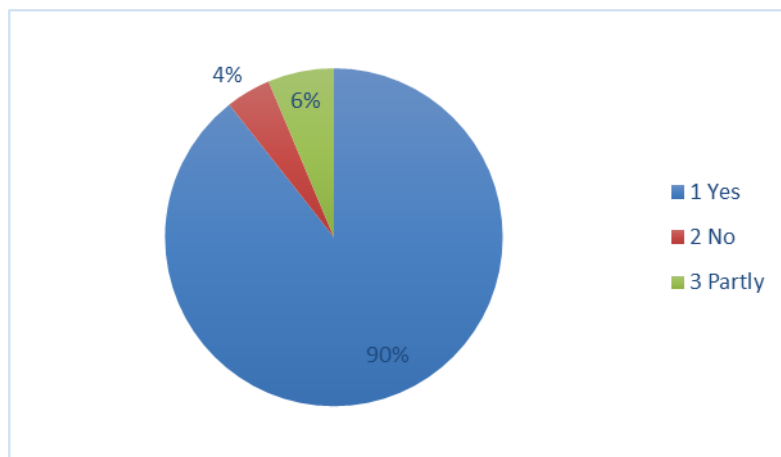


On the other hand non-adopters claim that they would invest in new farm equipment if economically justified – i.e. expectations for increased profit, justified cost/benefit ratio, reduction of production costs and the like (29%), if their equipment gets damaged or too old (26%), for spray efficacy reasons (24%) and for work comfort (13%). Technology per se and environmental protection fall far behind (6% and 4% respectively).

Among the farmers (N=90) who have seen other farmers using innovative spraying equipment 63% said that due to such an experience their interest in such equipment was raised, out of whom 73% said that it confirmed their attitude regarding innovative spraying equipment.

2.5 Best management practices

Figure 43: Knowledge of what spray drift is

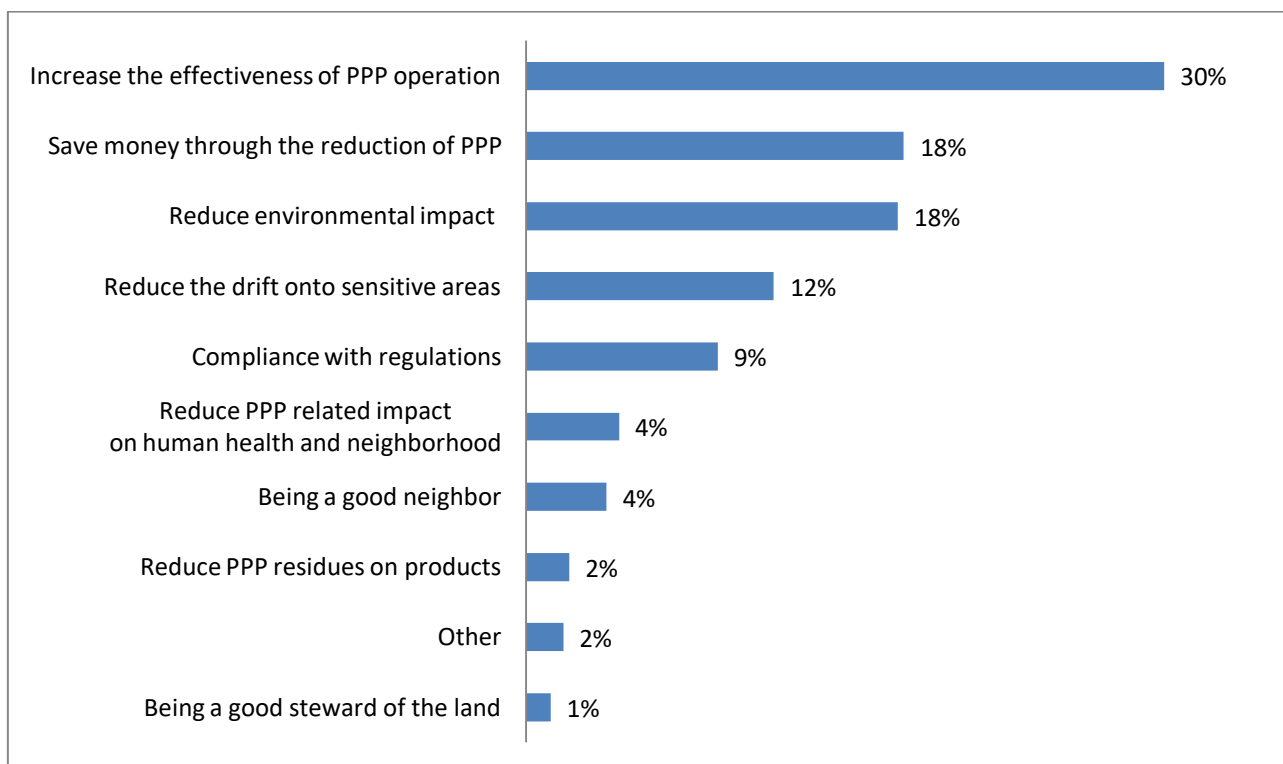


Among the interviewees, 90% know what spray drift is (for definition, see farmers' survey questionnaire) and 6% know something about it; only 4% do not know about spray drift.

In parallel, 93% claimed that they are aware of drift reduction spray equipment and practices.

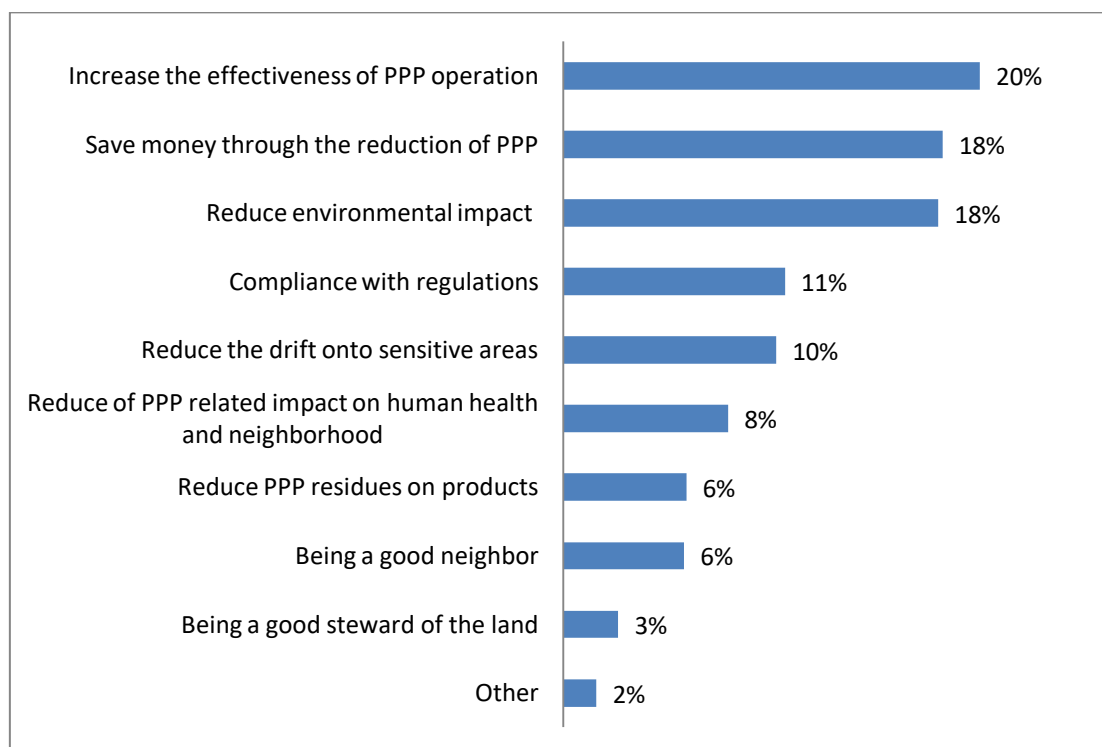
Furthermore, when spraying, 92% of the interviewees maintained that they take into account (consider) spray drift (95% among arable/open field vegetables; 94% among orchards/vineyards; and, 75% among greenhouses)

Figure 44: Most important motivation to apply spray drift reduction techniques



The most important reason that motivates interviewees to apply spray drift reduction techniques are to 'increase effectiveness' (30%) as well as to 'save money' and 'reduce environmental impact' (18% each) followed by the need 'to reduce the drift onto sensitive areas' (12%). Other less powerful reasons are related to compliance with Regulations (9%) and health and social issues (accounting, all together, for 13%).

Figure 45: Three most important reasons that motivate farmers to apply spray drift reduction techniques

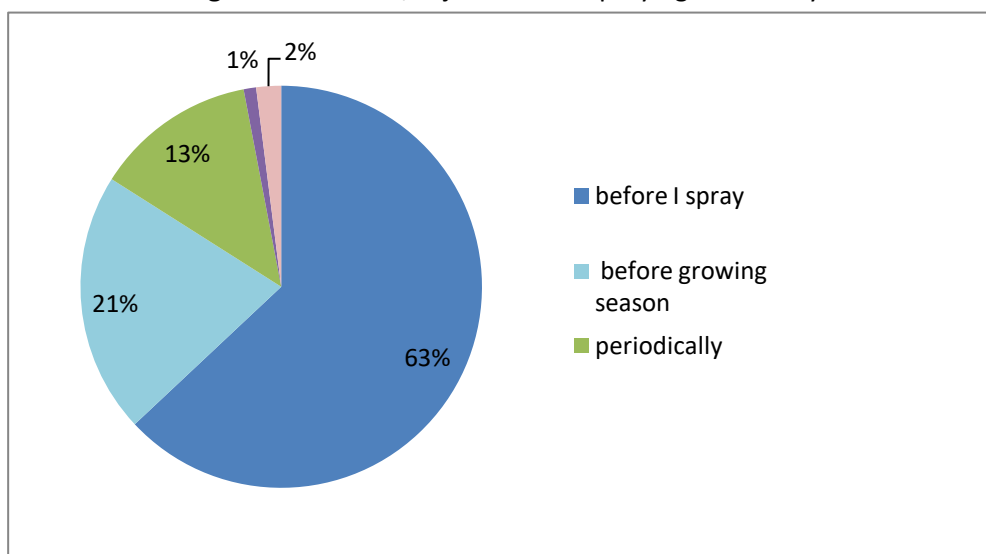


When the three most important reasons which motivate interviewees to apply spray drift reduction techniques are taken into account, then ‘effectiveness’ (20%), economy (‘save money’) and the ‘reduction of environmental impact’ (18% each) still lead, followed by ‘compliance to Regulations’ (11%) and ‘the reduction of drift onto sensitive areas’ (10%). Health and social issues seem more important as compared to the main reason only and (all together) account for 23%.

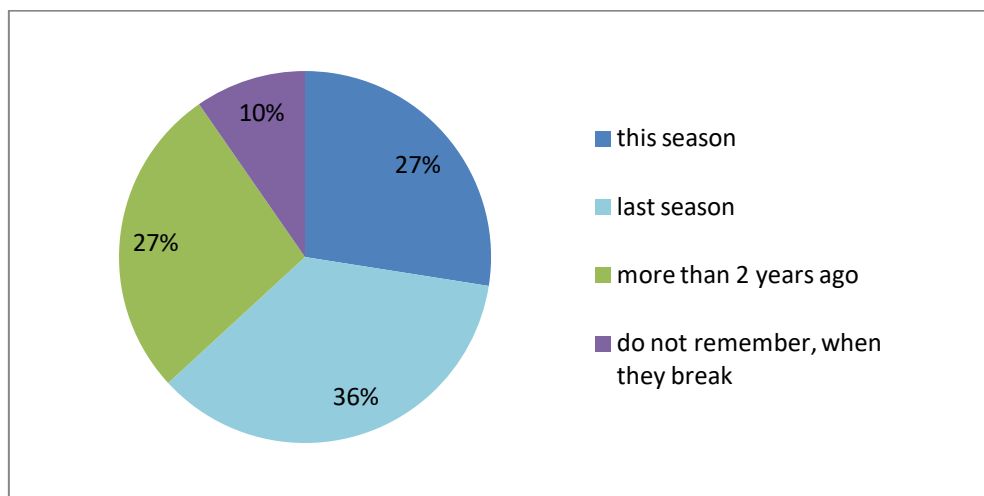
During spray applications the interviewees claim that they maintain constant speed (88%). The ones who use boom sprayers assert that they adjust the boom height according to the crop/target before spraying (95%) while the ones with orchards or vineyards said that they adjust their fan speed and air direction equipment during the season according to the crop stage (81%) as well as that they adjust the spray profile according to the crop architecture before spraying (82%).

As far as certain practices are concerned the interviewees said that:

- 88% maintain constant speed when spraying
- 96% in the case of arable crops/open field vegetables adjust the boom height according to the crop/target before spraying
- 81% in the case of orchards/vineyards adjust the fan speed and air direction during the season according to the crop stage
- 81% in the case of orchards/vineyards adjust the spray profile according to the crop architecture before spraying

Figure 46: Control/adjustment of spraying machinery

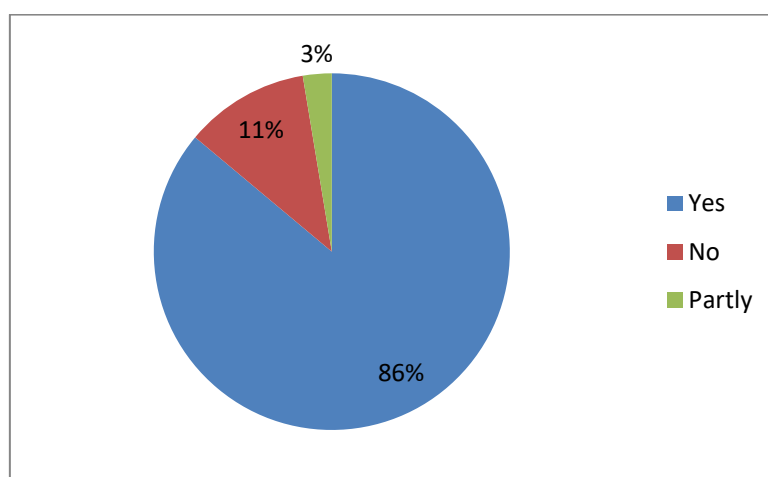
With regard to all spraying equipment, interviewees mention that they control and/or adjust their spraying machinery every time when they spray (63%), once before the growing season (21%) or periodically (13%).

Figure 47: Last change of nozzles

The interviewees also said that the last time they changed their nozzles mainly was the last (36%) or the current season (27%). Another 27% changed nozzles 2 years ago while 10% said that they do not remember as they change them whenever they need to ('when they break').

With regard to whether they take into account any weather conditions before application, the interviewees claimed that:

- 92% take into account wind speed (99% if greenhouses are excluded)
- 75% take into account wind direction (81% if greenhouses are excluded)
- 90% take into account temperature
- 64% take into account humidity

Figure 48: Knowledge of buffer zones

The majority of the interviewees are knowledgeable of buffer zones (86%) while 11% are not.

Almost all farmers with cereals and open filed vegetables are knowledgeable of buffer zones with farmers with orchards or vineyards being the least knowledgeable ($P = 0.000$).

Furthermore, 58% said that they leave buffer zones (farm zones which they do not spray) since it is mandatory and another 16% following the indication in the product label. On the other hand, 18% do not leave any buffer zone(s) out of whose 2% are aware that they should.

The practices concerning buffer zones on the part of arable/open field vegetables farmers and orchards/vineyards farmers are shown in Table 8.

Table 8. Farmers' practices concerning buffer zones

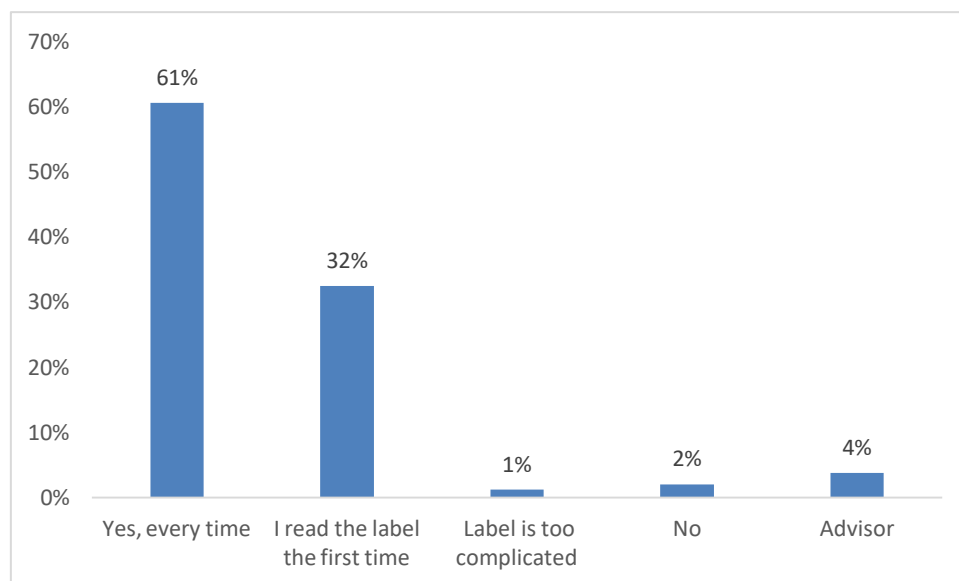
Keep buffer zones	Arable/Open field vegetables (%)	Orchards/Vineyards (%)
Yes (mandatory)	79	42
Yes (following the indication)	14	14
No. I know that I should but I do not practice	3	1
No	4	27
Other	0	16 ⁷

⁷ 'Other' refers to 19 cases out of which the most important are 'there is no need' (8 times) and 'I do not spray when neighbor is harvesting' (5 times).

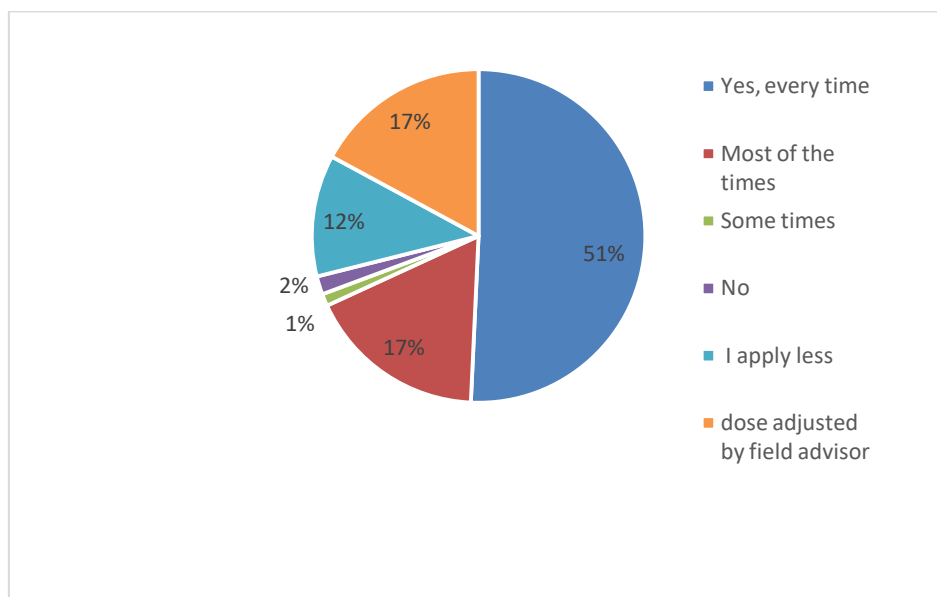
The situation per hub in terms of keeping of buffer zone(s) is as follows:

- Belgium and The Netherlands: 81%
- Spain: 49%
- France: 88%
- Greece: 13%
- Italy: 96%
- Poland: 98%
- Sweden: 88%

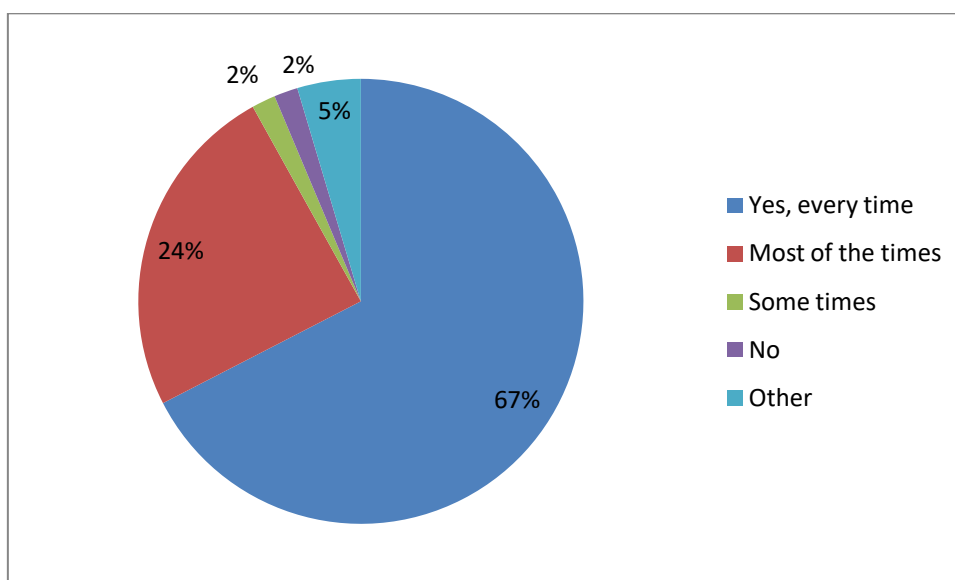
Figure 49: Farmers read the PPP label



The interviewees maintain that they read the PPP (Plant Protection Product) label every time before making the mixture and spraying (61%) or that they read it only the first time they buy the product (32%). Another 4% said they get advice from farm advisor, PPP dealer or the web/apps. On the other hand very few said that they do not read it (2%) or labels are very complicated (1%).

Figure 50: Application of recommended dose

Additionally, the majority of the interviewees claim that they always apply the recommended dose written on the PPP label (51%) with another 17% applying it most of the times. Another 17% follow the recommendations of their advisors. Furthermore, 12% assert that they apply less than the recommended dose written on the PPP label with 3% either not following it or applying more.

Figure 51: Respect of time lag between applications

Finally, 67% of the interviewees always spray according to the recommended time lag between applications, 24% most of the times and 2% some times⁸.

Figure 52: Most important source of knowledge/know-how with regard to PPP application



The most important source of knowledge/know-how with regard to PPP application (when, how much, precautionary measures, etc.) comes from PPP dealers (32%), farmers' experience (25%) and private advisors (20%). Less important main sources are public extensionists (7%) and farmers' associations/ cooperatives (5%) while all other sources account for 11%.

More specifically, the situation per hub is as follows:

- Belgium and The Netherlands: PPP dealers, private advisors
- Spain: PPP dealers, private advisors, my own experience
- France: my own experience, public service/extension service, private advisors
- Greece: Private advisors, my own experience, farmers' association/coop
- Italy: PPP dealers, my own experience, private advisors
- Poland: PPP dealers, my own experience, farm press
- Sweden: PPP dealers, my own experience, private advisors

⁸ 'Other' corresponds to 16 cases out of which the most important ones are: 'according to farm advisor' (7 times) and 'according to weather conditions and crop health status' (5 times).

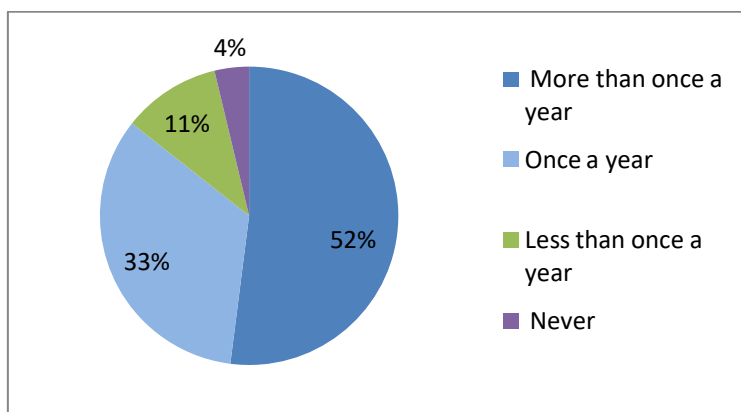
Figure 53: Three most important sources of knowledge/know-how with regard to PPP application



When the three most important sources of knowledge/know-how with regard to PPP application are taken into account, experience and PPP dealers predominate (23% and 21% respectively) followed by private advisors (13%). ICTs (9%), peers (8%), public extensionists (7%), the farm press (6%) and farmers' associations/ cooperatives (5%) are also important sources of information.

2.6 Information seeking behavior

Figure 54: Visits to agricultural fairs, field days/demonstrations or exhibitions



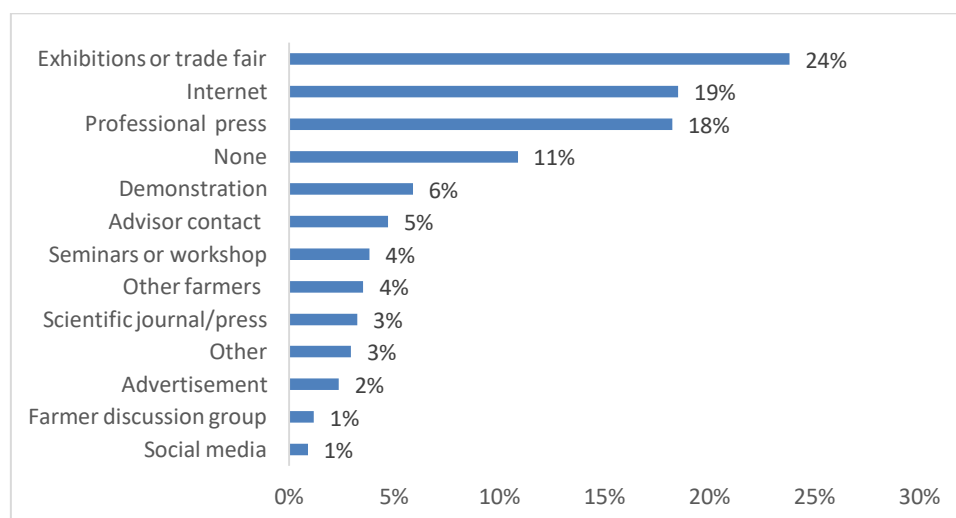
The majority of the farmers said that they visit agricultural fairs, field days/demonstrations, or exhibitions at least once a year (86%) – notably 51% more than once per year. Only 4% said that they have never visited such an event.

Farmers with different cropping systems manifest different behaviors ($P < 0.05$). Three quarters of the farmers with green houses visit more than once a year; 90% of the farmers with cereals and open field vegetables visit at least once a year; 20% of the farmers with orchards or vineyards visit less than once a year or never.

More specifically, the situation, with reference to farmers who never visit agricultural fairs, field days/demonstrations, or exhibitions, per hub is as follows:

- Belgium and The Netherlands: 0%
- Spain: 4%
- France: 2%
- Greece: 12%
- Italy: 2%
- Poland: 4%
- Sweden: 2%

Figure 55: Most recent source of information regarding innovative spraying equipment



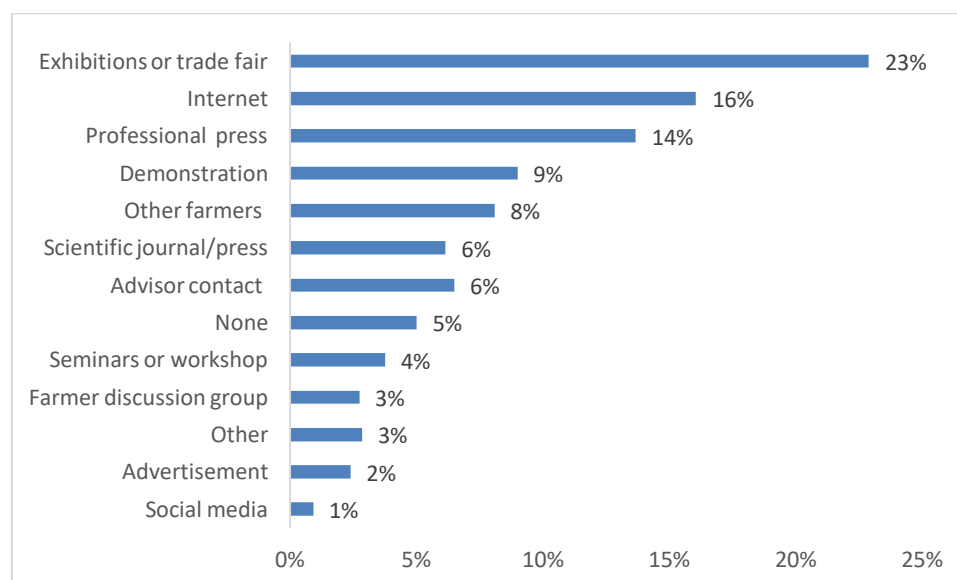
Farmers claim that the most recent source of information in which they sought out information in relation to innovative spraying equipment are exhibitions or trade fairs (24%), the Internet (19%) and professional press (18%), followed by demonstrations (6%), and advisors (5%). No relevant information during the year the interview was carried out (2018) was sought by 11% of the farmers.

More specifically, the situation per hub is as follows:

- Belgium and The Netherlands: professional press, none, exhibition or trade fair
- Spain: exhibition or trade fair, the Internet, demonstration
- France: professional press, seminar or workshop, exhibition or trade fair, demonstration
- Greece: Internet, none, exhibition or trade fair
- Italy: exhibition or trade fair, professional press, the Internet

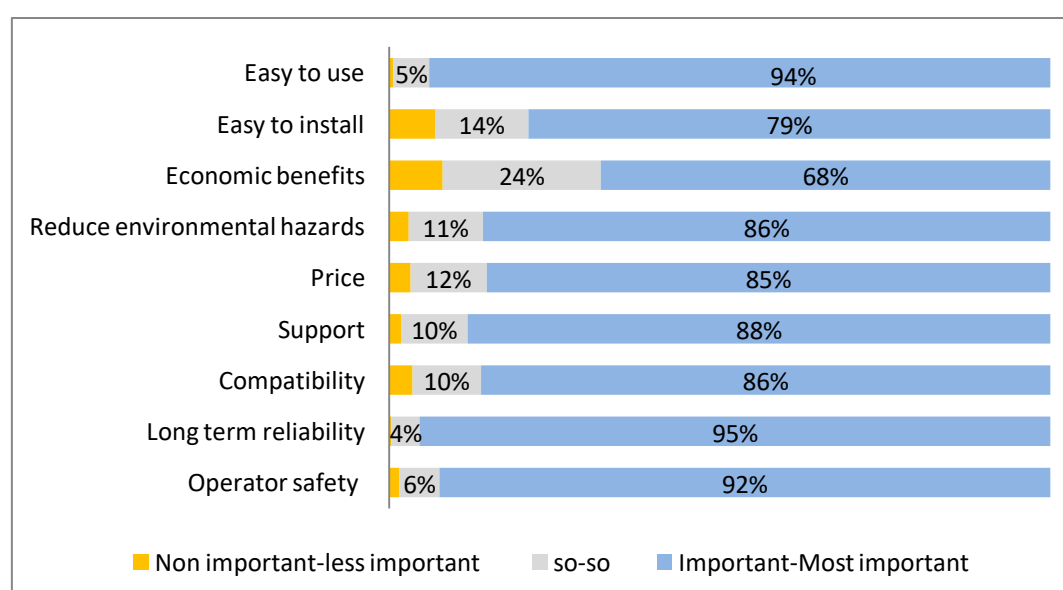
- Poland: professional press, exhibition or trade fair, the Internet
- Sweden: Internet, exhibition or trade fair, advisors

Figure 56: Most recent sources of information regarding innovative spraying equipment



In particular, farmers claim that the three most recent sources of information in which they sought out information in relation to innovative spraying equipment are exhibitions or trade fairs (23%), the Internet (16%) and professional press (14%), followed by demonstrations (9%), peers (8%), advisors (7%) and scientific journals/press (6%).

Figure 57: Characteristics that would make spraying equipment more relevant to farmers' needs



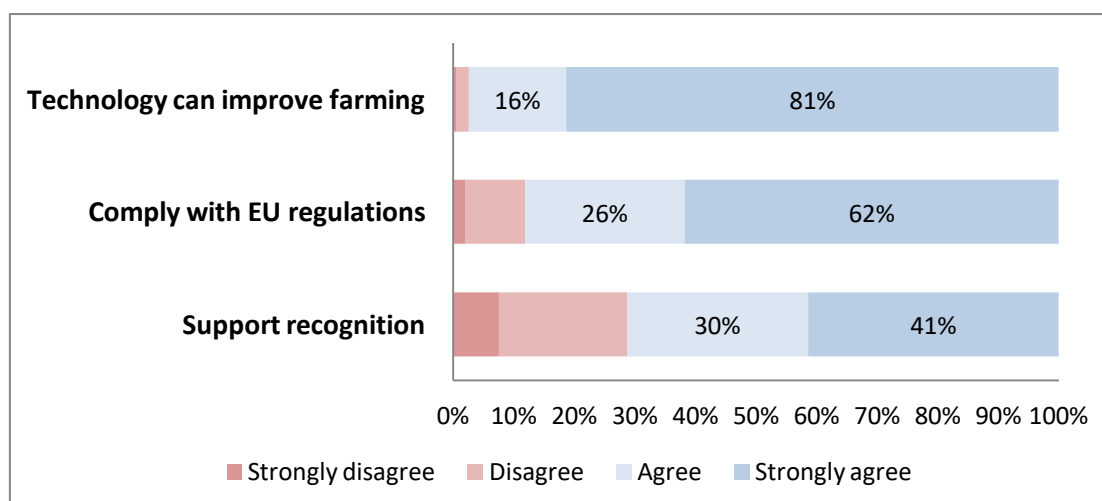
According to the interviewed farmers the most important spraying equipment characteristics that would make spraying equipment more relevant to farmers' needs are long term reliability (95%), ease of use (94%) and operator safety (92%), followed by the availability of technical support (88%), compatibility 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.

Economic benefits and compatibility with the existing machinery seem less important for cereal and open field vegetables cultivators ($P < 0.05$) while long term reliability seems to be more important for orchard/vineyards growers ($P < 0.10$).

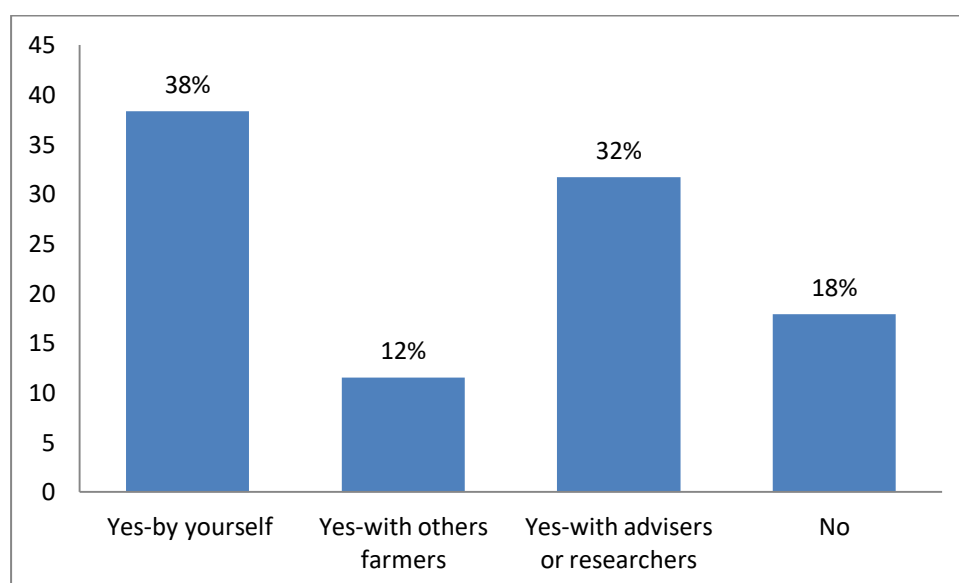
2.7 Farmers' attitudes towards technology and innovation

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 58).

Figure 58: Farmers' attitudes towards technology



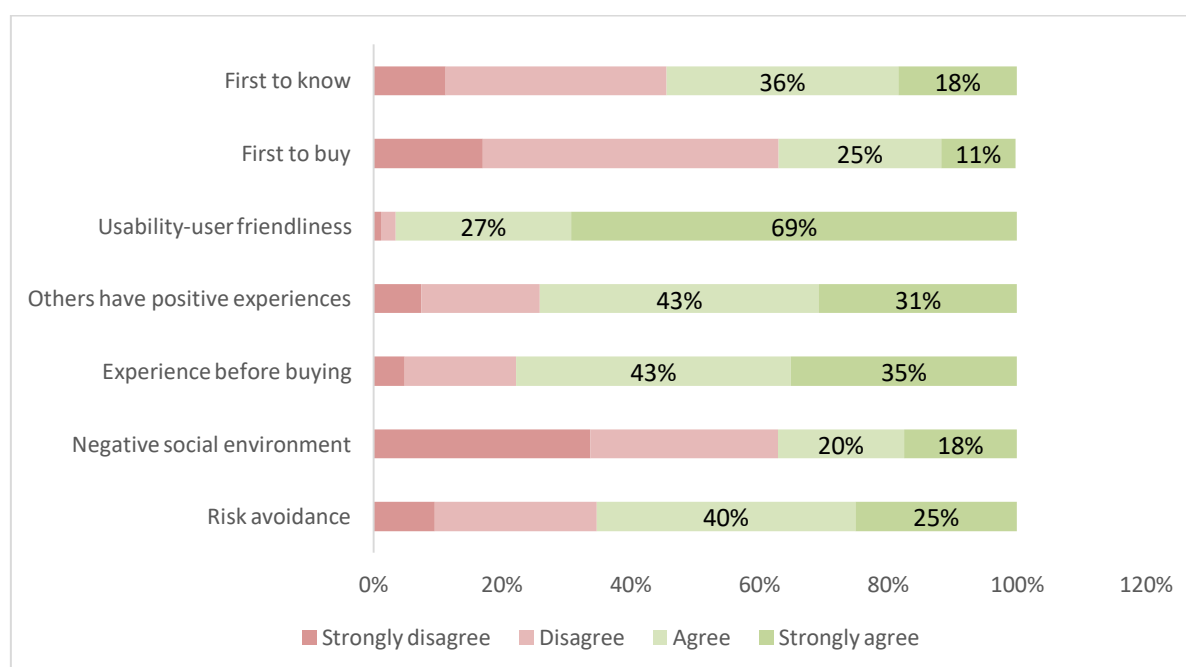
Farmers with different cropping systems have different opinions as to whether technology assists them in complying with EU Regulations with farmers with orchards and vineyards being more negative and farmers with cereals and open field vegetables being more positive ($P < 0.10$). Farmers with orchards and vineyards are also more negative than other farmers concerning the support of new technologies to the recognition (by the public) of farmers' work ($P < 0.10$).

Figure 59: Farmers' experimentation

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.

More specifically, the situation, with reference to farmers who do not experiment, per hub is as follows:

- Belgium and The Netherlands: 13%
- Spain: 25%
- France: 18%
- Greece: 12%
- Italy: 14%
- Poland: 18%
- Sweden: 26%

Figure 60: Farmer's innovativeness

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%).

Farmers' statements are not differentiated when their cropping systems are taken into account.

Farmers were also asked about the incentives they would like to see in future policies to facilitate the acquisition of innovative spraying equipment. Two out of three of the interviewed farmers ask for some kind of financial support, in principle the subsidization of the purchase of innovative spraying equipment. Other financial incentives, albeit with few supporters, include tax reductions (8), reduced equipment prices (18) and higher/fair prices for their produces (20); some also ask for non-repayable incentives (17) as well as long term mortgages or exemption from VAT. In parallel, some ask special treatment (increased support) for small-scale farms (10), support to certified and/or high precision equipment (3) as well as the reduction of bureaucracy (6).

Furthermore, one out of seven asked for training and technical support from independent (extension/advice) providers. Training is somewhat more frequently asked by the interviewed farmers as compared to the demand for technical support (as such) and information dissemination; the demand for demonstration, on top of the demand for technical support, is also interesting to notice (12 farmers).

The change of regulations as for example towards more strict inspections, compulsory use of Low Drift Nozzles and the like is supported by one out of ten of the farmers. Another 10% maintain that the characteristics of the equipment (especially spraying efficiency followed by ease-of-use) could be a good incentive as well. Finally, around 5% of the farmers declare that they do not need/ wish to have any incentives

2.8 Adopters vs. non-adopters of innovative spraying equipment

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 years of experience with spray (PPP) applications and the existence of a successor - or not.

Adopters are more likely to be full-time farmers ($P=0.10$), to be more satisfied from farming ($P<0.10$) and to be located in plain areas than non-adopters ($P<0.05$).

Non-adopters are most likely to be involved in farming due to family tradition ($P<0.05$) as well as to be less dependent on agriculture in terms of the contribution of agriculture into the family income ($P=0.001$).

Adopters and non-adopters while not showing any statistically significant difference in terms of holding a Training Certificate on PPP use according to the Directive 2009/128/EC, they differ in terms of having attending a training course in spraying machinery (legislation, equipment use, sprayers settings, maintenance, environment protection - point sources and diffuse sources) with adopters being more likely to have attended such a course ($P<0.10$).

Non-family farms (companies, cooperatives) are more likely to use innovative spraying equipment than family farms ($P=0.001$)

Adopters and non-adopters seem to consider different sources of knowledge/know-how on the use and operation of their spraying equipment as being more important to them ($P<0.05$). Non-adopters rely much more on their own experience (as compared to adopters as well as to other sources of information) while adopters more on the industry (sprayers' and PPP manufacturers/dealers).

With respect to the criteria for buying/choosing spraying equipment, economic considerations are more important for non-adopters ($P < 0.05$), while the reduction of PPP inputs and environmental protection are less important ($P < 0.05$).

Adopters visit agricultural fairs, field days/demonstrations, or exhibitions more often than non-adopters ($P < 0.05$).

With reference to the characteristics of spraying equipment that would make them more relevant to farmers' needs adopters put more emphasis to the ease of use ($P < 0.05$) and to the availability of technical support ($P < 0.05$) than non-adopters.

Adopters are stronger believers in the capability of technology to improve farming ($P = 0.000$) and to help them to comply with regulations ($P = 0.000$) as well as that technology can support farmers' work recognition by the public ($P = 0.001$) than non-adopters.

Adopters are more likely to be the first in their social circle of friends and relatives both to know about and buy new machinery/technology ($P = 0.000$). On the other hand, non-adopters are more likely to wait to buy new things, until they know others have positive experiences with it ($P < 0.010$) and prefer to have some experience with something before I buy it ($P = 0.001$) as compared to adopters.

3 Expert's interviews

3.1 Challenges and the role of SETA

3.1.1 Challenges

Concerning the main challenges facing European agriculture nowadays and in the future, most of the *academics* and *researchers* point to, on the one hand, food safety and quality and, on the other hand, environmental sustainability (incl. climate change) and productivity, and their interplay⁹. Additionally, some specifically mentioned the sustainable use or the reduction of the use of PPP (re: environment). The Swedish pointed in particular to the problems of the Nordic countries face with available biological and chemical PPP due to small market and few and small growers.

Environmental concerns along with farms' competitiveness predominate among *industry* representatives; quite a few of them put special emphasis on the need to produce better sprayers as a response to both the demand for cleaner production and climate change. The Greeks stressed the problems farmers face, due to structural conditions (small and fragmented farm land), vis-à-vis precision agriculture as well as that there are no inspection mechanisms to secure compliance with regulations.

Extensionists/advisors underlined that the main challenges are, on the one hand, to produce without damage to the environment and, on the other hand, the need for new products and approaches to plant protection. The need for viable farms as well as farmers' training on new technologies is also (albeit marginally) referred to.

Farmers concur with advisers on the need for new products and approaches to plant protection and for cleaner production ('less dependent on chemistry'); the Dutch put emphasis on the social pressure's farmers experience which, in turn, makes them 'at the forefront of ambitions with respect integrated pest management and resilience'. On the other hand, the Greek representative maintained that the main threat for the survival of family farms is globalization.

⁹ Social sustainability/constraints are mentioned only once; the safety of the farmer and the (economic) viability of the farm were also mentioned only once each.

3.1.2 The role of SETA

According to *academics* and *researchers* to face such challenges, on the one hand, spraying equipment must be improved (precise applications/ reduction of losses, operators' safety) towards 'sustainable treatments' and, on the other hand, farmers must be not only aware of new technology but trained on both equipment and PPP. This way, as underlined by the Swedish representatives, farmers will also trust technology.

Industry representatives believe that (the development of) new technology, like technologies related to precision agriculture, can assist in dealing with challenges but they also take notice of the fact that technology becomes 'more expensive and more susceptible to failures' and this is an additional challenge for R&D. The misuse of modern technology and thus the need for farmers' training is also stressed.

For *advisors*, to face such challenges, best practices comprising (how to perform) precise applications and the reduction of PPP use must be disseminated among farmers. Moreover, according to the Swedish representatives, scientists and advisors need to understand the complexity of on-farm (under real conditions) plant protection. The French claim that while for viticulture we should be looking for the dissemination of existing technologies and practices, in arboriculture the task is to find out such technologies and practices.

Farmers agree for the need of new technologies and stress the need of the farming population for technical advice/ support and training.

3.2 Pressures upon farmers to adopt SETA

3.2.1 Policy

Legislation is a powerful tool, according to *academics* and *researchers*, with regard to the adoption of new technology and good practices by farmers. However, as the Belgians summarize it, regulations must not only target cleaner production but, at the same time, be realistic and be implemented in practice (vs. rhetoric); as the Greeks said 'the enforcement of regulations is equally important'. Some reservations were also noticed concerning the role lobbies (vs. society) play in legislation.

Industry representatives also agree with the importance of legislation both at EU and at national level (the latter is stressed by the French, Dutch and Italian representatives). The industry representatives note the influence of environmental parties and/or NGOs and the willingness of industry to avoid complaints. Finally, it is underlined that the provision of subsidies would favor greatly the dissemination of innovative technology; or the benefits of such technologies and practices should be clearly visible right for the beginning of their adoption to the farmer.

Extensionists/advisors also agree that legislation is a powerful tool but they argue that many times farmers are not amply informed or do not understand it correctly; otherwise legislation can have adverse implications (farmers misunderstanding or not implementing it). As the Swedish argued “Regulations must allow relevant changes but remaining acceptable for all farmers”. On the other hand, French said that there is ‘no strong policy pressure favoring SETA’.

Farmers believe that ‘laws drive’ (Swedish representative). However, they have reservations concerning the aim of some pieces of legislation or the bureaucratic procedures involved in their implementation.

3.2.2 Economy

Academics and *researchers* believe that if consumers start demanding environmental-friendly produces and will be willing to pay a higher price for such produces that would be a very strong signal (to change their production system) towards farmers. They also stress that the farmer, in order to adopt, must be able to see clearly the economic benefits; nevertheless, some argue that this is not easy especially if the cost of innovative spraying machinery is compared only to the benefits owing to the reduction (of the cost) of PPP. Therefore, the call to reduce the costs of both innovative spraying equipment and PPP and/or assist farmers (re: access to funding, subsidies - and their increase where they already exist) to adopt them.

According to the *industry* representatives, farmers do not face any particular economic pressures to adopt innovative technology. On the other hand, they admit that such technology is more expensive (as it is more advanced/ innovative). They also take notice of the increase of PPP costs and the stricter legislation which, in turn, leads them to argue that the use of innovative spraying machinery will become necessary; then, farmers may have to become bigger (to bear the costs) or subcontract such equipment.

Extensionists/advisors argue that although some support to farmers (subsidies) are welcome (notwithstanding the bureaucratic procedures involved) they are not enough to cover the costs of

innovative equipment; 'innovations are expensive'. Therefore, some argue that the turn to organic farming may be preferable for farmers.

Farmers claim that they would need both subsidies and better prices for the produces in order to adopt innovations. The argument that the use of innovative equipment might in turn make possible the use of banned/ wider range of PPP must also be noted.

3.3.3 Environment

Academics and *researchers* believe that farmers are largely ignorant about the environmental consequences of farming and they do not feel the need to use innovative spraying technology - as noted especially by the Spanish and French, respectively. On the other hand, the Swedish note that compulsory training makes farmers aware of the issues. Another important observation is that farmers do not feel individually responsible for the environment as environmental damage usually is (appears to be) the result of collective action. Food safety and traceability along with the protection of water aquifers appear to be the most important pressures upon farmers which may result in the adoption of innovative equipment.

The interviewees coming from the *industry* state that major issues are the development of pests' resistance to PPP; the risks related to the transfer of PPP from the industry to the final user; and, the enactment of environmental laws.

Extensionists also believe that the environmental pressures 'are not enough to have an influence on the choice of a sprayer'. In the same vein as the academic/researchers, they argue that it is hard to say to what extent farmers are concerned about environmental issues. Nevertheless, some advisors claim that farmers care about PPP residues in the water and/or in general about the impact of farming activities on the environment; the Swedish maintain that there are big differences between farmers with farmers' training being very important.

Farmers claim that nowadays they are sensitized, especially about water issues.

3.3.4 Society

Social pressure upon farmers in terms of both environmental protection and food safety is very important, say *academics* and *researchers*. Although pressure from the cities is not clearly visible to farmers, as the Spanish underscore, the pressure from smaller cities located in rural areas and neighbours, especially in terms of PPP and noise pollution and thus health issues, are clear; this is very true in the case of neo-rurals/néoruraux (people from the cities who have decided to live in the country-side) who do not have relevant background. On the other hand, such conflict can give

rise to discussions which, in turn, may raise farmers' environmental consciousness. The pressure from consumers is equally important as it makes big retailers asking for cleaner and/or certified produce and puts pressure on the state for stricter legislation; these signals/pressures are clear and important for the farmer while also orientating research.

The *industry* representatives take notice of the pressure of environmental organizations/ NGOs as well as of media campaigns (and the fact that they may spread inaccurate information or totally negative attitudes towards PPP). They also said that farmers feel the pressure of their neighbours, especially if neo-rurals. As a consequence, according to the Dutch, the farmer may feel 'entrapped; to make certain decisions (without much space to manoeuvre).

According to the *advisors*, social pressure is increasing (media campaigns, neo-rurals, turn to organic farming produces, etc.) - although sometimes on the grounds of misinformation. At local level (and due to the lack of dialogue) such pressure (and, perchance, misinformation) may result in conflicts. Nevertheless, this does not seem to influence the adoption of innovative technology - owing to its much higher costs. On the other hand, the dissemination of best practices (through demonstrations, open field days and study groups) may help.

According to the *farmers* social pressure affects (even if indirectly) farmers' decision-making. Social pressure seems to be quite important for farmers; as the Dutch said: "Dutch growers are concerned about their *license to produce*".

3.3 Advantages and disadvantages of innovative spraying technologies

According to *academics* and *researchers* the main advantage of the adoption of innovative spraying equipment relates to the reduction of the use of PPP and its environmental (environmental protection) and economic (reduction of costs) benefits. Operator health and safety as well as compliance with legislation and market demand were also stressed; finally, work comfort and professional pride were also mentioned. The Greeks noted that taking full advantage of the features of innovative technologies depends on farmer's training.

On the other hand, *academics* and *researchers* unanimously pointed to the high initial (purchase) costs of such equipment as being their main disadvantage (for some, such costs are not justified),

followed by the need for the continuous training of the farmers¹⁰. Some also pointed to the fact that such equipment is complex (not user-friendly as well, for some interviewees) and vulnerable, thus in need of quick access support. It was also argued that farmers may feel insecure due to both the fact some technologies may have been proven in practice and the continuous change of legislation.

For *industry* the main advantages of innovative equipment relate to spraying effectiveness and thus environmental and economic benefits as well as to work comfort. Compliance with regulations and save of time were also mentioned. According to the Greek(s) once you have experienced the advantages of new equipment you never go back to the old ones. Finally, the need for training was underlined.

High initial costs (as well as complexity, for a few interviewees) and the need for training and technical support were identified as the main disadvantages of innovative technology.

More or less in the same line of argumentation, *advisors* argue for innovative spraying equipment in terms of efficiency and thus environmental and economic benefits while also pointing to the safety and comfort of the operator as well as to professional pride and positive public image (vs. social/moral pressures).

Initial price is again identified as being the main disadvantaged in relation to innovative technologies. Further concerns relate to the need for skillful operators, the difficulties such technologies face in difficult topographies, the fast replacement of technologies by newer ones (in the market) as well as the technical limitations/ vulnerability of such complex technologies.

Farmers more or less agree with previous opinions and underline, on the one hand, the satisfaction the farmer gets due to his/her own good performance and, on the other hand, their insecurity related to the performance of such equipment under their farm conditions.

3.4 Adoption and non-adoption of innovative spraying technologies

According to *academics* and *researchers* the main motivation and criterion on the part of farmers to adopt innovative spraying equipment relates to the tangible results the farmer can see him/herself in a situation similar to his/her own ('in their environment'). Spraying effectiveness, reduction of

¹⁰ Awareness about new equipment and their potential benefits was also mentioned.

PPP losses and costs, environmental protection, compliance with legislation and societal demands, and work comfort and safety are some of the 'incentives' referred to. Economic incentives and training also help.

The benefits due to spraying effectiveness (with emphasis on economy) are underlined by *industry* representatives. It is further mentioned that 'the most advanced' farmers need continuous improvement of the machinery/equipment while the Dutch claim that innovatory technology is their only option - since (being small country) they cannot substantially enlarge their farms.

Advisors seem to put more emphasis on the social pressures and farmers' concern about the environment (especially the French) while for the Swedish farmers' own interest about advanced technology along with compliance to legislation are important.

Farmers stress the need to combine environmental protection and agronomic efficacy (SE) along with legislation (NL) and farm/household economy (GR).

Regarding the characteristics of adopters of innovative technologies, *academics* and *researchers* claim that farm size (bigger farms), farmer's age (younger farmers), education and 'personality – mentality' (comfortable with technology, willing to experiment, open-minded) are most likely to be the factors that characterize the adopters of innovative equipment and practices.

For *industry* representatives, farm size, age and personality (especially young, technology enthusiasts; professional farmers) are the factors defining who adopts innovative technology (or not). Production intensification, farmers' groups (coops/ associations, etc.) or companies and public image were also mentioned as affecting adoption.

Extensionists stressed that environmental consciousness is an important factor influencing the adoption of innovative spraying machinery along with age, personal interest in technology and farm size. The French said that farmers who are also wine-makers are likely to adopt such technologies due to their (and their vineyards') image in the market.

Farmers identify farm size and capital as well as age and technophilia as important factors. The Dutch stress the importance of the surroundings (neighbouring with sensitive areas, especially with waters) and the crops which are cultivated. The pressure from (environmental-friendly) legislation is also stressed.

The lack of training seems to be the main constraint vis-à-vis the adoption of innovative spraying equipment and practices for *academics* and *researchers*; in the same vein, the lack of (environmental) education was also mentioned. Affordability, farm size, insecurity (re: equipment vulnerability) and farmers' mentality were also referred to.

For *industry* representatives the high prices of innovative equipment predominate among the obstacles farmers face. Age, low educational level, unawareness about new technology, along with occasionally contradicting messages from the industry and confusion about legislation, and the ‘wait-and-see’ attitude of farmers are further factors impeding the diffusion of innovations.

According to the *advisors*, besides affordability, non-adoption owes to farmers’ technophobia. Reference was also made to the lack of critical thinking (re: current spraying practices), farmers’ low educational level, unsuitable farms’ topography and the pressure of immediate social environment (neighbors’ opinion). The Polish underscored the lack of technical support.

Farmers claim that besides affordability, the fast developments in technology (including the expectation for better and cheaper equipment) and the lack of time for training/ study are major constraints. On the other hand, the Dutch stress that non-adopters are phasing out.

3.5 The development of innovative technologies

According to *academics* and *researchers* the main target groups of research are the potential clients, i.e. the most dynamic businesses, including big, entrepreneurial family farms, companies engaged in farming, younger farmers and the most profitable crops; local opinion leaders are said to be the main target-group in Greece. Despite the need for global developments (addressing all kinds of farms and farmers – the whole sector) it is noted that smaller farms can rarely benefit.

For the *industry* big farmers or companies (professionals/entrepreneurs and/or early adopters) are the main target groups since they are the ones who need innovative technology more than the others and are willing to buy it. Younger farmers and profitable crops were also mentioned.

Big, innovative farmers (who already have relevant know-how and up-to-date technology) comprise the target group of technology development said the *advisors*.

According to the *farmers* technology is developed for all crops (thus all farmers) although developments are faster and more obvious in the cases of more profitable crops or crops cultivated in larger areas.

Academics and *researchers* say that although there is a need for R&D to take into account farmers’ needs relevant communication channels are difficult to establish/ identify. Some argue that farmers are actually in a weak position as they are placed at the end of the innovation pipeline and do not have a chance to influence what happens at the other end. It is underlined that it might be possible

for the universities to undertake an intermediation role between farmers and the industry; however, this necessitates the turn of universities to more applied research. On the other hand, it is maintained that small-scale, local/regional companies take a closer look to their clients' needs (and produce specialized technology for them) as compared to larger national and/or international companies (which either do not have contacts with farmers or have contacts with certain contact groups). Furthermore, for some, the dialogue between R&D and farmers is hampered due to the low level of farmers' education - which negatively affects the expression of precise and realistic demands on the part of farmers. Finally, scientists said that innovation development is a process with its own dynamics and, although in spraying most developments are marginal/ incremental rather than radical ones, it is not possible to take into account all kinds of demands or to produce technology which will be suitable for everyone. It is also worth noting that "We have examples of ideas from innovative farmers that never come to application process for projects since they don't fit into the politics that decide research program funding".

According to the *industry* representatives there is two-way communication between farmers and the industry: companies take into account farmers' demands and also make proposals to farmers to see their reactions (i.e. if interested). Cases in which farmers took the initiative to propose improvements/ innovations were also referred to - but it is underlined that farmers may not take into account/ know legal and other constraints which make such proposals unsuitable for R&D. Joint experimentation is rather rare. The industry believes that both actors are very important in technology development and thus their relationships must be improved.

The prevailing view among *advisors* is that, with respect to the development of technology, there are not any links between industry and farmers. The two parts are related via the market; additionally, the industry has to respond in the case of complaints. For extensionists the industry is more subject to pressures from legislation rather than to demands from farmers¹¹.

For *farmers* the available technology is mainly supply-driven than demand-driven resulting in a 'mismatch'. Farmers do have interesting/ innovative ideas but they are not taken up.

Given their preceding views, *academics* and *researchers* believe that the affordability of the innovative spraying equipment and the demonstrability of their benefits are key characteristics which will allow (or not) for their wide adoption/use. Other characteristics of the technologies, such as ease of use and maintenance, flexibility, and reliability in time, are equally important. According to the Belgians there is lot of advanced technology on the shelf which is not yet in the application stage.

¹¹ Sometimes the industry collects farmers' opinions or expectations.

Efficiency and profitability are of paramount importance for the wide acceptance of innovative technologies by farmers according to the *industry*; furthermore, the advantages of innovative technology must be visible and explained to farmers. Other important factors are the initial price which must be reduced and user-friendliness of the technology.

The price and attractiveness of technologies are of major importance for *advisors* for such technologies to be widely adopted. User-friendliness and flexibility/ adaptability are key characteristics favoring adoption. More attention to small farmers and feedback from farmers is also needed.

According to the *farmers* currently the development of spraying technology is biased towards bigger farms while the focus of development is one-sided, i.e. environmental protection, thus ignoring farmers' interests.

3.6 The gap between best/recommend and current farmers' practices

The lack of knowledge and training are the main impediments vis-à-vis the application of best practices on the part of farmers, according to *academics* and *researchers*. Additionally, sometimes best practices incur extra costs or their benefit may not be visible. Other reasons include farmer's unwillingness to change and the lack of controls concerning the imposition of legislation.

Industry representatives agree that there is considerable lack of education and training which, in turn, would allow farmers to understand the (importance of) recommended practices. Extra costs were also mentioned as a constraint to the adoption of best practices.

Advisors believe that there is confusion due to the multiplicity and the rapid changes in legislation; in some cases advice also confuses farmers. The complexity of practices and the lack of training are equally important constraints; costs may be a further limiting factor for farmers.

Farmers focus on the lack of training (including relevant demonstrations and the like) as the main factor for the gap between their practices and the recommended ones.

In accordance with their previous views, *academics* and *researchers* believe that the use of innovative spraying equipment and practices is demanding in terms of knowledge and skills and thus the need for farmers' training re-emerges. As someone commented, "farmers must develop a professional profile with a view to precision agriculture".

Among the *industry* representatives there are divergent opinions: farmers need training vs. farmers already have the necessary knowledge and skills (i.e. farmers do not need in-depth knowledge and very advanced skills to use advanced technology and/or there many tools in the market to make farmers' life easier).

Extensionists note that despite farmers' training needs when courses are organized few of them attend. In parallel they note that farmers may be misinformed by both dealers and advisors. On the other hand, it must be taken into account that "farmers are growers, not technicians".

Farmers also agree that they must at least be able to "read and understand technology¹²". However, they note, manuals are not written in an understandable language.

3.7 PPP applications

Academics and *researchers* claim that dosage rate and mode of application are very often based on tradition and not on the instructions provided on the products' labels. This is attributed to the ignorance of farmers (re: technical issues, environmental pollution, regulatory framework) and the lack of training as well as to the pressure farmers feel when a disease breaks out, the heterogeneity of the conditions under which farming is practice (re: applicability/adaptability of available solutions; complexity of available solutions) or the lack of alternatives (re: use of banned PPP). On the contrary, the Belgians maintain that due to strict legislation farmers largely follow the recommended practices (dosage rate and timing; farmers only spray when needed).

The representatives of the *industry* claim that compared to the past farmers pay due attention to the application of PPPs mainly because of the high costs incurred. In addition, labels are often unclear and controversial; furthermore, the combination of PPPs and treatments may be very complex a task for the farmers. The lack of support is a major factor for such deviations from best practices.

Advisors, more or less, agree with academics and researchers and stress that wrong applications may result in losses in terms of yields. They also note that farmers are, in general, largely based on their experience (i.e. they use new PPPs following past practices; or, they are based on the results

¹² Reference to the difficulties that farmers have with the manuals.

of the first application of a new PPP without taking into consideration factors that may affect its effectiveness).

Farmers' view is that they rely on tradition but that they also have a more global view of the situation (re: scientists and the industry). The Dutch argue for the need to take into account agronomic considerations – not only environmental ones.

Given their previous assessment, *academics* and *researchers* underline that the correct application of PPPs requires sound technical knowledge of the equipment, the PPP and the mode of application which the average farmers does not have. Therefore, the need for training and technical support; according to the Spanish, farmers in associations do not have such problems due to the advice provided to them by specialized technicians (employed by the associations). The fact that relevant training has become mandatory is underscored by most; on the contrary, the Polish do not believe that PPPs application is demanding in terms of current farmers' knowledge and skills.

The representatives of the *industry* note that awareness raising concerning the fact that good practice will benefit everyone and will also result in the reduction of costs is necessary among farmers; training is also needed.

Advisors state that farmers despite extensionists' efforts still lack sound knowledge of complex operations; additionally, they cannot easily follow (by themselves) developments in technology and legislation.

Farmers believe that new technologies put pressure on farmers in terms of knowledge and skills and thus better communication (targeting farmers) clearly pointing to causes and effects is needed.

3.8 The role of research and advice

3.8.1 Research and advice

Academics and *researchers* believe that research, despite the fact that in many cases it does not aim at results that can be implemented straightforward in practice, should assist in the demonstration of the effectiveness and cost/benefit of innovative spraying machinery, practices and PPP, their objective comparison and the identification of new (best) practices, emerging due to changes in the natural and socio-political environment. Research should also strive to identify innovations that can work under real (on-farm) conditions and establish links with and between all stakeholders (i.e. bridge the gap between farmers, advisors, research, industry).

Furthermore, *academics* and *researchers* maintain that the role of extension/advisory services is, on the one hand, to contribute to the wide diffusion of innovations (equipment, practices, PPP) and, on the other hand, to identify farmers' needs and inform industry. It is underlined that the information has to be neutral (objective, independent). Advisory services can of course assist farmers through independent tests and demonstrations as well as through the examination of the suitability of recommended best practices on their fields.

Academics and *researchers* also believe that farmers' immediate social environment exerts considerable influence on them unless the advisor has proven him/herself. Given this, advisory services are said to be responsible to provide independent technical advice as opposed to, quite often, unsubstantiated opinions. It is also noticed that in many cases farmers rely on the information provided by dealers and sales-people; this again makes the need for independent advisory services urgent.

According to the representatives of the *industry*, research and advisory services should collaborate for innovations that are easy to use and implement (sprayers), test innovations and provide independent information, help manufacturers to identify farmers' needs, provide training and information to farmers. For the *industry* representatives it does not matter who provides information insofar as this information has its origin in science/ research.

Extensionists/ advisors believe that research and advisory services should work closely in order to select the most relevant (re: their farmers/target-groups) innovations among all the technologies that are developed, test them (with the participation of farmers) and communicate the results to farmers. The establishment of communication links between the main stakeholders is imperative. Advisory services are more suited to undertake the demonstration of innovations and farmers' (practical) training. Furthermore, extensionists claim that farmers are paying attention to the information provided by the advisory services, especially if these services have proved to be effective in transmitting neutral and independent information and showing examples on solutions to farmers' problems. Advisors state that dealers and sales-people play an important role; thus the need for a good, independent advisory service.

Farmers state that they do not have relationships with research. On the contrary they praise their relationship with advisors and the help they provide in terms of the dissemination of independent information on innovations (including their effectiveness) and other farmers' good practices/ experiences.

3.8.2 The Agricultural Knowledge and Innovation System (AKIS)

For *academics* and *researchers* all the actors (possibly) comprising AKIS (re: the branch of innovative spraying technologies) should cooperate¹³. However, such links currently are very weak. Some argue that politics is often the weakest link due to its excessive slowness in decision-making and bureaucratic inefficiency. Moreover, decision-makers rarely consult farmers when they take measures about farming; policy makers often change the legislation due to pressures from actors other than farmers. The second weakest link is said to be between farmers and the industry; even if manufacturers interact with farmers they usually interact with a very small group which is not representative of the heterogeneity in farming. The weak links between all the interested parties result in gaps; the most characteristic one is the gap between theoretical/experimental developments and their applications in practice; in addition, it is maintained that the users' capacity is not often taken into account: "new technologies are sometimes very complex for farmers".

The *industry* representatives also note the lack of a comprehensive discussion/innovation platform on spraying equipment and the difficulty of bringing stakeholders together (especially on the horizontal level, i.e. competing manufacturers). They argue that extension/advisory services (should) intermediate between stakeholders, especially between farmers and researchers (farmers <-> extension <-> research) since they have good relationships with both of them. Furthermore, demonstrations are/can become the meeting place of the parties involved in certain technologies.

Advisors claim that there are many gaps between research (not interested in practical applications), industry (have their own objectives), farmers (rarely consulted) and policy-makers (making legislation without knowing/taking into account the realities of the sector/ the field). It is underlined that even if the rest of the actors somehow cooperate, farmers are left out.

Farmers note that researchers are not primarily targeting farmers and their needs while industry have their own development plans and even when they get ideas from farmers their overarching considerations relate to market realities.

¹³ In the first place, of course, actors must realize that (potentially) they are members of the certain AKIS/ innovation network.

3.9 Incentives for the adoption of innovative spraying technologies

Academics and *researchers* support the subsidization of the purchase of innovative spraying equipment (especially for small farms) mainly due to the need to “renovate the sprayer fleet” – although there are also reservations as to the effectiveness of subsidies and burden of the accompanying them bureaucratic procedures. On the other hand, it is argued that there must be a transition from subsidization to stricter legislation (for example, ban the marketing of the least efficient sprayers or reward implementation of best practices) – given that such legislation will be coherent, clear and enforced (i.e. control mechanisms are put in place).

The *industry* representatives, while being in favor of subsidization, notice that subsidies should be targeted to equipment which meet certain requirements (for example, certified as environmentally friendly; precision spraying). The same holds true for techniques/practices which guarantee environmental protection and safe produces. However, subsidies should not be the sole measure taken; information campaigns concerning the benefits of innovations (equipment, PPP and practices), legislation and inspections/controls are equally important.

Advisors note that so far innovations are too expensive and there are still very few tools (subsidies) to encourage/support their adoption – although subsidies are burdensome in terms of administration/bureaucracy. In parallel, the wide promotion of innovations and their benefits is recommended. Coercive measures are not favored.

Farmers argue for the need to bring agricultural and environmental components together; such an approach would greatly relieve producers. Furthermore, given that equipment is depreciated in approximately 15 years, they note that wide adoption of innovations takes a lot of time.

4 Discussion

In the first place it has to be noted that farmers with different cropping systems show statistically significant differences in terms of gender; age; education; training on PPP as well as on spraying machinery; experience in farming as well as in spraying applications; satisfaction from farming; identification of successor; farm location; farm size; participation in certification schemes; direct payments and other (Pillar II) subsidies; some (4 out of 10) criteria for buying spraying equipment; the most important source of knowledge/know-how on the use and operation of spraying equipment; knowledge of buffer zones; number of visits to agricultural fairs, field days/demonstrations or exhibitions; some (2 out of 9) most important spraying equipment characteristics that would make spraying equipment more relevant to farmers' needs; attitudes towards technology (2 out of 3 statements).

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

Furthermore, the majority of the interviewed farmers are aware of the innovative spraying equipment they were shown. Moreover, farmers' opinions concerning the innovative spraying equipment which they know best (among the alternatives presented to them) are clearly favorable. In the case of cereals and open field vegetables the reduction of pollution and usefulness are the characteristics mostly appreciated by farmers (>90% of farmers); the same holds true in the case of orchards and vineyards while in the case of greenhouses effectiveness, work comfort and ease of use - as compared to current equipment – are mostly appreciated.

The main criterion which usually affects farmers' decisions on buying/choosing spraying equipment (>90% of farmers) is 'spraying efficacy' followed by (>80% of farmers) 'ease of use', 'operator safety', 'compliance with EU Regulations', and 'reduction of PPP inputs'.

Adopters of innovative spraying equipment state that their innovative equipment are mainly (>90% of farmers) easy to work with, reliable and economically justified.

According to all the interviewed farmers, the most important spraying equipment characteristics (>90% of farmers) that would make spraying equipment more relevant to farmers' needs are long term reliability, ease of use and operator safety.

Farmers' most important source of knowledge/know-how on the use and operation of their spraying equipment (>10% of farmers) is their own experience followed by information/advice from equipment manufacturers and dealers and advisors (private and public/cooperative). Some differentiations are observed among hubs. Furthermore, farmers with cereals and open field vegetables mainly rely on their own experience closely followed by the industry (sprayers' manufacturers, PPP distributors and their dealers); farmers with orchards/vineyards equally rely on the industry and their own experience; and growers with greenhouses rely on their own experience followed away by advisors (private or public).

Farmers claim that the most recent source of information in which they sought out information (>10% of farmers) in relation to innovative spraying equipment are exhibitions or trade fairs, the Internet and professional press; relevant information during the year the interview was carried out (2018) was not sought by 11% of the farmers. In parallel, the great majority of the farmers said that they visit agricultural fairs, field days/demonstrations, or exhibitions at least once a year.

The most important adopters' source of information (>10% of farmers) on buying innovative spraying equipment is sprayers' manufacturers/dealers followed by farmer's own experience, other farmers and private advisors (10%). Differences were detected for France and Poland.

On the other hand, the most important source of information/test non-adopters would trust (>10% of farmers) before deciding to purchase innovative spraying equipment are demonstrations followed by other farmers using the equipment, a cost-benefit model tailored to their farm as well as a personal trial or conversation with someone with advisory capacity. Differences are detected in the cases of Sweden and Italy.

Additionally, the most important (>20% of farmers) source of knowledge/know-how with regard to PPP application (when, how much, precautionary measures, etc.) is PPP dealers, farmers' experience and private advisors.

The majority of the interviewed farmers claim that they experiment on their farms either by themselves or with advisors and/or researchers and to a much lesser degree with their peers. On the other hand, 18% said that they do not experiment on their farms.

It is also important to note that less than 20% of the adopters said that a specific subsidy (i.e. a subsidy other than the direct farm payment) gave them the opportunity to invest in their innovative spraying equipment.

On the other hand, the majority of non-adopters claim that they would buy innovative spraying equipment if they would get a subsidy as well as relevant training. According to them, in all the hubs, the main reasons for not having innovative spraying equipment are their small sized farms or that they cannot afford it.

Non-adopters claim that they would invest in new farm equipment mainly if economically justified – i.e. expectations for increased profit, justified cost/benefit ratio, reduction of production costs and the like, if their equipment gets damaged or too old, for spray efficacy reasons or for work comfort. Technology per se and environmental protection fall far behind (<10% of farmers).

At the same time, most of the non-adopters said that they do not renew their farm equipment frequently; nevertheless, there are important differences between Poland and Sweden where the majority of the farmers frequently renew their equipment as compared to Greece, Spain and Italy where less than 20% do.

Almost all the interviewed farmers claim that usability and user-friendliness are very important to them when they buy new things in the farm. Their majority prefers to have some experience with something before they buy it as well as to wait to buy new things, until they know that others have positive experiences with them. Therefore, they are not the first to buy and they claim that they don't like taking risks with their farming business. Finally, if interested, they would buy new

equipment even if their (social) environment would be negative on it. The majority of the interviewed farmers also said that they are the first to know about new machinery/technology in their social circles.

It must be underlined that the majority of the adopters did not test the equipment before buying it. On the other hand, almost two out of three among the non-adopters who have seen other farmers using innovative spraying equipment said that due to such an experience their interest in such equipment was raised; furthermore, about three out of four of the latter said that this experience confirmed their attitude regarding innovative spraying equipment.

Adopters and non-adopters show quite a few differences. Adopters are more likely to be full-time farmers, to be more satisfied from farming, to be located in plain areas and having attended a training course in spraying machinery than non-adopters.

Non-adopters are most likely to be involved in farming due to family tradition as well as to be less dependent on agriculture in terms of the contribution of agriculture into the family income.

Adopters and non-adopters seem to consider different sources of knowledge/know-how on the use and operation of their spraying equipment as being more important to them. More specifically, non-adopters rely much more on their own experience (as compared to adopters as well as to other sources of information) while adopters more on the industry (sprayers' and PPP manufacturers/dealers). In general, adopters visit agricultural fairs, field days/demonstrations, or exhibitions more often than non-adopters.

With respect to the criteria for buying/choosing spraying equipment, economic considerations are more important for non-adopters, while the reduction of PPP inputs and environmental protection are less important.

With reference to the characteristics of spraying equipment that would make them more relevant to farmers' needs adopters put more emphasis to the ease of use and to the availability of technical support than non-adopters.

Adopters are stronger believers in the capability of technology to improve farming and to help them to comply with regulations as well as that technology can support farmers' work recognition by the public than non-adopters.

Adopters are more likely to be the first in their social circle of friends and relatives both to know about and buy new machinery/technology. On the other hand, non-adopters are more likely to wait to buy new things, until they know others have positive experiences with it and prefer to have some experience with something before I buy it as compared to adopters.

It is also interesting to note that adopters with different cropping systems show statistically significant differences in two out of six statements concerning their innovative spraying equipment.

As aforementioned more than 90% of farmers hold the Training Certificate on PPP use according to the Directive 2009/128/EC while just over 60% have attended training courses on spraying machinery. Farmers with cereals or open filed vegetables are the ones who have been mostly trained on both PPP use and spraying machinery with farmers with greenhouses being the least trained in spraying machinery.

The majority of non-adopters mentioned that relevant training is a prerequisite for the adoption of innovative spraying equipment. It has also to be noted that the reasons 'too complicated to work with/ not user-friendly' and 'too complicated to understand' account for 5% each among the three main reasons concerning the non-adoption of innovative spraying equipment. Finally, as aforementioned, adopters are more likely to have attended training courses on spraying machinery than non-adopters.

Additionally, technical support was mentioned by farmers themselves (vs. questionnaire options) as important concerning the criteria which affect farmers' decisions on buying/choosing spraying equipment (13 cases). Technical support is also underlined by adopters in terms of relevance of innovative equipment to farmers' needs.

In parallel, limited technical assistance accounts for 7% of the three main reasons given by all non-adopters for not adopting innovative spraying equipment. In particular, in the case of greenhouses the lack of technical assistance is the second more important reason (behind small size) for not adopting innovative spraying equipment.

Finally, as far as best management practices are concerned farmers appear knowledgeable of spray drift and spray drift reduction equipment and practices, which they largely put in practice. Their majority also mentioned that they control and/or adjust their spraying machinery every time when they spray, once before the growing season or periodically as well as that they changed their nozzles at most 2 years ago. They also maintained that they take into account weather conditions before application.

Furthermore, the majority said that they leave buffer zones (farm zones which they do not spray) since it is mandatory and to a much lesser degree following the indication in the product label. They also, always or most of the times, apply the recommended dose written on the PPP label with almost one in seven following the recommendations of their advisors and one in eight claiming that they apply less than the recommended dose written on the PPP label. Finally, two out of three of the interviewees always spray according to the recommended time lag between applications.

Finally, two out of three of the interviewed farmers ask for some kind of financial support, in principle the subsidization of the purchase of innovative spraying equipment; one out of seven asked for training and technical support from independent (extension/advice) providers. Quite some farmers also claim that the change of regulations as well as the characteristics of the new equipment could also be a good incentive as well.

On their part, the interviewed experts argue in favor of innovative spraying equipment due to their efficiency and thus environmental and economic benefits; other characteristics to which they point to are the safety and comfort of the operator and ease-of-use of such equipment. On the other hand, they underline the high initial (purchase) costs of such equipment as well as their complexity, thus the need to provide farmers with continuous training and technical support. The technical limitations/ vulnerability of such advanced, complex technology is also noticed.

Experts agree with farmers for the need of targeted subsidization (certified machinery, best management practices, possibly more favorable for smaller farms). However, subsidies should not be the sole measure taken; stricter legislation and its enforcement, information campaigns,

farmers' training and technical support by independent extension/advisory services are equally important. Attention should be also given to farmers' demand for the better balance between environmental and agronomic performance of new technologies (spraying machinery and PPP).

Finally, the lack of functional AKIS/ innovation platform in the branch of spraying technologies has to be underlined since it results in gaps which, although rather known to the actors concerned, are not possible to be bridged. According to the interviews in the framework of INNOSETA, along with the theoretical background (D. 2.1), extension/advisory services seem to be in the best position (as compared to the other actors) to play an intermediation role, i.e. to negotiate with other actors the creation of the relevant AKIS network.

5 Appendices

- A. Sampling
- B. Farmers' questionnaire
- C. Experts' interview guide
- D. Innovative technologies (Pictures)

APPENDICES

APPENDIX A: Sampling

FINAL SAMPLE							PLANNED SAMPLE					
						Cropping system						
BELGIUM							BELGIUM					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
	1	9	4	1	15	Cereals			4	6	6	16
		2		4	6	Open field vegetables			2	2	2	6
2	3	1			6	Greenhouses		4	2			6
					27							28
GREECE							GREECE					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
4	15	11			30	Orchards	8	18	4			30
6	3	2			11	Greenhouses	2	6	2			10
2	5	3	1		11	Vineyards	2	6	2			10
					52							50
SPAIN							SPAIN					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
	7	15	2	4	28	Orchards		8	10	6	6	30
3	6	1		1	11	Greenhouses	2	4	2		2	10
	3	7			10	Vineyards			6	2	2	10
					49							50
FRANCE							FRANCE					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL

RUR-10-2018

		1	7	21	29	Cereals			2	8	20	30
		6	2	1	9	Orchards			6	2	2	10
	3	6	4		13	Vineyards			6	2	2	10
					51							50
ITALY							ITALY					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
	1	11	6	8	26	Cereals		2	10	6	8	26
2	8	4			14	Orchards	2	8	4			14
	4	4		2	10	Vineyards		4	4		2	10
					50							50
THE NETHERLANDS							THE NETHERLANDS					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
		1	2	4	7	Cereals			2	4	6	12
		2	2	4	8	Open field vegetables			4	2	2	8
1	3				4	Greenhouse	2	4				6
					19							26
POLAND							POLAND					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL
	1	11	11	11	34	Cereals		6	14	4	6	30
	1	4		1	6	Open field vegetables		4	2	2	2	10
1	5	4			10	Orchards		6	4			10
					50							50
SWEDEN							SWEDEN					
<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL		<2 ha.	2-10 ha.	10-50 ha.	50-100 ha.	>100 ha.	TOTAL

RUR-10-2018

		5	8	18	31	Cereals			6	6	18	30
			4	5	9	Open field				4	6	10
	2	4	2	2	10	Orchards		2	4	2	2	10
					50							50

APPENDIX B: Farmers' questionnaire

Farmers' questionnaire

Country:

Questionnaire Code:

Questionnaire

Intro:

To whom it should be addressed: the **farmer and** in case of contractor, **the contractor** for Best Management Practices.

Name _____

Telephone number _____

Email _____

Farm

1. Region:
2. How would you describe your region (choose the one where most of your fields are located):
 1. Flat
 2. Hilly
 3. Mountainous
3. Cropping system (choose only the main one, **in terms of area cultivated**):
 1. Cereals
 2. Open field vegetables
 3. Orchards
 4. Vineyards
 5. Greenhouse

4. Legal status of farm:

- ☐ Family farm
- ☐ Company
- ☐ Cooperative farm
- ☐ Other _____

(Only if “family farm” was chosen in Question above)

Proportion of income from agricultural production for household income is estimated at about:

5. _____%

6. Total area cultivated:

- ☐ <2 ha
- ☐ 2-4.9 ha
- ☐ 5-9.9 ha
- ☐ 10 -19.9 ha
- ☐ 20 – 29.9 ha
- ☐ 30 – 49.9 ha
- ☐ 50 – 99.9 ha
- ☐ 100 -199 ha
- ☐ 20 - 499 ha
- ☐ >500 ha

7. Land ownership (ha)

- Land owned (ha): _____
- Land rented in (ha): _____
- Land rented out (ha): _____
- Other: _____

8. Are there any non-agricultural activities on farm (agro-tourism, etc.?) [Yes=1, No=2]

- ☐ Yes (Please specify: _____)
- ☐ No

9. Participation in certification schemes? (PGI/PDO, integrated farming, organic farming, Global G.A.P., etc.)

[Yes=1, No=2]

- ☐ Yes (Please specify: _____)
- ☐ No

10. Does the farm receive direct payments? (Pillar 1 of the CAP) [Yes=1, No=2]

- ☐ Yes
- ☐ No

11. Does the farm receive any other subsidies? (Pillar 2 of the CAP: diversification, young farmers' scheme, agri-environmental measures, organic farming, farm modernization scheme, etc.) [Yes=1, No=2]

- ☐ Yes (Please specify: _____)
- ☐ No

12. Are some of your fields neighboring to: [Yes=1, No=2]

- | | |
|---|--------|
| 1. Organic cultivations? | Yes No |
| 2. Surface water (lakes, streams, rivers)? | Yes No |
| 3. Protected areas (hospitals, kindergarten, public garden, NATURA regions, etc)? | Yes No |
| 4. Inhabited areas (houses, family gardens)? | Yes No |

Spraying Equipment and Machinery

13. Who owns the majority of the spray equipment **used** in your farm? [Yes=1, No=2]

- | | | |
|--|-----|----|
| <input type="radio"/> Privately owned | Yes | No |
| <input type="radio"/> Cooperative | Yes | No |
| <input type="radio"/> Rented (used by myself) | Yes | No |
| <input type="radio"/> Sub-contractor | Yes | No |
| <input type="radio"/> Combination of the above (please specify: _____) | Yes | No |

14. Is your sprayer(s) subcontracted out (to other farms on payment agreement)? [Yes=1, No=2]

- ☐ Yes
- ☐ No

15. If you **ONLY** use a subcontractor (to rent the spraying equipment you use or to do spraying in your farm) why do you choose him/her?

15.1 Most important reason _____

15.2 Second most important reason _____

MEMO (possible answers to Q15)

1	S/he owns advanced spraying equipment
2	S/he is the only available in the area
3	S/he is the cheapest in the area
4	I cooperate with her/him for a long time
5	Other (please specify)

In case the farmer uses ONLY a subcontractor to do the job (spraying), for Q16-18 please ask the subcontractor - in which case the farmer continues with Q19!

16. Which are your criteria for buying/choosing spraying equipment? (Please rank importance of each criterion, 1 = least important to 5= most important).

1	Economic considerations	1	2	3	4	5
2	Spray efficacy	1	2	3	4	5
3	Reduction of PPP inputs	1	2	3	4	5
4	Farm size	1	2	3	4	5
5	Environmental protection	1	2	3	4	5
6	Comply with EU/other regulations	1	2	3	4	5
7	Ease of use	1	2	3	4	5
8	Reputation (company, brand name)	1	2	3	4	5
9	Other farmers, friends etc. use it	1	2	3	4	5
10	Operator safety	1	2	3	4	5
11	Other (Please specify):	1	2	3	4	5

17. Which are the three most important sources of knowledge/know-how on the use and operation of your spraying equipment (including your experience)?

18.1 Most important: _____

18.2 Second most important: _____

18.3 Third most important: _____

MEMO (possible answers to Q17)

1	On my own experience
2	National or regional agricultural (public, cooperative) extension services
3	Private advisors
4	PPP distributors/local dealers
5	Sprayers' manufacturers/ local dealers
6	Technical press
7	Internet
8	Farmers' (discussion) group

9	Other farmers/peers (not including farmers' group)
10	Other (please specify)

18. How old are your spraying machinery (type and year)?

	Type	Years	Year of last mandatory inspection
1			
2			
3			
4			

Innovative Spraying Equipment

19. I would like you to look at the photos and tell me which of the following Innovative Spraying Equipment you are aware of. Whether or not you own this spraying equipment is not important for the following questions. (See Appendix)

Picture 1	Yes	No
Picture 2	Yes	No
Picture 3	Yes	No
Picture 4	Yes	No
Picture 5	Yes	No
Picture 6	Yes	No

20. Then I would like you to choose the most advanced one which you know well enough, and having this in mind, let me know **how much you do or do not agree with each of the following questions.**

(1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

21. Which spraying technology do you choose? _____

22. The innovative equipment you chose is useful for farming (in your job).	1	2	3	4
23. The innovative equipment you chose is easier to use compared to the technology or tools you have or had in the past.	1	2	3	4

24. Using the innovative equipment you chose decreases input costs compared to not using it.	1	2	3	4
25. Using the innovative equipment you chose increases your effectiveness (application efficacy) compared to not using it.	1	2	3	4
26. The innovative equipment you chose helps reducing pollution from farming.	1	2	3	4
27. The innovative equipment you chose improves farmers' work comfort.	1	2	3	4

28. Do you **own** any innovative spraying equipment **not included** in the list?

If YES, which? _____

29. Do you **have or use** any of the spraying equipment **in the photos**?

- ☐ Yes (**continue with Adopters: Users, QUESTION30**)
- ☐ No (**continue with Non-adopters: Non Users, QUESTION45**)

Adopters (Users)

30. Which of the innovative spraying equipment showed to you in the photos do you **have or use** (most often)? _____

31. Did you test the innovative spraying equipment before getting/purchasing it? [Yes=1, No=2]

- ☐ Yes
- ☐ No

32. Which were the most important sources of information for buying it?

32.1 Most important: _____

32.2 Second most important: _____

32.3 Third most important: _____

MEMO (possible answers to Q32):

1	On my own experience
2	National or regional agricultural (public, cooperative) extension services
3	Private advisors

4	PPP distributors/local dealers
5	Sprayers' manufacturers/ local dealers
6	Technical press
7	Internet
8	Farmers' (discussion) group
9	Other farmers/peers (not including farmers' group)
10	Other (please specify)

33. Did the introduction of innovative spraying equipment change the way you do spraying or other farming practices?[Yes=1, No=2]

- ☐ Yes, (How? _____)
- ☐ No, (Why? _____)

34. How long did it take for you to become comfortable using this innovative spraying equipment?

_____ (months)

In the next few questions, you will be asked if you disagree or agree with the following statements.

(1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

35.	It is easy to work with this spraying equipment.	1	2	3	4
36.	It is easy to get technical support for this spraying equipment.	1	2	3	4
37.	This spraying equipment is economically justified / the cost-benefit of this spraying equipment is as you expected.	1	2	3	4
38.	Sharing costs with other farmers has allowed you to use this spraying equipment.	1	2	3	4
39.	This spraying equipment is reliable.	1	2	3	4
40.	This spraying equipment requires a lot of maintenance.	1	2	3	4

41. Who repairs and maintains this spraying equipment?(Tick all that apply)[Yes=1, No=2]

- | | | |
|---|-----|----|
| 1. You (farmer being interviewed) | Yes | No |
| 2. Supplier/retailer/maker of equipment | Yes | No |
| 3. Independent company | Yes | No |
| 4. Public service | Yes | No |
| 5. Other farmer | Yes | No |
| 6. Other _____ | | |

42. Did a specific external subsidy other than the direct farm payment give you an opportunity to invest in the selected this spraying equipment?

- ☐ Yes

- No

43. (Show photos again) What is the next spraying equipment from the list that you could potentially purchase? _____

44. (If you are going to buy it) Why would you purchase it?

Continue with QUESTION 55

Non Adopters (Non Users)

45. Which of the following **information/tests would you trust** before deciding to purchase innovative spraying equipment?

45.1 Most important _____

45.2 Second most important _____

45.3 Third most important _____

MEMO (possible answers to Q45):

1	Demonstration
2	Cost benefit model to reflect farm specifics
3	Video
4	Conversations with unofficial contact (neighbor, other farmer)
5	Conversations with official contact (advisor, official, someone paid for their service)
6	Personal test/trial
7	See other farmers using it
8	Results on other farms
9	Other (please specify):

46. Would you get innovative spraying equipment if they were supported through subsidies?[Yes=1, No=2]

- Yes
- No

47. Would you get innovative spraying equipment if you could share costs with others?[Yes=1, No=2]

- ☐ Yes
- ☐ No

48. Would you get innovative spraying equipment if you could get training/support on how to use it?[Yes=1, No=2]

- ☐ Yes
- ☐ No

49. What are your **five** most important reasons for **NOT** adopting innovative spraying equipment? (1= most important; 5= least important)

49.1 Most important _____

49.2 Second most important _____

49.3 Third most important _____

49.4 Fourth most important _____

49.5 Fifth most important _____

MEMO (possible answers to Q49):

1	Land is too small
2	Not the best fitting technology available yet (tailored to my situation/ cultivation system)
3	Not interested in the available technology
4	Not affordable (due to high upfront costs)
5	Do not see future profit benefit
6	I am too old
7	Too complicated to understand its use (not compatible with current skills and knowledge)
8	Too complicated to work with it/not user friendly
9	The technology is not compatible with existing technology in my farm.
10	The guarantee of long term efficiency of the technologies is limited
11	Limited guarantee of assistance when asked
12	Other (please specify):

50. Do you frequently renew your farm equipment?[Yes=1, No=2]

- ☐ Yes
- ☐ No

51. What makes you think about investing in something new?

52. Have you watched other farmers using innovative spraying equipment?[Yes=1, No=2]

- ☐ Yes (continue with QUESTION53)

- ☐ No

53. (Only if “yes” was chosen in QUESTION 52): Did this raise your interest in innovative spraying equipment?[Yes=1, No=2]

- ☐ Yes (which one:_____)
- ☐ No

54. (Only if “yes” was chosen in QUESTION 53) Did this confirm your attitude regarding innovative spraying equipment?[Yes=1, No=2]

- ☐ Yes
- ☐ No

Farmer or subcontractor

Best Management Practices

55. Interviewee

- | | |
|-----------------|---------|
| 55.1 Farmer | Yes/ No |
| 55.2 Contractor | Yes/ No |

56. Do you know what spray drift is?

- ☐ Yes
- ☐ No
- ☐ Partly (explain)

Spray drift is the transfer of small spray droplets out of the target area due to wind, poor calibration or application practices or incorrect nozzles.

(Only if “yes” or “partly” was chosen in the Question above)

57. Are you aware of spray equipment and practices that can reduce spray drift? [Yes=1, No=2]

- ☐ Yes
- ☐ No

58. Do you take into account (consider) spray drift during spray applications?

- ☐ Yes

- No
- Only for the plots close to sensitive areas

59. Which are the three most important reasons that will motivate you to apply spray drift reduction techniques?

59.1 Most important _____

59.2 Second most important _____

59.3 Third most important _____

MEMO (possible answers to Q59):

1	Increase the effectiveness of PPP operation	
2	Save money through the reduction of PPP	
3	Reduce PPP residues on products	
4	Reduce the drift onto sensitive areas	
5	Compliance with regulations	
6	Reduce environmental impact (water, soil and air contamination)	
7	Reduce of PPP related impact on human health and neighborhood	
8	Being a good steward of the land	
9	Being a good neighbor	
10	Other (please specify):	

● **Spray application equipment**

60. Do you try to maintain a constant speed while spraying? [Yes=1, No=2]

- Yes
- No

For boom sprayers

61. Do you adjust the **boom** height according to the crop/target before spraying (in case of arable crops/open field vegetables)? [Yes=1, No=2]

- Yes
- No

For orchard/vineyard sprayers

62. Do you adjust your **fan speed and air direction** during the season according to the crop stage? [Yes=1, No=2]

- Yes

- ☐ No

63. Do you adjust your **spray profile** according to the crop architecture before spraying? [Yes=1, No=2]

- ☐ Yes
- ☐ No

For all sprayers

64. Do you **control and/or adjust your spraying machinery** at the beginning and throughout each growing season?

- ☐ Every time before I spray
- ☐ Once before the growing season
- ☐ Other _____

65. When was the last time you changed your nozzles?

- ☐ This season
- ☐ Last season
- ☐ More than two years ago
- ☐ I do not remember

● Weather conditions

66. Before application, do you take into account any weather conditions before application? Which ones?

- | | | |
|------|----------------|-----------------------|
| 66.1 | Wind speed | Yes/ No [Yes=1, No=2] |
| 66.2 | Wind direction | Yes/ No |
| 66.3 | Temperature | Yes/ No |
| 66.4 | Air humidity | Yes/ No |

67. Which time of the day do you usually spray?

● Buffer zones

68. Do you know what the buffer zones are?

- ☐ Yes
- 2. No
- 3. Partly (explain) _____

69. Do you leave any (buffer) zones (which you do not spray)?

- ☐ Yes (it is mandatory)
- ☐ Yes (following the indication in the product label)
- ☐ No. I know that I should but I do not practice (Why? _____)
- ☐ No
- ☐ Other: _____)

● Dose application

70. Do you read the label before mixture and spraying?

- ☐ Yes, every time
- ☐ I read the label only the first time
- ☐ Label is too complicated (to understand)
- ☐ There is no useful information in the label
- ☐ No
- ☐ Other

71. Do you apply the recommended dose written on the PPP (Plant Protection Product) label?

1. Yes, every time
2. Most of the times
3. Some times
4. No
(Why? _____)
5. I apply less (Why? _____)
6. I apply more (Why? _____)
7. Other (please specify) _____

72. Do you spray according to the recommended time lag between applications?

1. Yes, every time
2. Most of the times
3. Some times
4. No (Why? _____)
5. Other (please specify) _____

73. Which are the three most important sources of knowledge/know-how with regard to **PPP application** (when, how much, precautionary measures, etc.) (including your experience)?

73.1 Most important: _____

73.2 Second most important: _____

73.3 Third most important: _____

MEMO (possible answers to Q73):

1	Me, based on my experience
2	Farmer friends
3	PPP dealer
4	Machinery dealer
5	Public Service/Extension Service
6	Private advisor
7	Farmers Association/coop
8	Internet and/or apps
9	Farm press
10	Demonstration/Field days
11	Other (please specify)

Farmer's attitudes regarding *information seeking on innovative spraying equipment.*

74. How often do you visit agricultural fairs, field days/demonstrations, or exhibitions?

- ☐ More than once a year
- ☐ Once a year
- ☐ Less than once a year
- ☐ Never

75. Which were the **three most recent sources of information** in which you sought out information, this year, in relation to innovative spraying equipment?

75.1 First most recent _____

75.2 Second most recent _____

75.3 Third most recent _____

MEMO (possible answers to Q75):

1	None
2	Professional press (e.g. farmer association magazines)
3	Scientific journal/press
4	Advertisement
5	Exhibitions or trade fair
6	Seminars or workshop

7	Demonstration
8	Internet
9	Social media
10	Farmer discussion group
11	Other farmers (not including discussion group)
12	Advisor contact (public/ private?)
13	Other:

76. **Please rank the following characteristics** of spraying equipment that would make them more **relevant to farmers' needs** (1 = not crucial ;5 = very crucial

77.

1	Easy to use	1	2	3	4	5
2	Easy to install on the sprayer	1	2	3	4	5
3	Show economic benefits right away	1	2	3	4	5
4	Reduction of environmental hazards	1	2	3	4	5
5	Reasonable price	1	2	3	4	5
6	Technical support	1	2	3	4	5
7	Compatible with existing machinery/equipment	1	2	3	4	5
8	Long-term reliability	1	2	3	4	5
9	Operator safety	1	2	3	4	5
10	Other (please specify)	1	2	3	4	5

Farmer's opinions about technology, in general

(1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

78.	Technology can improve farming.	1	2	3	4
79.	Technology can help farmers comply with regulations (e.g. CAP Greening).	1	2	3	4
80.	Technology can support farmers' work recognition by the public.	1	2	3	4

Farmer's Innovativeness

81. Do you like to experiment on your farm, i.e. trying new technology or practices on the farm before you adopt it at full scale?

1. Yes – by yourself
2. Yes – with other farmers
3. Yes – with advisers or researchers
4. No

In the next few questions, you will be asked if you disagree or agree with the following statements.

(1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

82. In general, I am the first in my social circle of friends and relatives to know about new machinery/technology.	1	2	3	4
83. In general, I am among the first of my friends and relatives to buy new machinery/technology.	1	2	3	4
84. Usability and user-friendliness are very important to me when I buy new things.	1	2	3	4
85. I wait to buy new things, until I know others have positive experiences with it.	1	2	3	4
86. I prefer to have some experience with something before I buy it.	1	2	3	4
87. Even if I am interested, I wouldn't buy if my (social) environment would be negative on it.	1	2	3	4
88. In general, when making farm decisions, I don't like taking risks.	1	2	3	4

89. What kind of incentives would you like to see in future policies to facilitate the acquisition of innovative spraying equipment?

Farmer

90. Age:

91. Gender:

- ☐ Male
- ☐ Female

92. What is the highest level of education you completed?
- ☐ Elementary (approximately 4-7 years of general education)
 - ☐ Secondary school (approximately 8-12 years of general education)
 - ☐ Technical school and/or apprenticeship (approximately 2-4 years follow-up after secondary school)
 - ☐ University (any level, Bachelor, Master, or PhD)
 - ☐ Other: _____
93. Is farming your primary occupation? [Yes=1, No=2]
- ☐ Yes
 - ☐ No
94. For how long have you been a farmer? (years _____)
95. Is there a farm successor or someone who will inherit and/or take over the farm? [Yes=1, No=2]
- ☐ Yes
 - ☐ No
96. How much experience do you have in spray (PPP) applications?
Years: _____
97. Why did you become a farmer?
- ☐ Tradition (family, farm inherited)
 - ☐ Profession of choice
 - ☐ No other choice
 - ☐ Other (please specify) _____
98. How would you rank your satisfaction with farming?
- ☐ Very unsatisfied
 - ☐ Unsatisfied
 - ☐ Satisfied
 - ☐ Very satisfied
99. **(Optional)** Which are the reasons for dissatisfaction?

100. Do you **hold** the **Training Certificate on PPP use** according to the Directive 2009/128/EC? [Yes=1, No=2]
1. Yes
 2. No

101. Have you **attended** any **training course in spraying machinery?** (legislation, equipment use, sprayers settings, maintenance, environment protection - point sources and diffuse sources e.g. TOPPS trainings) [Yes=1, No=2]

1. Yes
2. No

102. Any other comments on innovative spraying equipment, training and advice?

APPENDIX C: Experts' interview guide

To whom it should be addressed:

Expert groups:

- 1. Research:** Universities, Research Institutes, Universities of Applied Science
- 2. Industry:** Experts in companies (CEOs, managers, technical experts)
- 3. Practice:** Agricultural advisors (agronomists, consultants, public/private agricultural extension services), representatives of agricultural cooperatives/associations, etc.

Data Collection:

The expert interviews will be conducted face-to face or via Skype.

Use of voice recorder, after the agreement by the interviewee.

Recordings will be transcribed and translated

1. Introduction

Description of organization

- Could you briefly describe your organisation? (Main activity, date of establishment, different levels of organisation (national, regional, local), total number of staff)

Description of the interviewee

- Could you briefly describe your career and training background?
- What is the SETA field that you have expertise in?

2. Questionnaire

1) What are the main challenges facing European agriculture nowadays and in the future?

2) What is the role of SETA in overcoming these challenges?

3) What is the role of policy, economic, social and environmental pressures which drive farmers to adopt and use SETA?

What are the policy pressures for using SETA?

What are the economic pressures of using SETA?

What are the environmental pressures of using SETA?




What are the social pressures for using SETA? (Are there social values/social pressure that force farmers towards a more environmental friendly agriculture? If yes which? How strong influence do you believe that these have in farmers' decision making?)



- 4) What are the advantages/ disadvantages for a farmer to use SETA?
- 5) Can you comment on the situation of SETA adoption and use in your country? (If you are aware) How does it compare to other EU Member States?
- 6) What are the main reasons (motivation and criteria) for farmers to adopt and use SETA?
- 7) What are the major personal and farm characteristics of farmers who adopt SETA (are there personal factors, life-stage of farm family as well as farm-specific factors, such as cropping system, size, proximity to sensitive areas, altitude, etc., on top of policy, social, economic, environmental pressures, etc.)?
- 8) What are the reasons that farmers do not adopt SETA?
- 9) Which are the main target groups (farmers and types of farms) of SETA development/ innovation?
- 10) How are farmers' needs and demands taken into account/ What is the role of farmers (their needs, values, interests) in the direction of technological innovations in the application of PPP?
- 11) Are there any SETA characteristics (economic, technical, etc.) which need improvement/ change so that SETA will become more relevant and affordable to farmers and thus more widely adopted?
- 12) Are you aware of the problems concerning the optimal use of SETA?
 - What are the main factors contributing to the gap between best/recommend and current farmers' practices?
 - Are there specific demands on farmers' knowledge and skills regarding the use of advanced SETA?



- 13) Are you aware of the problems concerning PPPs application? (limited consideration to the dosage rate, optimum number of applications, timing and frequency resulting in rampant use of these agrochemicals)
- What are the main factors contributing to not complying with recommended practices?
 - Are there specific demands on farmers' knowledge and skills with regard to PPPs application?
- 14) What is/ what should be the role of a) research b) advisory services in
- a) Promoting certain spraying machinery innovations amongst farmers?
 - b) Promoting best practices in PPP application
 - c) What is the role and importance of research and advisory services vis-à-vis family and neighbor-level and/or other information sources?
- 15) What is/ what should be the role of subsidies, policies, or regulations in directing the adoption and dissemination of SETA innovations?
- 16) Can you please comment on the cooperation (or not) between AKIS actors (policy, research, extension, farmers, industry, commerce, consumers, etc.) in SETA development/ innovation (are there links between actors; how are decisions on technology development taken?)
- a) in the assessment of innovation needs (farmer's/end user's needs?)
 - b) the production of innovative SETA?
 - c) Are there gaps between theory and practice or between farmers and developers? Which are they and why do they occur?
- 17) Which of the following technologies (see Appendix 4) do you consider as being the most used by farmers? Why?
- 18) Which of them do you believe are the most useful for farmers? Under what conditions? Why?

APPENDIX D: Main categories of spraying technologies/ equipment per cultivation(s)





Cereals/Open field vegetables



<i>Technology category</i>	<i>Description</i>	<i>Photos</i>
1. Drift reducing nozzles	Drift reducing nozzles reduce the number of fine droplets that are present with conventional flat fan nozzles reducing spray drift and allowing spraying in more marginal conditions	 
2. Air support/twin fluid nozzles	Air assistance on field sprayers creates a forced airstream under the spray boom which blows the spray droplets into the crop, reducing drift of spray droplets and the amount of PPP and spray liquid needed.	


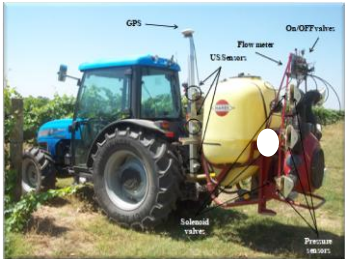
3. Electronic control system for spray boom height/stability	<p>Auto boom height is used to maintain the spray nozzles at a constant height above the target area even in hilly conditions. This allows the desired nozzles spray overlapping, a more uniform distribution and less drift. Electronic boom-mounted sensors generally generate ultrasonic pulses which are reflected back to the sensor by the ground or canopy in order to determine the distance between them and the boom.</p>	
4. GPS, spray computer and individual spray boom section/nozzle control	<p>GPS based automated switching on/off of boom sections or individual spray nozzles to avoid spray overlap in the field and spraying out off the field boundaries</p>	

5. Variable rate sprayer	Spray system to automatically change spray volume depending on the position in the field based on task maps or sensor measurements and allows PPP savings.	
6. Autonomous sprayer	Robotised driverless sprayer using camera, GPS and/or sensors to position itself and to perform variable rate spraying based on task maps or sensor measurements. It allows manpower and PPP savings.	




Vineyards / Orchards


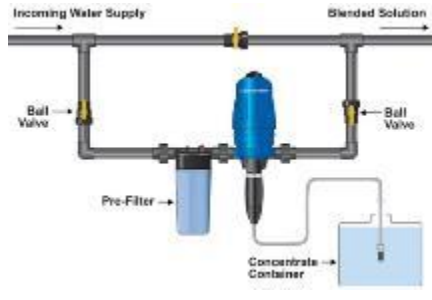

1. Drift reducing nozzles	<p>Drift reducing nozzles (air injection nozzles, compression chamber nozzles) reduce the number of fine droplets compared with conventional hollow cone and flat fan nozzles reducing spray drift and helping spraying close to sensitive areas (water source, suburban areas, etc.)</p>	 
2. Deflectors/adjustable air spouts for air flow direction adjustment	<p>These systems allow to re-direct the air flow toward the crop, limiting spray loss in the air.</p>	 

<p>3. Devices for manual/automated volume adjustment</p>	<p>This system allow to cut the air flow on a single side of a sprayer in order to prevent drift toward sensitive areas while spraying the edges of an orchard</p>	
<p>4. Shielded sprayers - Tunnel sprayers</p>	<p>Tunnel sprayers are side-by-side sprayers with “shields” on spray ramps, allowing to recover part of the spray that do not reach vegetation and cross the canopy.</p>	

5. Target detection systems (automatic spray on/off)	<p>This system automatically detects the end of a row and/or gaps in the row due to missing trees, and switch off the spray in order to generate less drift.</p>	
6. Automatic variable rate sprayer	<p>This device can adapt the amount sprayed in real time to the vegetation that is treated. This principle enables to reduce the amount of PPP inputs and spray drift</p>	

Greenhouses

1. Lance with pressure control device	<p>It allows to apply the desired volume and droplets size by means of changeable pressure control (nozzle) or a pressure adjustment system and a manometer to control it.</p>	
2. Lance equipped with nozzle holder for ISO/drift reducing nozzles	<p>Thanks to the possibility to mount ISO/drift reducing nozzles the user can easily modify the output flow rate and the droplets size according to the needs of the crop to treat and environmental circumstances.</p>	
3. Manually pulled vertical/horizontal spray booms	<p>A frame with wheels and vertical/horizontal boom pulled by the operator that allows a more uniform spray distribution and a reduced contamination of the operator.</p>	

4. Self propelled sprayers with vertical/horizontal booms	A small self-propelled sprayer able to pass in very narrow rows allowing a more precise and safe PPP application.	
5. Dosing /direct injection system	A precise dosing system inserted into fixed pipeline that allows to apply the correct amount of PPP and or of liquid fertilizer.	
6. Automated/remotely controlled horizontal/vertical boom sprayers	A small automated self propelled sprayer that could be remotely controlled allowing to save time and a complete operator safety.	

APPENDIX 5: Survey Participant Information Sheet and Consent Form



[logo partner]

Survey Participant Information Sheet

INNOSETA (Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture through the mobilization of Agricultural Knowledge and Innovation Systems)

info partner researcher(s), responsible for the area:

(name)

Address for correspondence:

Email: ... Telephone: ...

Date

Dear

Thank you for your interest in this study: Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture through the mobilization of Agricultural Knowledge and Innovation Systems.

You are invited to participate in this project and we are required to provide a participant information sheet and consent form to inform you about the study, to convey that participation is voluntary, to explain the potential risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask us any questions you may have. If you agree to take part, we will ask you to sign a consent form. Please take as much time as you need to read it. You should only consent to take part in this study when you feel that you understand what is being asked of you and you have had enough time to think about your decision.

PURPOSE OF RESEARCH

We are undertaking this research at (**partner institution**) as the organization representing (**country**) in the larger European Horizon 2020 project INNOSETA that brings together a wide range of actors across Europe. You have been contacted about this study because you are a farmer who uses spraying machinery and their components which is the focus of this research. Your answers will form part of our study on SETA (spraying machinery and relevant training and advice) throughout Europe.

INNOSETA

The aim of INNOSETA is to set-up a Thematic Network on 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 area¹⁴.

Why are my details important?

The more participants included in this survey the more beneficial it will be to both the agricultural sector and to relevant industries and research institutes. Your contribution is very important in increasing the understanding of farmers' needs and interests, and identifying factors influencing adoption and diffusion of SETA technologies and best practices.

WHAT YOU WILL DO

Your participation is entirely voluntary. If you consent to take part you will be asked to reply to a number of questions included in the INNOSETA farmers' questionnaire. This questionnaire will take you around 90 minutes to complete. All information provided in the interview and surveys will be kept anonymous and strict confidentiality will be ensured.

POTENTIAL BENEFITS

The findings of this study will be presented in (country) and in Europe. As aforementioned, it is the aim of this research to promote effective exchange of novel ideas and information between research, industry, extension and the farming community so that existing research and commercial solutions can be widely communicated, while capturing grassroots level needs and innovative ideas from the farming community.

POTENTIAL RISKS

We do not foresee any negative effects arising from your participation in this study. Please understand that you are free to withdraw from participation in advance of the interview as well as to stop the interview at any stage. All information and topics discussed are confidential and the content of the discussion/questionnaire data will not be disclosed with third parties.

PRIVACY AND CONFIDENTIALITY

We will collect your name, organisation, and professional email address if further details are necessary when analysing the data. However, your participation in this survey will be treated anonymously and your personal data will only be kept for internal research purposes; your data and that of other persons and places mentioned in the survey and/or interview will remain confidential at all times.

In case the survey and/or interview is recorded, all electronic and recorded versions of the survey interview will be securely stored and treated anonymously. The only record of your participation in the interview will be stored in (researcher location) in a secure location for the duration of the study, in case we need to contact you again. Anonymised versions of the interview data will be shared with and analysed by INNOSETA project partners.

The results of this study will be published or presented at professional meetings but the material used will not allow the identification of any of the participants in this survey, at all times.

YOUR RIGHTS TO PARTICIPATE, SAY NO, OR REQUEST MY WITHDRAWAL

¹⁴For more information this European Horizon 2020 project, please see Annex and/or visit: <http://www.innoseta.eu/>

Participation in this research project is completely voluntary. You have the right to say no. You may change your mind at any time or withdraw. You may choose not to answer specific questions or to stop participating at any time.

CONTACT INFORMATION FOR QUESTIONS AND CONCERNS

If you have any questions about this study, or about your role or rights as a research participant, please contact the researchers and their Data Protection Officer(DPO) at the address above.

(researcher) + (contact of the DPO of the partner's organization)

Summary

Participation in this study is based on the clear understanding that your participation is voluntary and can be withdrawn at any time. A consent form accompanies this participant information sheet. A copy of both will be provided to you. You are required to sign a copy of the consent form should you agree to participate in this study - please return one copy of the signed consent form. Thank you for considering taking part in this study.

ANNEX

THE INNOSETA PROJECT

Plant Protection Products (PPP) industry and research have been developing more sustainable novel PPPs that show high efficacy in lab environment, but their efficacy rate is reduced significantly, when applied in field conditions. Even more, spraying technologies have experimented in the last years an important improvement in terms of efficiency and safety, including in their development the latest advances in electronics, data management and safety aspects. New sprayers have experienced a revolutionary improvement allowing a better and safer use of PPPs. New PPP developments and the latest advancements in intelligent sprayers have been complemented with a large list of Best Management Practices (BMP), alternative methods for dose/volume selection adapted to canopy structure, safe recommendations to reduce drift, resident exposure and point sources' contamination, development of electronic and web based Decision Support Systems (DSS) to improve the phase-use of PPPs. But unfortunately, there is still an important gap between research developments and the actual use of the available tools and practices by the farmers, especially for this large number of small and medium producers with limited access to the information. If this gap closes, then European agriculture could become more sustainable with minimum environmental, socioeconomic and human health impact. Since new legislation has applied efforts to the use-phase of PPPs, it is now time to integrate all the available tools and practices that previous research have demonstrated to be interesting. However, there is still another key element that is absolutely needed to achieve success in the whole process: an adequate training of all the professionals involved in the process, which represents the key factor for the whole integration. Therefore, only when agricultural stakeholders gain knowledge of existing and future technological advancements in spraying technology and adequate training is achieved in all of the European territory will the system be able to implement the policies in the legal framework and to produce food in a better and more sustainable way.

INNOSETA is organized to explore spraying application needs in the most commonly used crops (cereals, vegetables, orchards, vineyards and greenhouses) in seven European countries which will be linked through international workshops. This Thematic Network will address important and timely issues that are critical to improve crop productivity and reduce environmental impact to enable farmers and pesticide companies to decide on the most suitable to them technology combination for certain pesticide application.

Therefore, the main objective of INNOSETA is to set up a Network on SETA (Spraying Equipment, Training and Advising) to contribute in closing the gap between the available novel high-end crop protection solutions either commercial or from applicable research results with the everyday European agricultural practices by promoting effective exchange of novel ideas and information between research, industry, extension and the farming community so that existing research and commercial solutions can be widely communicated, while capturing grassroots level needs and innovative ideas from the farming community.



[+ logo Partner]

Consent Form

INNOSETA (Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture through the mobilization of Agricultural Knowledge and Innovation Systems)

info partner researcher(s), responsible for the area:

(name)

Address for correspondence:

Email: ... Telephone: ...

Date

Please initial box

1. I confirm that I have read the participation information sheet dated **(Date)** ☐
for the above study and have had the opportunity to ask questions
2. I confirm that I understand the information provided and have had enough ☐
time to consider the information.
3. I understand that my participation is voluntary and that I am free to ☐
withdraw at any time.
4. In signing this consent form I [Participant] agree to volunteer to participate ☐
in this research study being conducted by **(leading partner researcher)** and
research colleagues.
5. I agree: ☐
- to the data being audio-recorded for the purposes of data processing
and, ☐
- to the interview being archived in a digital repository subject to my name and
identifying information being removed
6. I understand that I will participate in a recorded interview with the ☐
researcher on the agreed topic.
7. I grant full authorization for the use of the above information on the full ☐
understanding that my participation will be kept anonymous and confidentiality
will be preserved in public use of these data.
8. I understand that participation is completely voluntary and that I am free to ☐
withdraw my data at any time, without giving a reason.

_____ Participant	_____ Date	_____ Signature
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_____ Researcher	_____ Date	_____ Signature
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APPENDIX 6: A first approach to factors potentially affecting the adoption of innovative technologies and practices (source: EUROSTAT 2013)

Table 6.1: Numbers of holdings per cultivation category (included in the INNOSETA study) per country

	Arable (excluding fresh vegetables)	Orchards (fruits, citrus & olives)	Vineyards	Open air vegetables	Greenhouses (vegetables)
Belgium	26,590	1,410	0	5,810	1,040
Greece	265,060	584,300	103,050	42,910	8,460
Spain	355,330	656,280	123,410	109,240	19,130
France	298,290	40,420	76,990	36,350	9,700
Italy	579,500	688,840	249,390	79,710	21,700
Netherlands	37,920	2,350	100	8,050	1,520
Poland	1,108,100	198,250	0	141,890	13,790
Sweden	62,270	740	0	2,330	290

Table 6.2: Age of farmers per country (%)

	< 35 (%)	35-54 (%)	>55 (%)
Belgium	4.0	48.0	48.0
Greece	5.2	38.6	56.2
Spain	3.7	37.8	58.5
France	8.8	51.8	39.4
Italy	4.5	32.5	63.0
Netherlands	3.1	49.1	47.9
Poland	12.1	53.9	33.9
Sweden	4.4	37.6	58.0

Table 6.3: Size of agricultural holdings per country

	Zero ha		< 2 ha		2 to 4.9 ha		5 to 9.9 ha		10 to 19.9 ha		20 to 29.9 ha		30 to 49.9 ha		50 to 99.9 ha		100 ha and over	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Belgium	420	1.11	1600	4.24	3460	9.16	4980	13.19	6840	18.11	4930	13.06	6810	18.03	6530	17.29	2190	5.80
Greece	5910	0.83	358970	50.59	179470	25.30	86520	12.19	45560	6.42	15080	2.13	11120	1.57	5430	0.77	1450	0.20
Spain	20700	2.15	253410	26.26	232440	24.09	140780	14.59	110800	11.48	51550	5.34	53550	5.55	49960	5.18	51820	5.37
France	8500	1.80	51590	10.93	56280	11.92	41090	8.70	44770	9.48	31610	6.69	47440	10.05	93330	19.76	97600	20.67
Italy	880	0.09	277910	27.51	313930	31.07	172900	17.11	114850	11.37	44690	4.42	39870	3.95	30180	2.99	15100	1.49
Netherlands	1690	2.50	6930	10.27	9860	14.61	9400	13.93	10060	14.91	6890	10.21	10980	16.27	9280	13.75	2390	3.54
Poland	7450	0.52	326140	22.82	444220	31.09	308200	21.57	208990	14.62	62040	4.34	40440	2.83	20570	1.44	10950	0.77
Sweden	590	0.88	710	1.06	6410	9.55	15770	23.48	13610	20.27	6650	9.90	7220	10.75	8160	12.15	8030	11.96

Table 6.4: Agricultural education of farm managers by country (%)

	Farm managers with agricultural training		Farm managers with practical experience only (%)
	Basic training (%)	Full training (%)	
Belgium	19.7	21.2	59.1
Greece	5.5	0.6	93.9
Spain	16.1	1.6	82.2
France	32.2	29.3	38.4
Italy*	90.8	6.1	3.1
Netherlands	64.2	7.7	28.1
Poland	20.2	27.6	52.2
Sweden	11.5	19.2	69.2

* In case of Italy the concepts of the different level of trainings are defined special.