



Report on farmers' needs, innovative ideas and interests

Del 1.3

Type: Report, Deliverable Title: Report on farmers' needs, innovative ideas and interests.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement ID 101000496

Document Summary

Deliverable Title: **Report on farmers' needs, innovative ideas and interests**

Version: **1.0**

Deliverable Lead: **AUA**

Related Work package: **1**

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Contributor(s): **CEMA, CERTH**

Communication level: **Public**

Project Number: **101000496**

Grant Agreement Number: **101000496**

Programme: **AgroFossilFree - Strategies and technologies to achieve a European**

Fossil-energy-free agriculture

Start date of Project: **October 1st, 2020**

Duration: **36 months**

Project coordinator: **Thanos Balafoutis - CERTH**

Abstract

The main aim of this document, i.e. Deliverable 1.3 of the AGROFOSSILFREE project is, based on the guidelines and templates produced in Deliverable 1.2 (i.e. screening of the national farm population, survey questionnaire - addressing different types of technologies/practices, production systems as well as both adopters and non-adopters, and experts' interview guidelines), to provide a report of the research results. The research results, aiming at identifying farmers' needs, innovative ideas and interests regarding FEFTS, are presented as follows: farmers' survey and experts' (mainly advisors) interviews are first presented separately and subsequently are jointly summarized with a view to factors that influence the adoption of FEFTS which may be relevant across Europe.

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1. Methodology

The rationale as well as the tools (farmers' questionnaire and experts' interview guide) of this study, based on the AFF Grant Agreement, were presented in Deliverable 1.2 (for the tools, see also Appendices A & B).

1.1 Farmers' survey: Sampling rationale and background

With reference to the farmers' survey, based on our literature review (Deliverable 1.2), 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 Renewable Energy sources as well as of energy efficiency and carbon sequestration technologies and practices vis-à-vis the available innovation support systems (advisory/extension services, including training), policy dynamics, environmental limitations, and farmers' sociocultural and economic circumstances.

As far as the experts' interviews are concerned, as mentioned in Deliverable 1.2, the target-group comprises key-persons from research, industry and practice while according to the project GA the focus are on advisors.

1.2 Farmers' survey: Sampling structure

Our study covered 8 different European countries: Denmark, Germany, Greece, Italy, Ireland, The Netherlands, Poland, and Spain. 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 capture 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 1.2. Therefore, in the first place, following the task leader's proposal (in agreement with the project coordinator) the consortium decided to interview 50 - 60 farmers, split between plant and livestock farms and comprising ca 50% adopters and ca 50% non-adopters per country. Following, based on the contribution (%) in terms of utilized agricultural area (UAA) or Livestock Units (LU) in each country, a first estimation of the sample (no. of farms/farmers per farm size per country) was made based on EUROSTAT 2013 data sets¹.

Table 1. AFF sampling per production system (farmers' survey)

Country	Plant production	Animal production	Mixed systems	Total
Denmark	20	7	25	52
Germany	14	10	35	59
Greece	28	16	18	62
Ireland	7	43	11	61
Italy	30	28	4	62
Netherlands	31	19	6	56
Poland	24	5	32	61
Spain	26	11	20	57
Total	180	139	151	470

¹ The analytical data concerning the size of all agricultural holdings per country, based on EUROSTAT 2013, were presented in Appendix 4, Deliverable 1.2

Data were collected by partners using the survey questionnaire made available at google docs (built by AUA); thus data were automatically entered in the appropriate EXCEL data basis and transferred to and analysed with the use of SPSS.23.

Table 2. AFF sampling per plant production system (farmers' survey)

Country	Arable	Permanent*	Other land**	Greenhouses
Denmark	44	10	38	1
Germany	52	6	43	5
Greece	35	8	5	7
Ireland	17	1	50	0
Italy	15	10	2	10
Netherlands	35	5	15	7
Poland	60	19	35	6
Spain	35	25	18	6
Total	293	84	206	42

* i.e. vineyards, orchards, etc.

** i.e. permanent grassland, etc

Table 3. AFF sampling per livestock and mixed production system (farmers' survey)

Country	Dairy cows	Beef (meat production)	Sheep	Goats	Breeding sows	Laying hens	Broilers
Denmark	7	7	4	0	16	0	2
Germany	28	17	9	2	14	19	8
Greece	4	3	16	5	2	3	4
Ireland	17	29	28	2	2	3	10
Italy	11	7	2	4	2	5	2
Netherlands	7	5	2	2	3	2	4
Poland	17	9	2	0	2	12	6
Spain	4	7	11	6	9	3	4
Total	95	84	74	21	50	47	40

1.3 Experts' interviews

Experts from the partner countries were also interviewed, chosen on the basis of their expertise.

As far as the experts' (i.e. those who are involved in agricultural technology development and innovation processes) interviews are concerned, it was initially decided to interview 5 stakeholders per country comprising researchers/ academics, industry representatives, extensionists/advisors and/or farmers (representatives of cooperatives/ associations). Nevertheless, following the project GA our focus were advisors. The overall aim is to capture 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). Overall 41 interviews with experts from 8 European countries were conducted as shown in Table 4.

Table 4. Composition of the experts' group

Country	Advisors	Researchers/ academics	Farmers' representatives	Industry representatives
Denmark	3	1		1
Germany	5	1	1	
Greece	5		1	
Ireland	5			
Italy	5			
The Netherlands	5			
Poland	3	1		1
Spain		2		1
Total	31	5	2	3

2. Farmers' survey: Data analysis

2.1 Farm and farmer characteristics

Men comprise the great majority of the sample (87.4%).

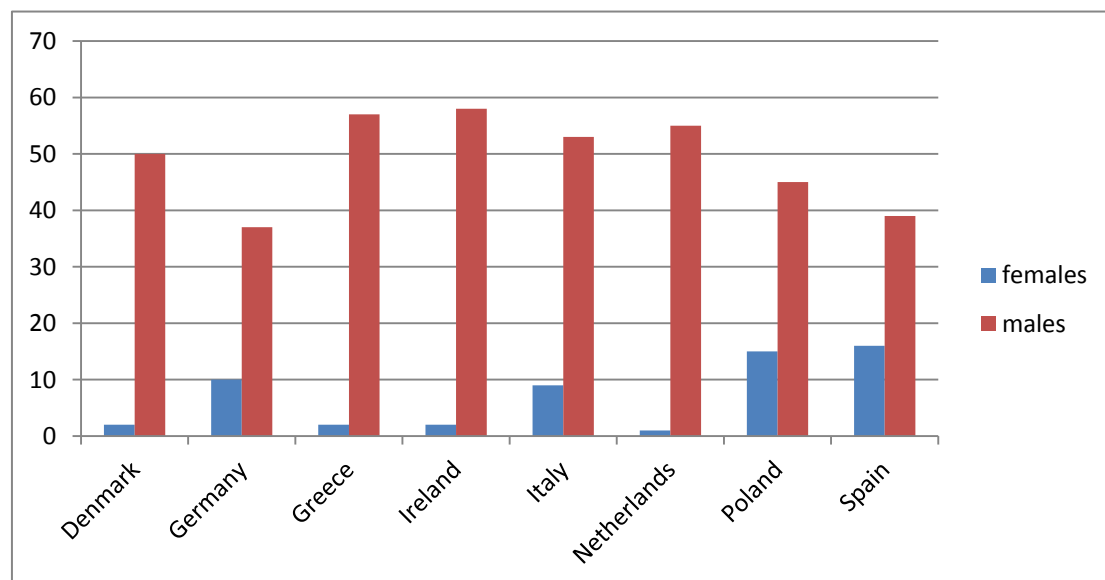


Figure 1: Number of interviewees per gender

The majority of the interviewees fall in the age category 50-59 years old (31.5%) and 40-49 yrs (29.7%), i.e. 61.2% of the sample falls in the category 40-59 years old. Farmers up to 40

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

years old account for 19.2% of the sample with farmers aged 60 years old and over being the 19.6% of the sample.

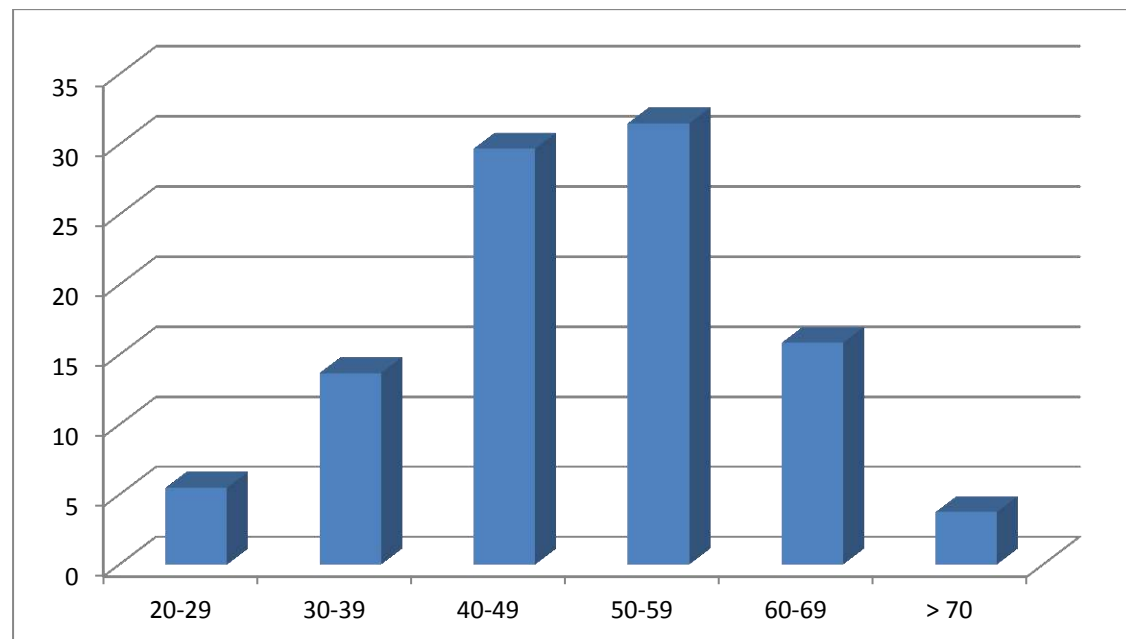


Figure 2: Interviewees' age (in%)

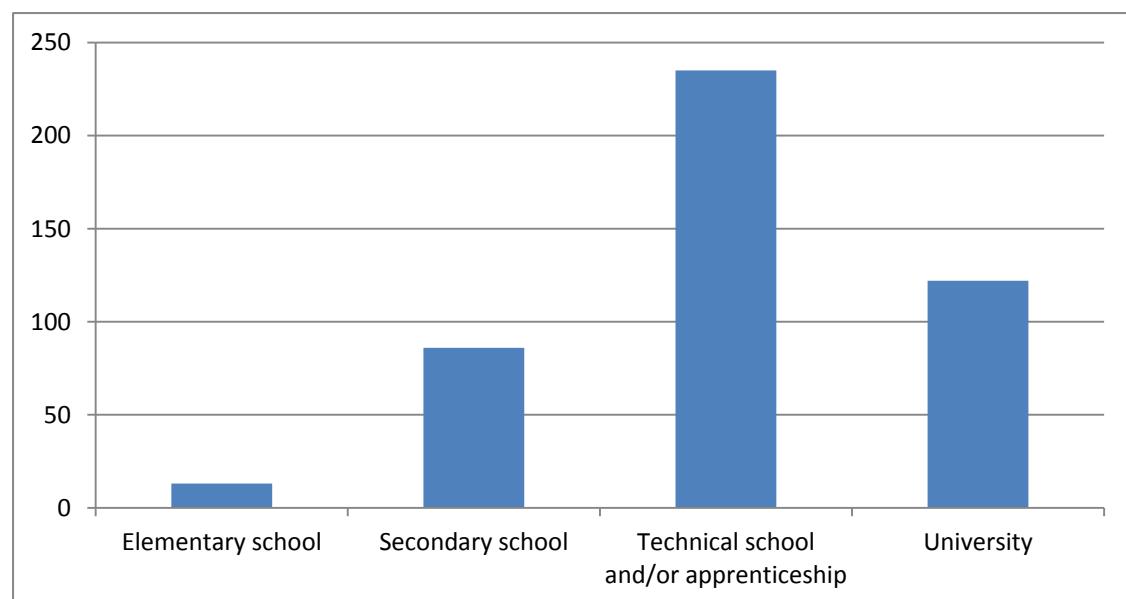


Figure 3: Interviewees' (farmers') education

In general, the interviewed farmers have medium (general secondary 18.9% and technical 51.5%) to high educational level (university 26.8%) (see Figure 3). This, as expected, differs between the countries involved in the survey: Denmark and The Netherlands have the highest percentage of farmers with technical education (86.5% and 75%, respectively) followed by Germany (57.4%) and Poland (52.5%); Italy and Spain have the highest percentages of university graduates (40.3% and 35.7%, respectively) followed by Germany (29.8%), Greece (29.5%) and Poland (27.9%); Greece and Ireland have by far the highest percentages of farmers with secondary education (45.9% and 42.6%, respectively); Spain,

Greece and Germany have some farmers with elementary education, although this segment remains a small minority (Figure 4).

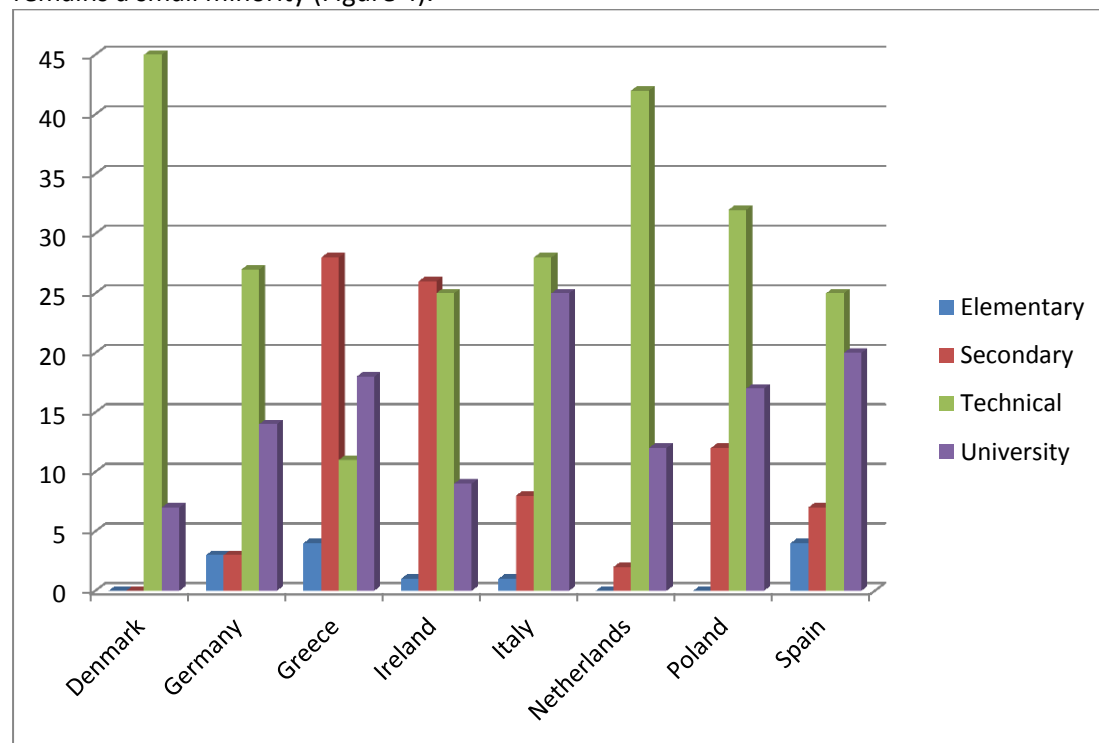


Figure 4: Farmers' education per country

Furthermore, 25.1% hold a Green Certificate (i.e. full professional/ occupational agricultural education/ training for at least 24 months – following the completion of compulsory education).

Three out of four interviewees (75.4%) said they use the Internet on a daily basis with an additional 13.2% using it a few days per week. Farmers in Denmark, The Netherlands and Spain (96.2 %, 89.3% and 83.9% respectively) are the ones who mostly use the Internet every day. In parallel, the majority of the farmers (54%) claimed that they have very good/ excellent digital skills; on the contrary 7.1% claimed none or very poor digital skills (illiterate). The majority of farmers in The Netherlands (78.6%), Denmark (66.7%) as well as in Germany (59.3%) and Poland (59%) have very good digital/excellent digital skills. On the other hand 17.7% of the Greeks and 10.7% of the Spanish are 'digitally illiterate'. Additionally, the interviewed farmers occupied in plant production are more frequent users of the Internet and have higher level of digital skills as compared to their livestock and mixed systems colleagues.

Farming is the primary (full-time) occupation for 81.7% of the interviewees. This is especially true for the Italians (91.9%), the Dutch (91.1%) and the Germans (90.2%).

Up to 10 years of experience in farming have 18.9% of the sample farmers while 29.7% have more than 30 years in farming. The other two classes of experience (11-20 and 21-30) account for 22.4% and 29% of the farmers, respectively.

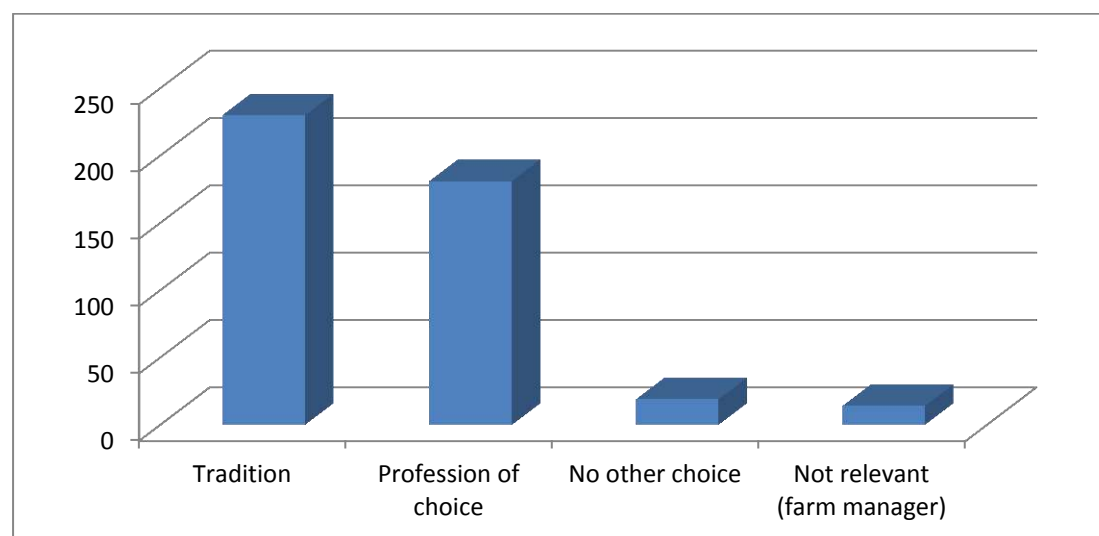


Figure 5: Reasons for becoming a farmer

Almost half of the total interviewees stated that tradition is the main reason to engage with farming i.e. family tradition and/or farm inherited (49.6%) or because they chose to (39%). The majority of the interviewees in The Netherlands (73.2%), Ireland (63.9%), Spain (60.7%), Italy (65.5%) and Germany (55.6%) said they engaged in farming due to tradition; on the contrary, the majority of Danish (76.9%) and Greeks (54.8%) said that farming was their professional choice. Relatively high percentages of Germans (11.1%) and Italians (9.7%) said there was no other occupational choice available to them.

Livestock farmers are more likely to have been engaged in farming due to family tradition than others ($P^3 < 0.05$).

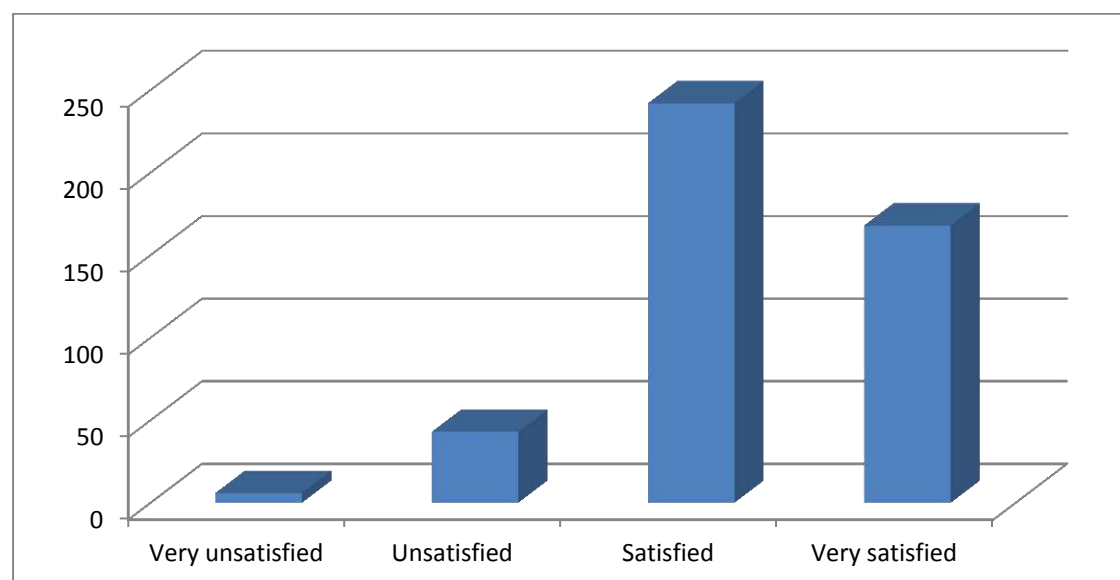


Figure 6: Satisfaction with farming

The majority of the farmers are satisfied (52.7%) or very satisfied (36.6%) with farming. On the contrary, 9.4% are unsatisfied (with 1.3% being very unsatisfied). Farmers in Spain and

³ P stands for the Approximate Significance of the relationship (cross-tabulations).

Ireland seem to be the most unsatisfied ones (23.6% and 19.7%) followed by Polish (11.5%) and Greeks (11.3%); on the other hand all Danish farmers are satisfied/ very satisfied.

Farmers with livestock appear to be the least satisfied ones ($P < 0.10$).

Only half of the family farms (51.2%) have identified a successor who will inherit and/or take over the farm. In particular, in only two countries the majority of the farmers have not identified a successor: Greece and Spain (65.5% and 61.5%, respectively). Farms with mixed systems seem to have secured succession at a higher rate ($P < 0.05$).

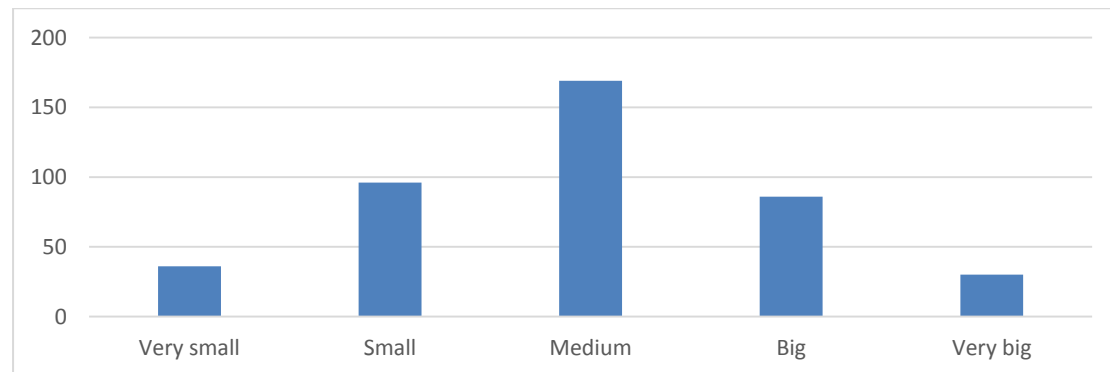


Figure 7: Farm size of the sample

Most of the farms (40.5%) included in the sample are characterized as medium farms. Big and very big farms account for 20.6% and 7.2% respectively while small and very small ones for 23% and 8.6%, respectively.

The majority of the interviewed farmers (410 out of 470) have lands in flat areas with 62.9% of them having at least 90% of their lands in plains and 58% having all their lands in plains. On the other hand 214 farmers cultivate in hilly areas (20.1% of whom have at least 90% of their lands on hills) and 46 cultivate in mountainous areas (37% of whom have at least 90% of their lands on mountains). It is clear that higher percentages of crop production farms' areas are found in plains ($P < 0.05$).

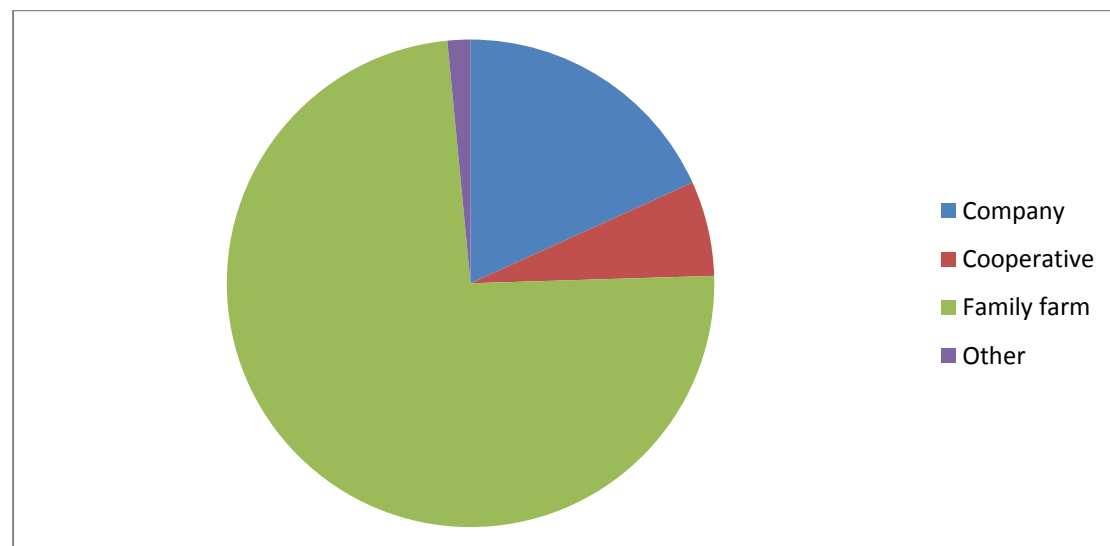


Figure 8: Legal status of the farm

The majority of the interviewed farmers operate their own family farm (72.6%). Companies represent 17.9% and cooperative farms 6.2% of the sample.

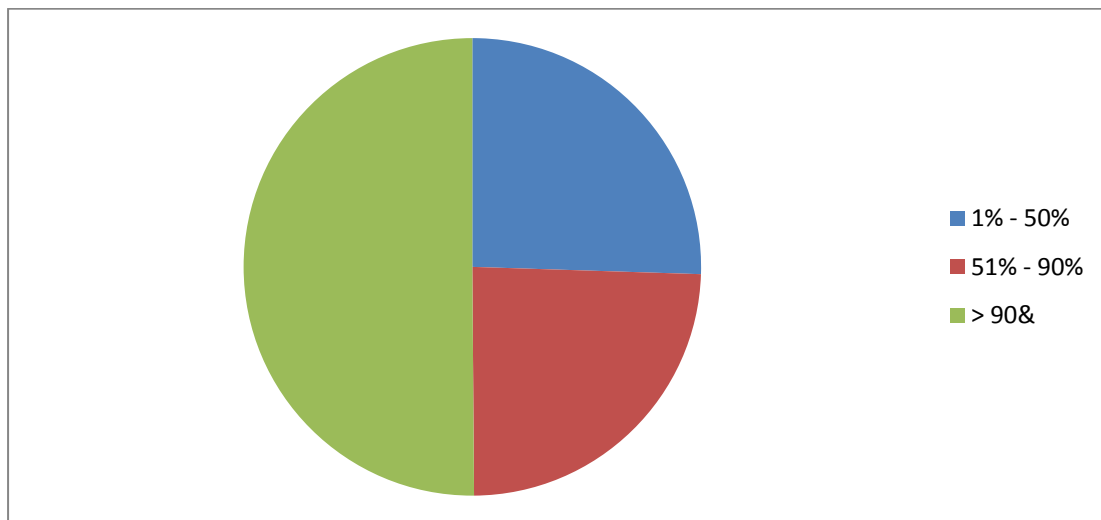


Figure 9: Percentage of farm income from agricultural activities

In terms of the contribution of income from agricultural activities to the total family income (Figure 9, the majority of the interviewees depends on agriculture (50.1% between 91% and 100%) while 25.5% earn up to 50% of their family income from agriculture and 24.4% between 51% and 90%. The countries in which the majority of farmers earn 90% or more of their family income from agriculture, in the sample, are Germany (76.7%), The Netherlands (75.9%), Greece (72.3%) and Poland (58.3%). Almost two thirds (64.5%) of the mixed farms depend on farming, i.e. earn more than 90% of their income from agriculture ($P=0.001$). The 33% of the total interviewees declared that they are engaged in on-farm non-agricultural activities i.e. diversification. Farmers in Germany (73.6%), followed by farmers in Spain (49.1%) show the highest percentages of engagement in non-agricultural activities while farmers in Ireland (9.8%) the least. Livestock farmers are least involved in farm diversification as compared to other farmers.

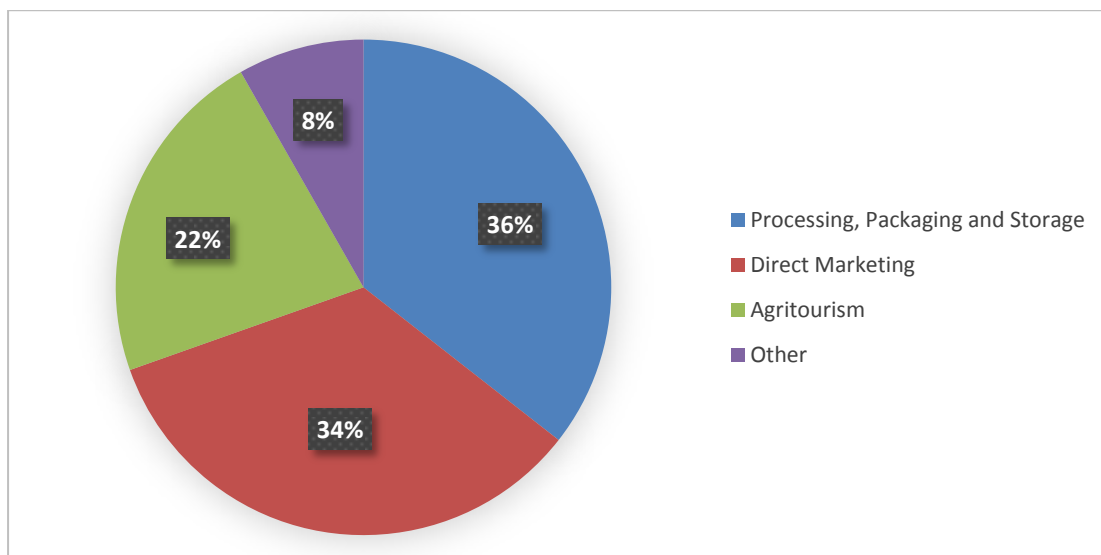


Figure 10: Non-agricultural on-farm activities

The most popular on-farm non-agricultural activities found on these farms are processing, packaging and storage (36%), direct sales (34%) and (agri-)tourism (22%). Other activities (8%) mostly include subcontracting and agricultural training/dissemination activities.

The majority of the interviewed farmers (53%) participate in a certification scheme. This is true for the majority of the farmers in Germany (64.4%), Spain (63.2%), Greece (62.3%), Ireland (55.2%) and Italy (50.8%).

The majority of the farmers in the sample receive direct payments from CAP (84.9%) while 53.2% receive other subsidies (Pillar 2 of the CAP).

Over 90% of the interviewed farmers in Poland (98.4%), Denmark (98.1%) and Ireland (93%) receive direct payments; in all countries more than 70% of the farms receive direct payment.

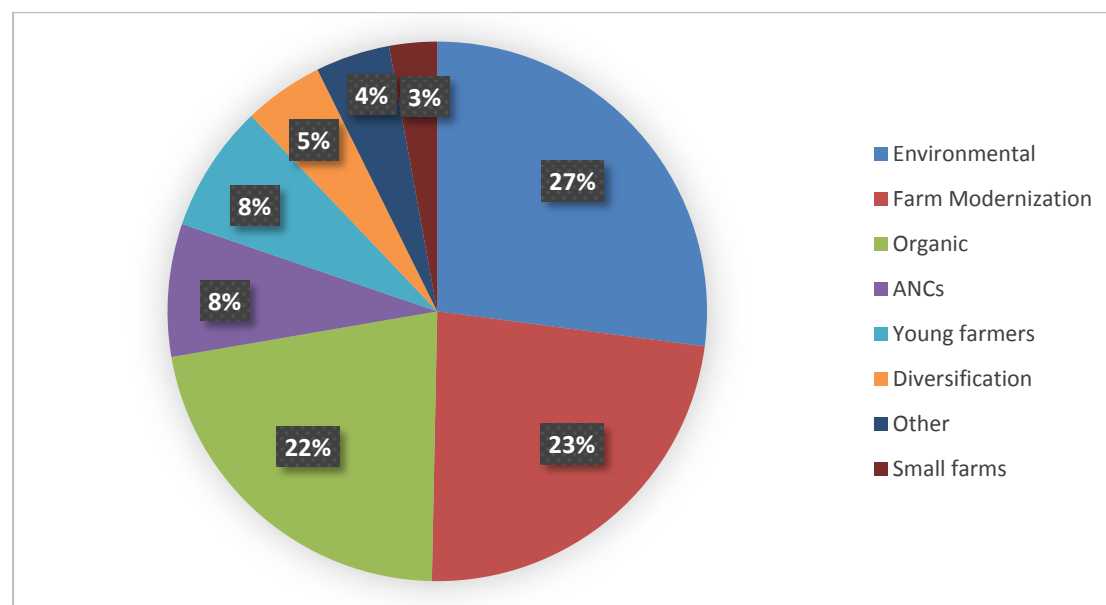


Figure 11: Other subsidies (excl. direct payments)

Other than direct payments, subsidies (Figure 11) concern environmental schemes (27%), modernization/investment schemes (23%), organic farming (22%), the young farmers measure (8%) and Areas with Natural Constraints (8%).

Other subsidies (CAP support Pillar II) are received by the majority of Polish (72.1%), Irish (70.7%), German (62.7%) and Spanish (55.4%) farmers as well as half of the Italian farmers.

Subsidies specific to Renewable Energy or energy-saving measures have been received by 26.6% of the interviewees. Such support is received by the majority of interviewed farmers in Germany (52.5%) followed by the farmers in The Netherlands (42.9%) and Italy (37.1%); in all other countries, less than 20% of the farmers have received RES-related or energy-saving-related subsidies.

2.2 Renewable energy sources (RES)

Farmers were asked if they are aware of 6 different RES, namely: Solar (PV, PVT, thermal); Wind turbines; Biomass/biofuels/biogas; Heat pumps (Geothermal or aerothermal or hydrothermal); Hydro; Any energy storage system as well as any other RES. Only 32 out of 470 (or 6.8%) interviewees have not heard about RES. Awareness per RES per country is shown in Table 5 and Figure 12.

Table 5. Farmers' awareness of RES (%) per country

Country	Solar	Wind turbines	Biomass/biofuels/biogas	Heat pumps*	Hydro	Energy storage system
Denmark	100.0%	100.0%	100.0%	100.0%	25.5%	21.2%
Germany	100.0%	89.7%	100.0%	91.4%	79.7%	98.3%
Greece	100.0%	56.5%	96.8%	61.3%	66.1%	83.9%
Ireland	70.5%	63.9%	55.7%	47.5%	47.5%	31.1%
Italy	95.2%	90.0%	95.0%	85.0%	82.3%	72.6%
Netherlands	94.6%	91.1%	83.9%	77.4%	75.0%	73.2%
Poland	100.0%	100.0%	100.0%	100.0%	96.7%	88.5%
Spain	93.0%	84.2%	89.5%	63.0%	57.9%	57.9%
Total	94.0%	83.9%	89.9%	77.8%	67.2%	66.6%

* Geothermal or aerothermal or hydrothermal

All (100%) Danish and Polish farmers have heard about 4 out of the 6 RES while all German farmers have heard about 2 of them and all Greeks about Solar. On the other hand less than half of the Irish farmers have heard about 3 of the RES presented to them, i.e. Heat pumps, Hydro and Energy storage, while only one fourth to one fifth of the Danish farmers have heard about the last two, respectively.

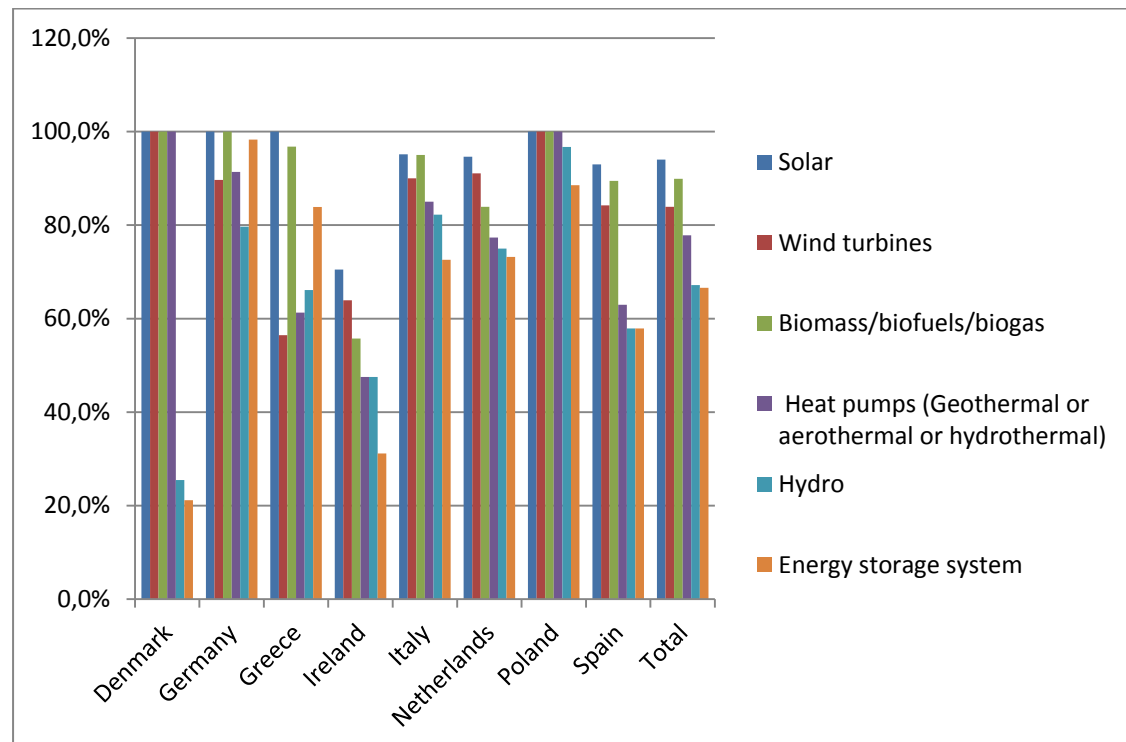


Figure 12: RES awareness (% of farmers per country per RES)

Overall the most well-known RES are Solar (94%) and Biomass (89.9%) followed by Wind turbines (83.9%) and Heat pumps (77.8%).

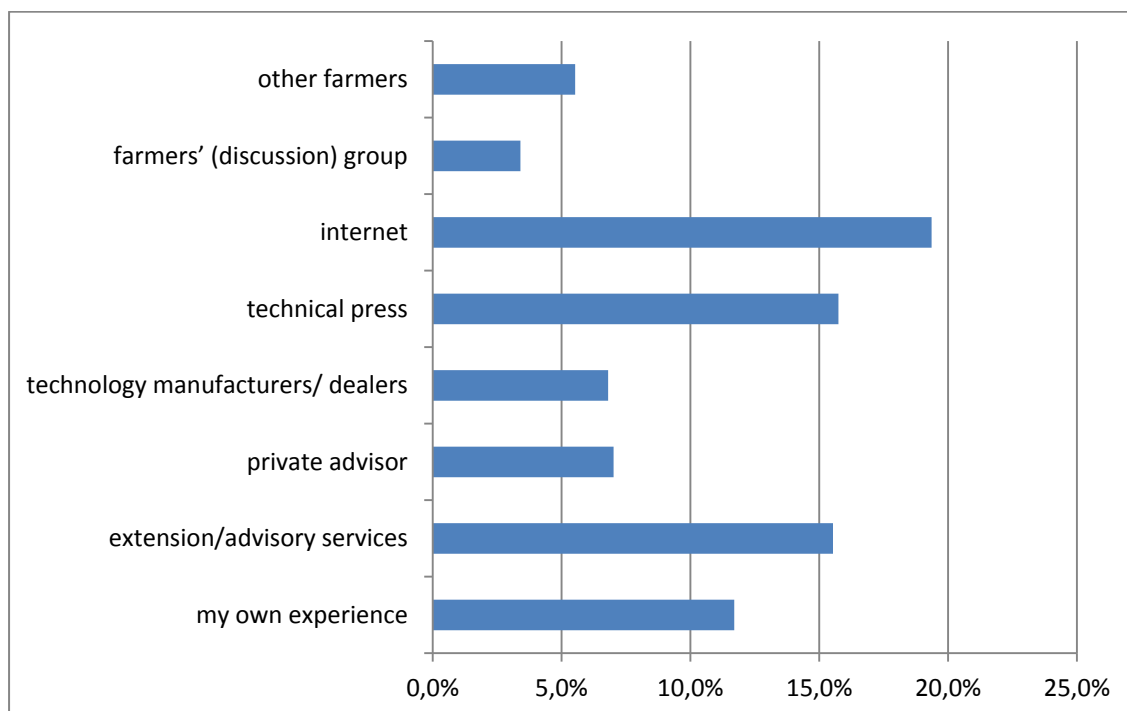


Figure 13: Most important source of information on RES

As far as farmers' most important *source of knowledge/ awareness* on RES is concerned, farmers said that they rely on the Internet (19.4%), the technical press (15.7%) and national or regional agricultural (public, cooperative) extension/advisory services (15.5%) and their own experience (11.7%). More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (25%), technical press (19.2%) and the Internet (11.5%)
- Germany: technical press (22%), the Internet (20.3%), own experience (18.6%) and other farmers (11.9%)
- Greece: the Internet (43.5%), private advisors (14.5%) and other farmers (14.5%)
- Italy: national or regional agricultural (public, cooperative) extension/advisory services (41.9%), own experience (12.9%) and private advisors (11.3%)
- Ireland: own experience (18%), national or regional agricultural (public, cooperative) extension/advisory services (13.1%) and the Internet (13.1%)
- The Netherlands: technical press (46.4%) and own experience (19.6%)
- Poland: the Internet (41%), national or regional agricultural (public, cooperative) extension/advisory services (19.7%) and technical press (11.5%)
- Spain: own experience (14%), technical press (14%) and the Internet (10.5%) along with other sources (12.3%)

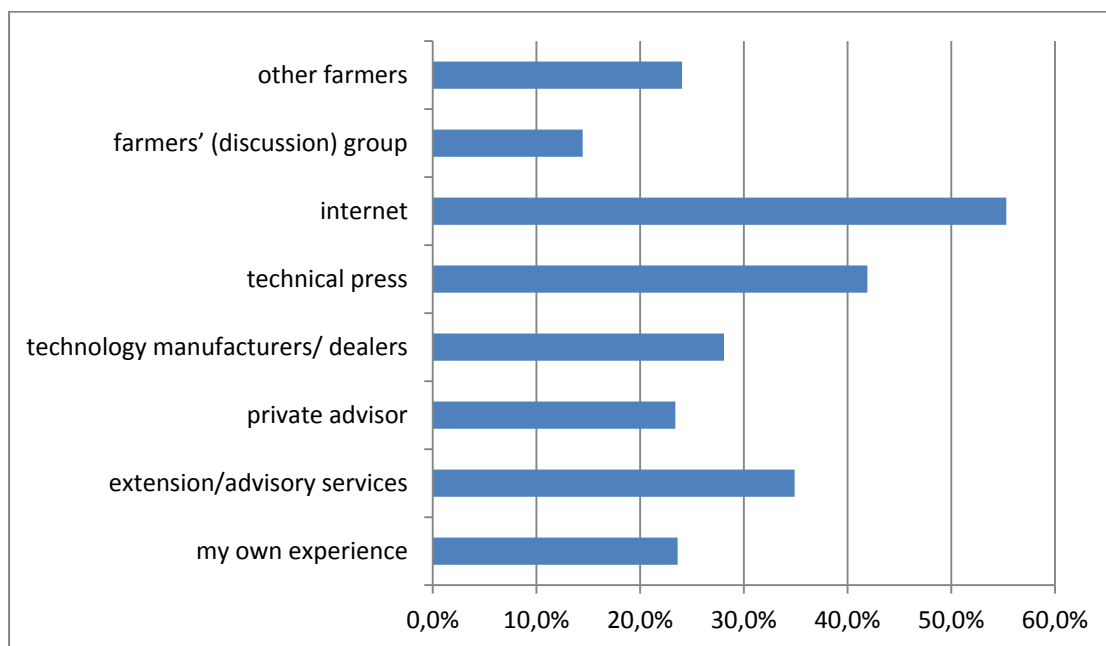


Figure 14: Three most important sources of information on RES

When the three most important sources of information are taken together the Internet (55.3%) and technical press (41.9%) predominate followed by national or regional agricultural (public, cooperative) extension/advisory services (34.9%). Additionally, technology manufacturers and dealers (28.1%), other farmers (24%), farmers' own experience (23.6%), private advisors (23.4%) are also playing a role in raising farmers' awareness on RES.

2.3 Adopters of RES

Out of the 438 interviewees (93.2% of the sample) who were aware of RES, 199 (45.4%) claimed that they use RES on their farms.

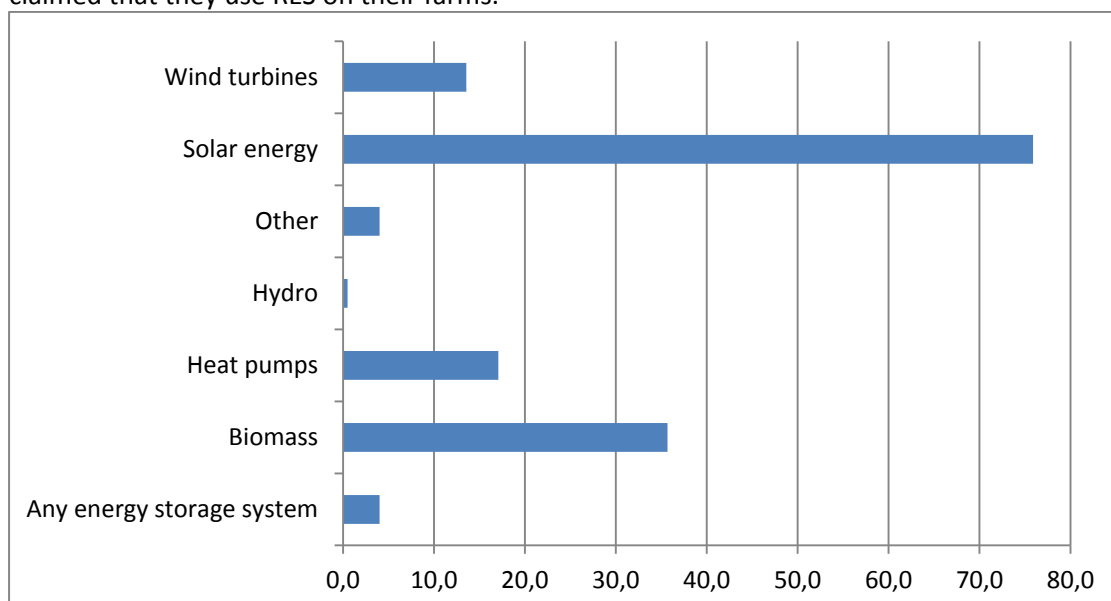


Figure 15: Three most used RES (on-farm)

As shown in Figure 15, solar energy is by far the most used RES on the farms (75.9% of RES adopters/users), followed by biomass/biofuels/biogas (35.7%), heat pumps (17.1%) and wind turbines (13.6%).

The majority of RES adopters (64.5%) said they had seen (demonstration/other farmer) or tested the technology before getting/purchasing it. However, the majority of Italian (58.6%) and Irish farmers (55.6%) had not.

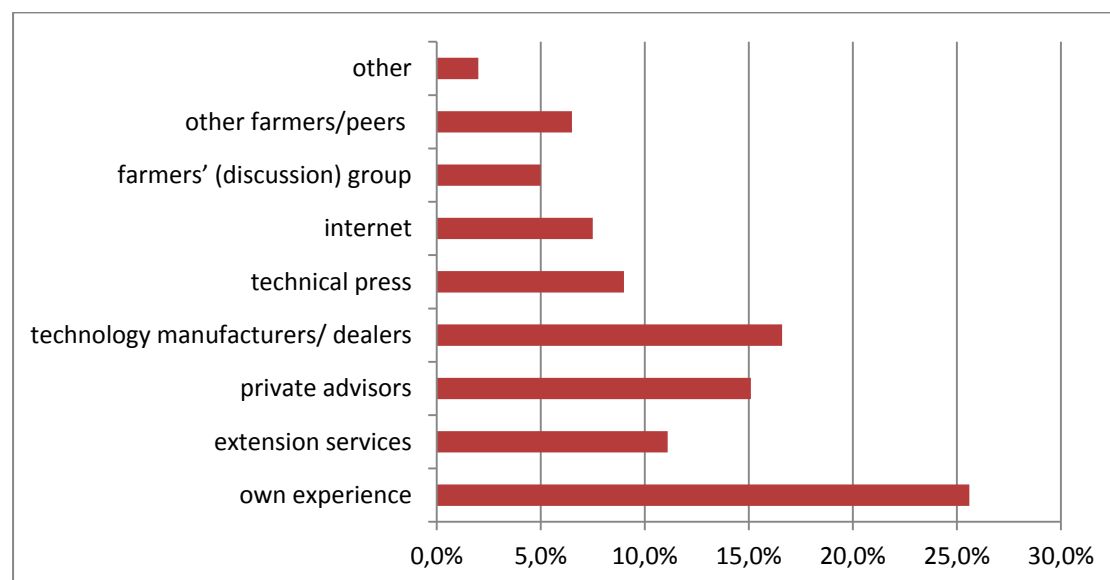


Figure 16: Most important source of information/support for RES assessment

The most important farmers' source of information/support on the *assessment* of RES is farmers' own experience (25.6%) followed by manufacturers/dealers (16.6%), private advisors (15.1%) and national or regional agricultural (public, cooperative) extension services (11.1%). All the other sources of information account for less than 10% each.

More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (27.3%), other farmers (22.7%), private advisors (18.2%) and farmers' own experience (13.1%)
- Germany: technical press (23.8%), technology manufacturers/ dealers (19%) and farmers' own experience (14.3%)
- Greece: private advisors (30.4%), manufacturers/ dealers (26.1%), other farmers (13%)
- Italy: own experience (26.7%), private advisors (20%), national or regional agricultural (public, cooperative) extension/advisory services (16.7%), farmers discussion groups (10%) and
- Ireland: private advisors (22.2%), the Internet (16.7%), technical press (11.1%) and farmers discussion groups (11.1%) and own experience (16.7%)
- The Netherlands: own experience (72.4%), manufacturers/ dealers (13.8%), private advisors (6.9%)
- Poland: the Internet (31.3%), own experience (18.8%), manufacturers/ dealers (12.5%) and national or regional agricultural (public, cooperative) extension/advisory services (12.5%)
- Spain: technology manufacturers/ dealers (36.8%), own experience (15.8%), private advisors (10.5%) and national or regional agricultural (public, cooperative) extension/advisory services (10.5%).

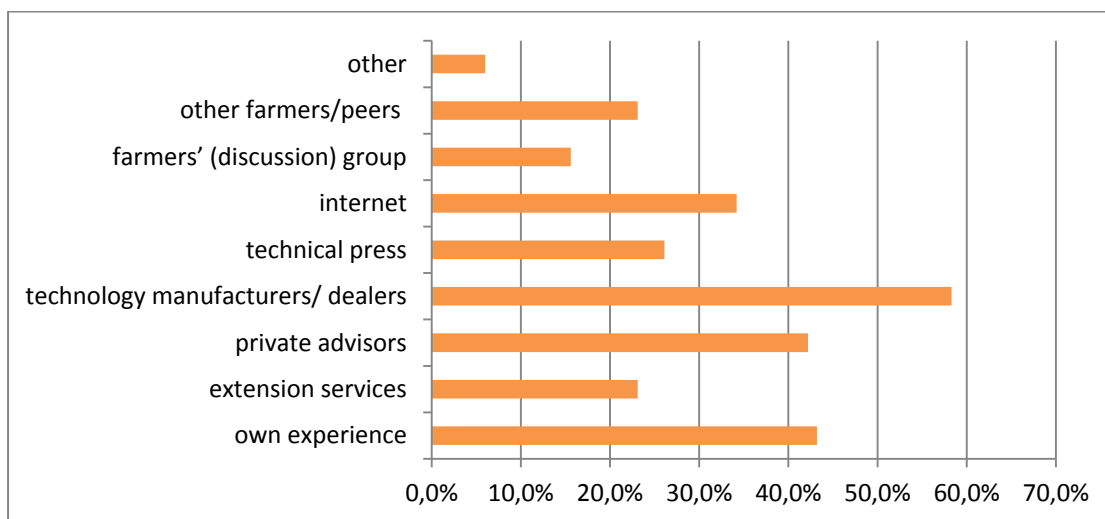


Figure 17: Three most important sources of information/support for RES assessment

Farmers said that the three most important sources of information/ support on the assessment of RES were manufacturers/ local dealers (58.3%) along with their own experience (43.2%) and private advisors (42.2%). The Internet (34.2%), technical press (26.1%) and national or regional agricultural (public, cooperative) extension services (23.1%) along with other farmers/peers (23.1%) and farmers groups (15.6%) also assist farmers to assess RES.

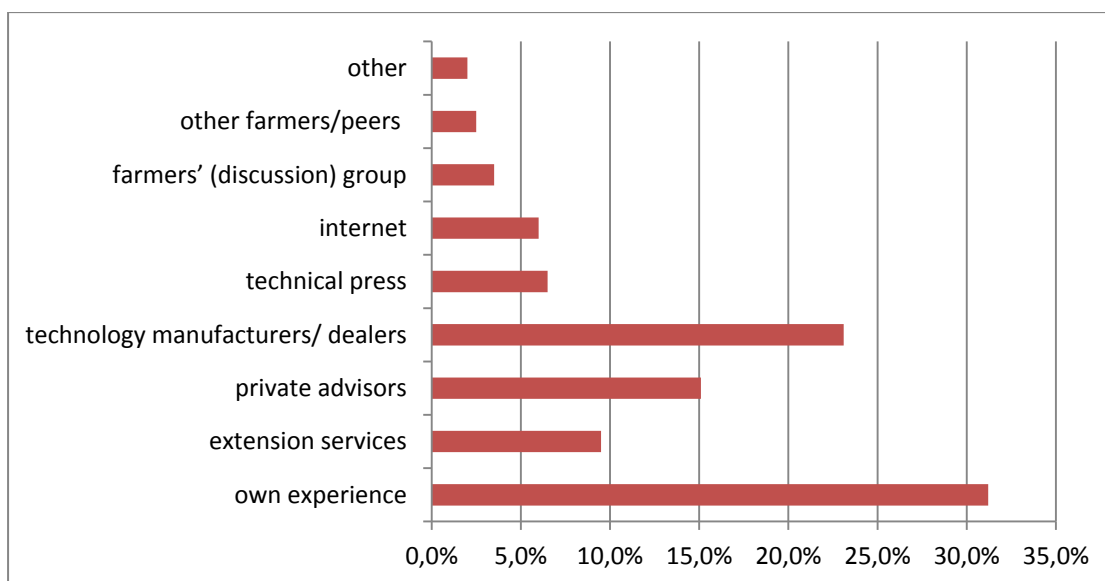


Figure 18: Most important source of information/support for RES establishment and use

The most important farmers' source of information/ support on the *establishment and use* of RES is farmers' own experience (31.2%) followed by manufacturers/dealers (23.1%) and private advisors (15.1%). All other sources of information account for less than 10% each. More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (36.4%), private advisors (22.7%) and farmers' own experience (13.6%), technology manufacturers/ dealers (13.6%)

- Germany: private advisors (28.6%), technical press (23.8%) and technology manufacturers/ dealers (16.7%)
- Greece: manufacturers/ dealers (73.9%) and own experience (17.4%)
- Italy: own experience (40%), manufacturers/ dealers (20%), national or regional agricultural (public, cooperative) extension/advisory services (16.7%) and farmers discussion groups (13.3%)
- Ireland: farmers' own experience (27.8%), private advisors (22.2%), the Internet (16.7%), national or regional agricultural (public, cooperative) extension/advisory services (11.1%),
- The Netherlands: own experience (86.2%), technology manufacturers/ dealers (6.9%) and private advisors (6.9%)
- Poland: the Internet (37.5%), technology manufacturers/ dealers (18.8%) and farmers' own experience (18.8%)
- Spain: technology manufacturers/ dealers (31.6%), farmers' own experience (26.3%), Internet (10.5%) and private advisors (10.5%)

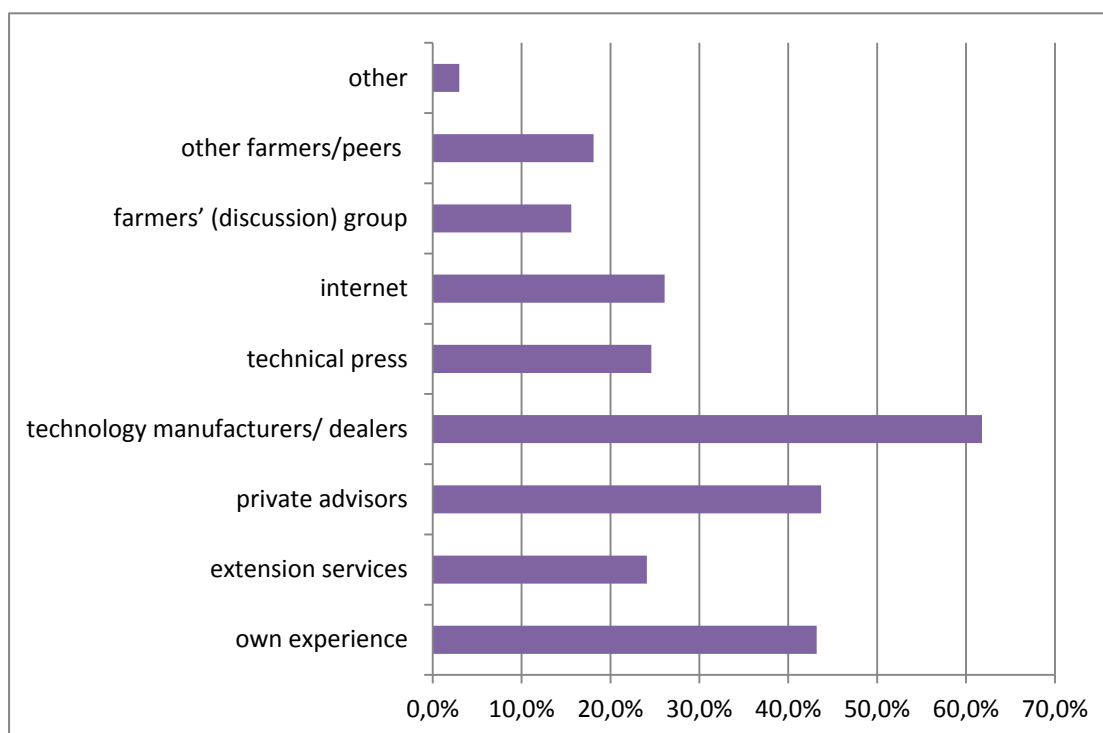


Figure 19: Three most important sources of information/support for RES establishment and use

Farmers said that the three most important sources of information/ support on the assessment of RES were manufacturers/ local dealers (61.8%) along with private advisors (43.7%) and their own experience (43.2%). The Internet (26.1%), technical press (24.6%) and national or regional agricultural (public, cooperative) extension services (24.1%) along with other farmers/peers (18.1%) and farmers groups (15.6%) also assist farmers to establish and use RES on their farm.

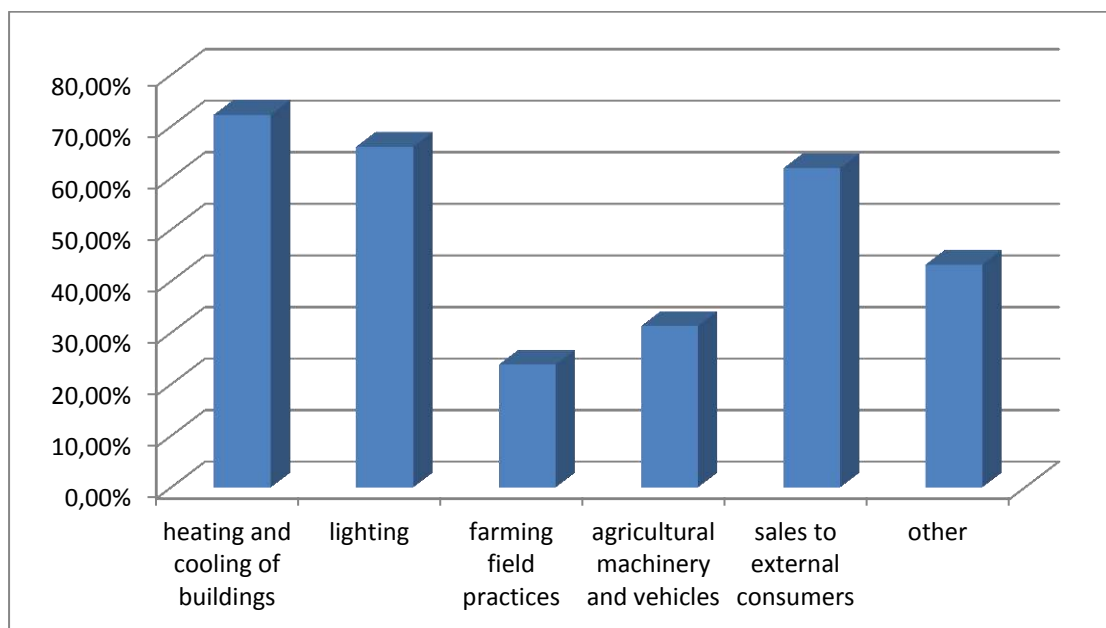


Figure 20: Uses of energy produced with RES

The most common use of the energy produced with RES concerns the heating and cooling of buildings (72.3%) and lighting (66.1%). Nevertheless, many farmers sell energy to external consumers (61.9%) while the use of energy for farm machinery and vehicles and farming practices are quite lower (31.3% and 23.8% respectively).

Farmers' opinions as to whether the introduction of RES changed their way of farming are bisected: 49.7% claim that they have with 48.2% not (2% did not respond).

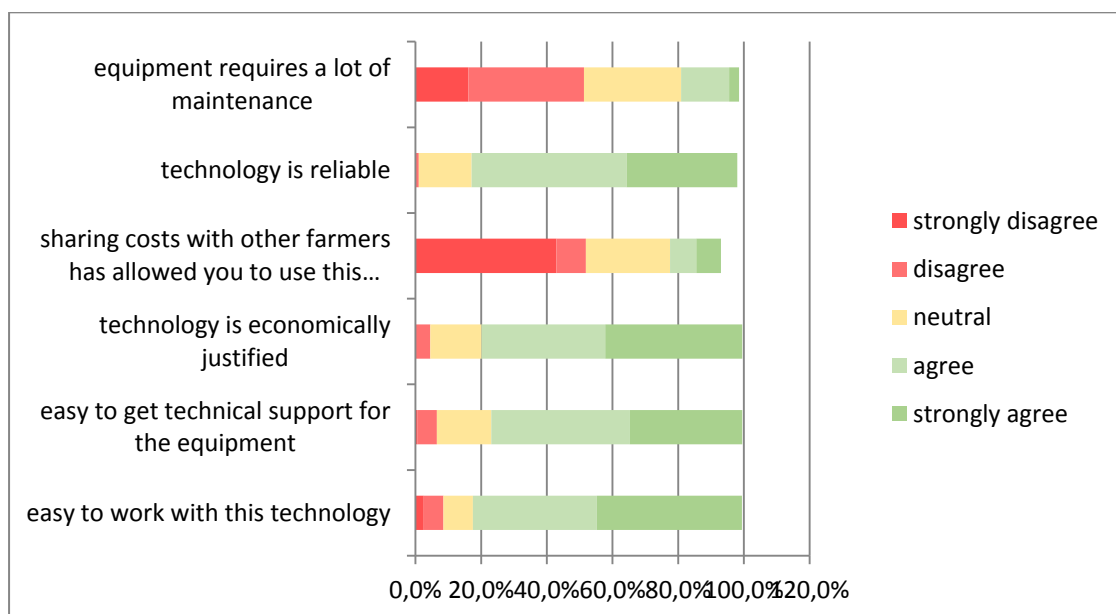


Figure 21: Adopter's opinions on the RES they have/use

In general, adopters state that RES are easy to work with (81.9%), reliable (80.9%) and economically justified (79.4%); additionally, it is easy to get technical support for their equipment (76.4%) which, in parallel, do not require a lot of maintenance (51.3%). Finally, farmers rather disagree with the statement that "sharing costs with other farmers has allowed you to use RES" (51.9%).

Farmers from Italy, Spain and Greece seem to have more negative opinions with regard to (most of) the abovementioned items as compared to farmers from other countries; nevertheless, the long-term reliability of RES is quite strongly disputed also by Polish, Irish and German farmers.

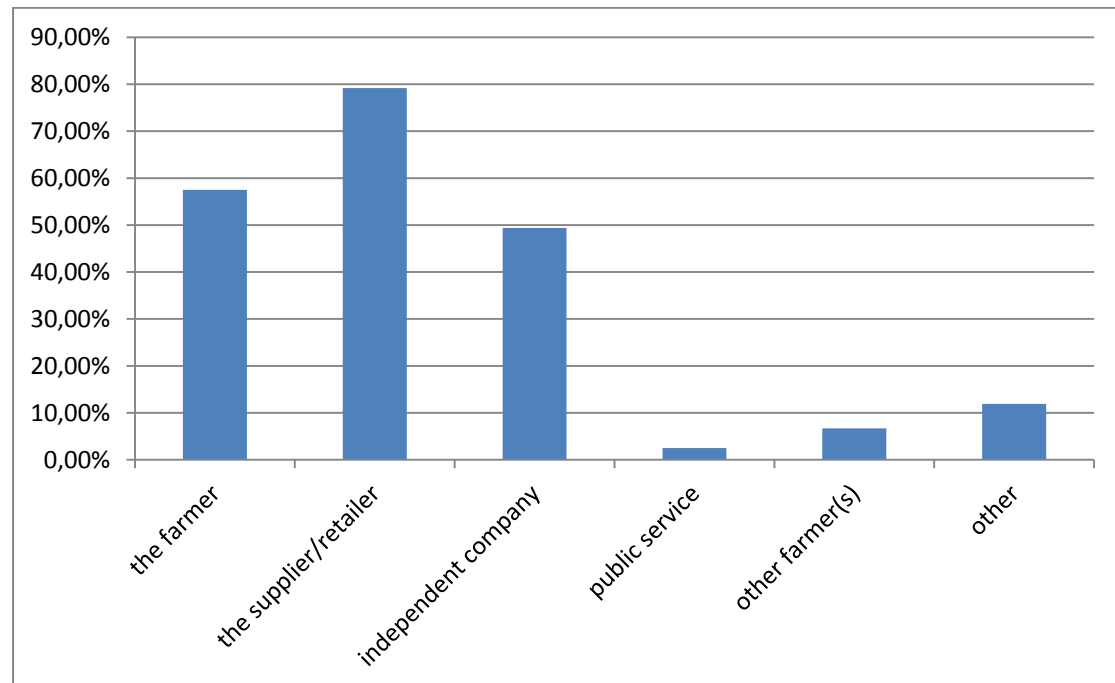


Figure 22: Equipment maintenance and repairs

For RES maintenance and repairs (when necessary), farmers mainly rely on the manufacturer (and/or technology retailers) (79.2%) followed by their own experience (57.5%) and independent service providers (49.4%).

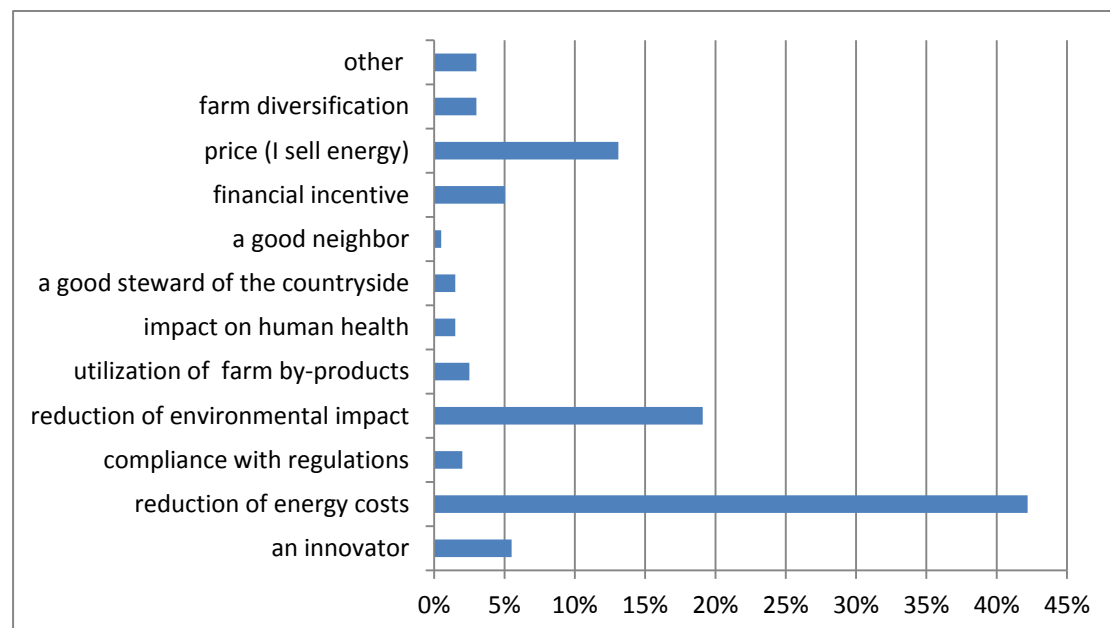


Figure 23: Main motivation for the adoption of RES

Economic reasons were referred to as the main motivation of RES adopters (reduction of energy costs: 42.2% and price of energy sold to others/ outside the farm: 13.1%, i.e. overall 55.3%). The reduction of environmental impact has been declared as a primary motivation by 19.1% of RES adopters.

In all countries, more than one third of the farmers are primarily motivated by their effort to reduce energy costs; this predominates especially in Poland (87.5%) followed by The Netherlands (44.8%), Ireland (44.4%) and Italy (43.3%). Environmental concerns are strong in Spain (47.4%) followed by Ireland (33.3%) and Italy (26.7%). The innovative profile of the farmer is somewhat important in The Netherlands (17.2%) and Ireland (11.1%) while compliance with Regulations concerns some among the Danish farmers (9.1%).

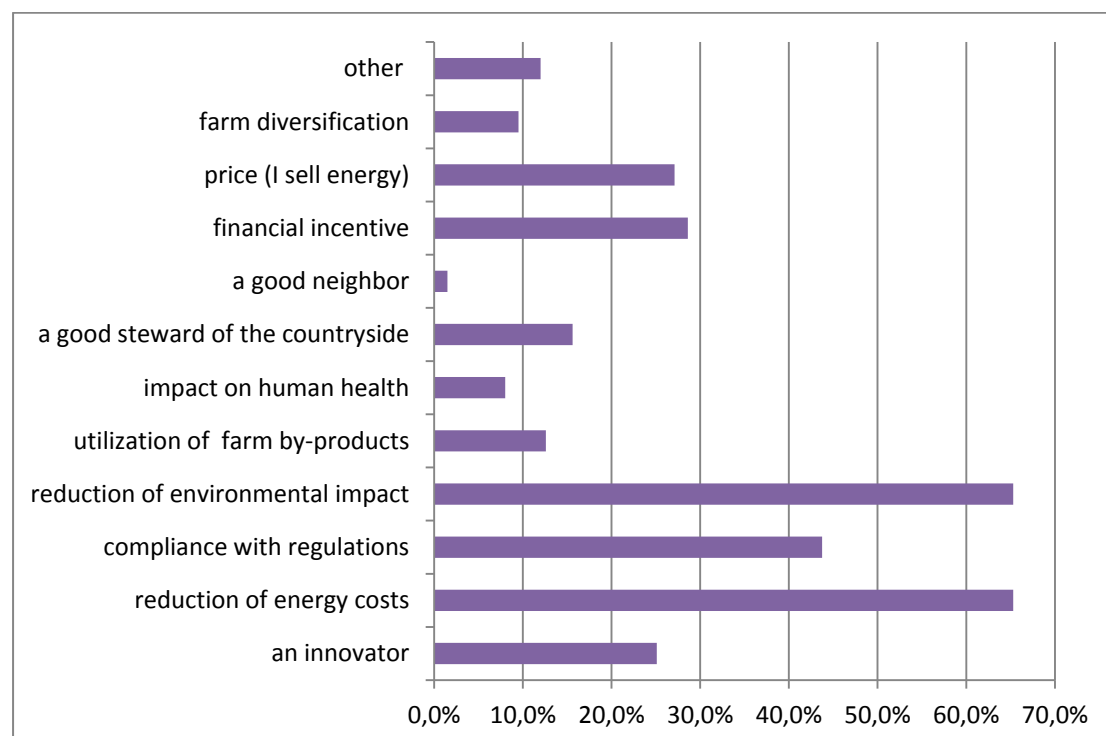


Figure 24: Farmers' three main motivations for the adoption of RES

With regard to the three most important farmers' motivations concerning the adoption of RES on their farm⁴, interviewees seem to prioritize again economic incentives, i.e. reduction of energy costs (63.5%), financial incentives in the form of subsidy and/or tax exemption (28.6%) and price of energy sold outside the farm (27.1%). Nevertheless, other motivations such as the reduction of environmental impact (63.5%), compliance with Regulations (43.8%) and self-esteem – in terms of being an innovator (25.1%) are also quite important. Finally, more than two out of three adopters (68.2%) said that a specific subsidy (i.e. a subsidy other than the direct farm payment) gave them the opportunity to invest in RES on their farms. This is especially so for German (85.7%), Dutch (79.3%) and Greek (78.3%) and Italian farmers (70%). On the contrary only 37.5% of the Polish adopters said they benefitted by a special subsidy for RES.

⁴ Farmers could state up to three motivations.

2.4 Non-adopters of RES

The non-adopters of RES are 239 interviewees accounting for 54.6% of those aware about RES⁵.

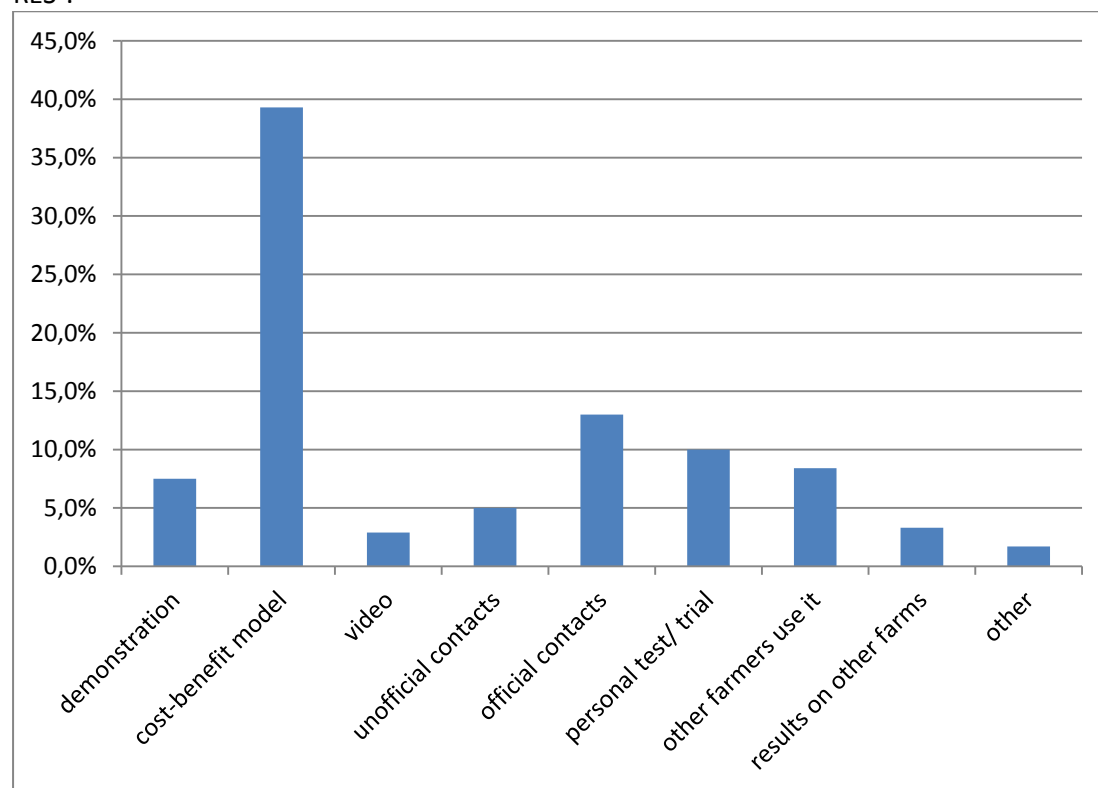


Figure 25: Information source farmers trust the most before deciding to establish (buy/use) such a technology - RES

These farmers declared that the most important source of information they would trust before deciding to adopt/ use RES technology are a cost-benefit model tailored to their farm (39.3%), official contacts (with an advisor, official or someone paid for their service) (13%) and personal trial (10%).

More specifically, demonstrations seem to be quite important for the Danish (25%), the Polish (15.6%) and the German farmers (11.8%). Cost-benefit models (tailor-made to the farm's specificities) are important for more than 10% in all countries; this is especially true (i.e. more than 50%) in Italy (87.5%), The Netherlands (75%) and Poland (55.6%). In Germany 23.5% of the farmers appreciate unofficial contacts with neighbors, peers, etc. while almost half of the Greeks (48.7%) as well as a number of Germans (12.5%) prefer official contacts with advisors/consultants, etc. Personal tests/ trials are preferred by more than one third of the Irish farmers (39.1%) along with quite a few (i.e. between 10% and 20%) of the Spanish, Danish and German farmers. Finally, more than one in five Danish farmers (21.9%) are keen in seeing other farmers using candidate technologies; this is true for quite some (between 10% and 12%) among the German and Greek farmers as well.

⁵ As aforementioned 32 farmers (6.8% of the total sample had not heard about RES).

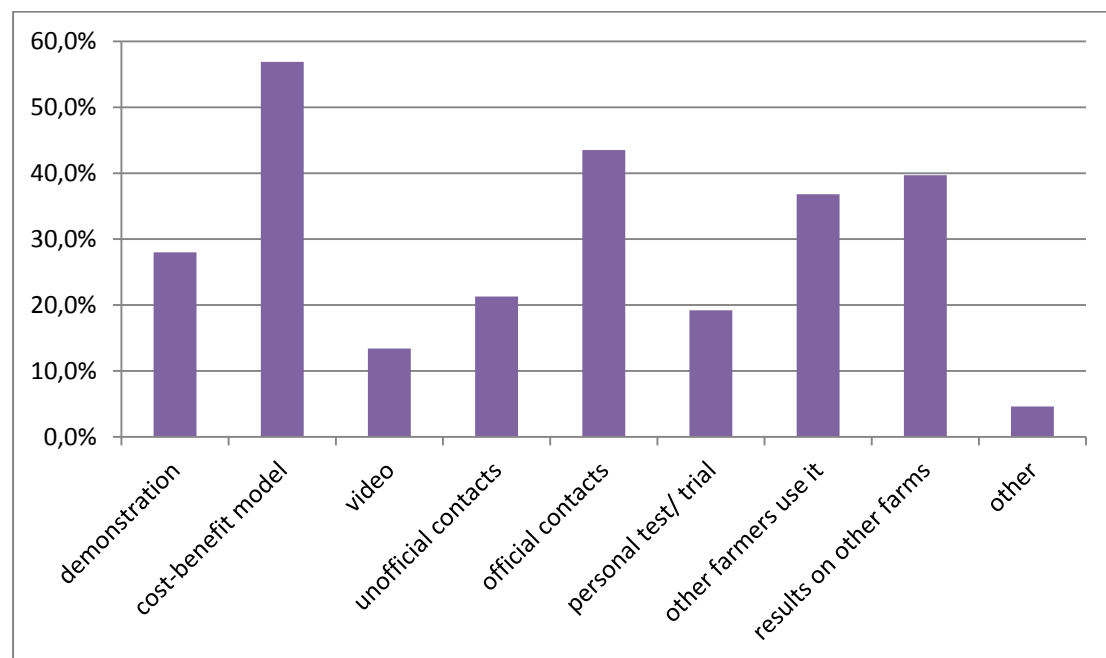


Figure 26: Three information sources farmers trust the most before deciding to establish (buy/use) such a technology - RES

When it comes to three most important sources of information, they would trust, before deciding to use RES on their farm, a cost-benefit model tailored to their farms still leads (56.9%), followed by official contacts (43.5%). Good practices on other farms and of other farmers using RES (39.7% and 36.8% respectively) as well as demonstrations (28%) are also considered very important.

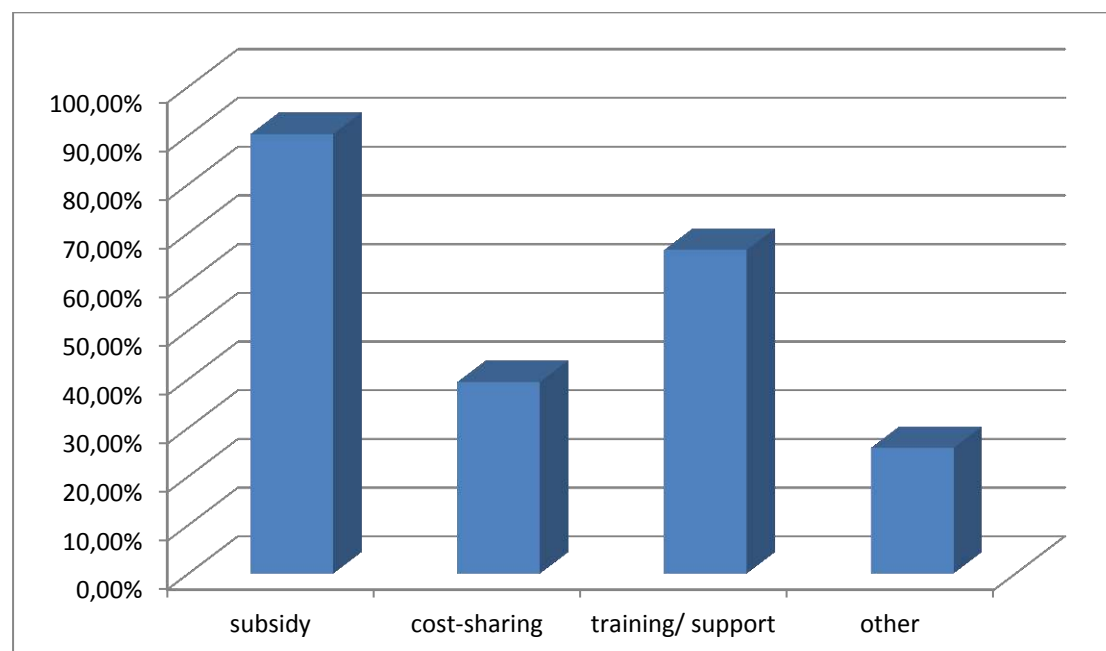


Figure 27: Incentives for adopting RES

Non-adopters claimed that they would use RES if they would get a subsidy (90.3%) as well as relevant training (66.5%) and to a much lesser degree if they could share initial (purchase) costs (39.4%).

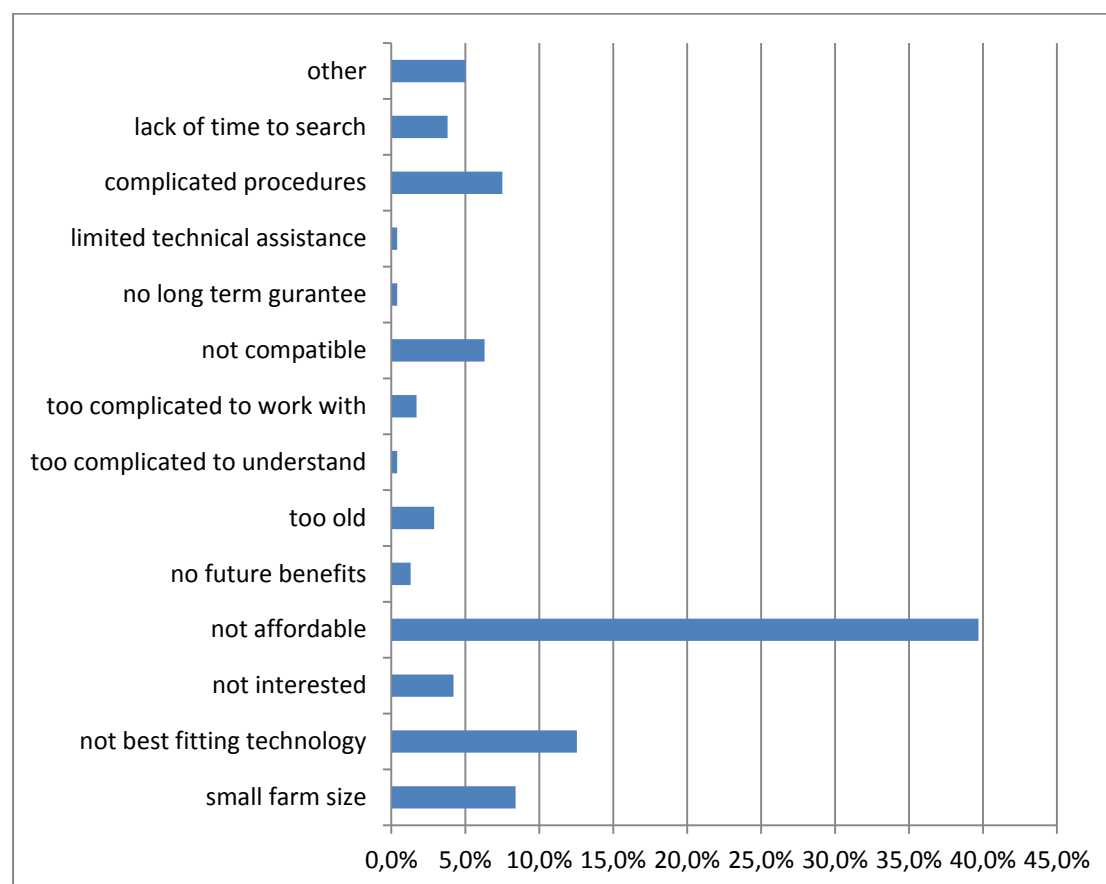


Figure 28: Most important reason for non-adopting RES

According to non-adopters, the main reason for not having/ using RES on their farms mainly owes to their claim that they cannot afford it (39.7%), followed by their consideration that the best fitting technology (tailored to their situation/ production system) is not available yet or that the available technology is not compatible with existing technology/ machinery/ equipment in their farm (12.6% and 6.3% respectively).

Small farm size was mainly referred to by Italian and Dutch farmers (25% and 12.5%, respectively). The lack of availability of the best fitting to the farm technology was mainly mentioned by the Irish (34.8%), Danish (25%), German (23.5%), Italian (15.6%) and Spanish (12.9%) farmers. Affordability was mentioned by relatively high percentages of farmers in all countries ranging from around 22% (Italians and Irish farmers) to over 40% (German and Dutch farmers) up to 62.2% for Polish farmers. Non-compatibility with existing technology/ machinery/ equipment in their farm was put forward as the main reason for non-adoption of RES by Irish (21.7%) and Danish farmers (14.3%) while difficult procedures (i.e. slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.) were claimed by Italian (15.6%), Greek (15.4%) and Spanish farmers (11.1%). Finally one in ten Germans said s/he lacked time to search, consider, apply for, and implement such technology/ practice while one in ten Greeks said that s/he is not interested in RES.

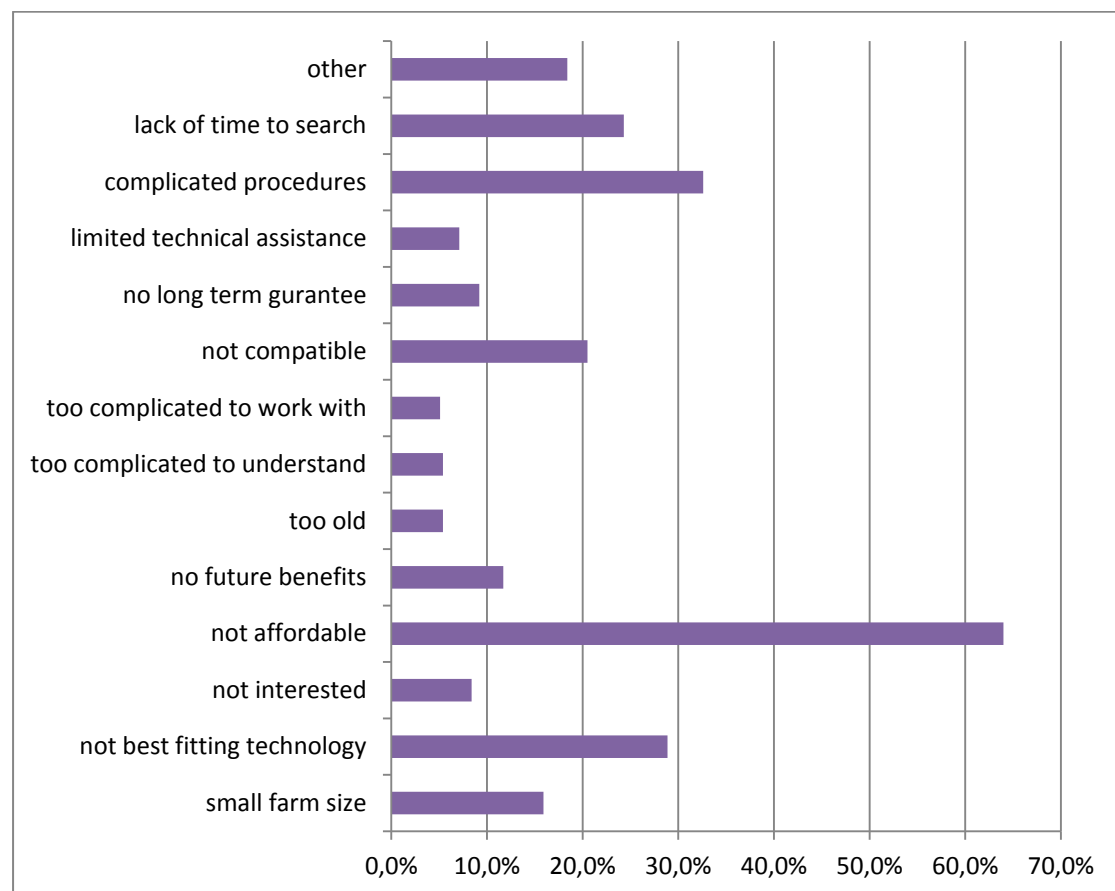


Figure 29: Reasons for non-adopting RES

When three reasons stated by each farmer for non-adoption are combined⁶, the issue of affordability again prevails (64%) followed by the lack of appropriate technology, i.e. the best fitting technology (tailored to their situation/ production system) is not available yet or the available technology is not compatible with existing technology/ machinery/ equipment in their farm (28.9% and 20.5% respectively). Other important factors are complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.) for establishing/ using RES (32.6%) as well as the lack of time on the part of the farmers to search, consider, apply for, and implement such technology/ practice (24.3%); small farm size is mentioned by 15.9% of non-adopters.

Among the 149 non-adopters who have seen other farmers using RES, 89% have seen solar systems and 33.5% biomass/biofuel/biogas; 13.14% have seen wind turbines and 12.72% heat pumps. Out of those 79.9% claimed that such an experience raised their interest in such a technology.

⁶ Farmers could state up to 3 reasons.

2.5 Energy saving technologies and practices

Interviewees were further asked if they are aware of a range of indicative energy-saving technologies and practices. In this respect, farmers were asked about such technologies and practices according to their production system as follows:

Open-field farms: efficient vehicles (biofuels or electricity fuelled, maintenance e.g. tyre pressure, logistics/planning); efficient tools (pumps or drip systems for irrigation, conveyors, refrigerators, mills/grinders, dryers); precision agriculture (seed/fertilizer/pesticide/lime/manure/water reduction); conservation agriculture (crop rotation, intercropping, soil coverage, no/minimum tillage); other

Greenhouses: Efficient buildings (windows, building management system, lighting); efficient vehicles (op. cit.); efficient tools (pumps or drip systems for irrigation, conveyors, refrigerators); precision indoor agriculture (seed/fertilizer/pesticide/lime/manure/water reduction); other

Livestock facilities: efficient buildings (op. cit.); efficient vehicles (op. cit.); efficient tools (milking machines, feeding equipment, conveyors, refrigerators, mills/grinders, dryers); precision livestock (feed/medicine/manure reduction, animal healthcare); other.

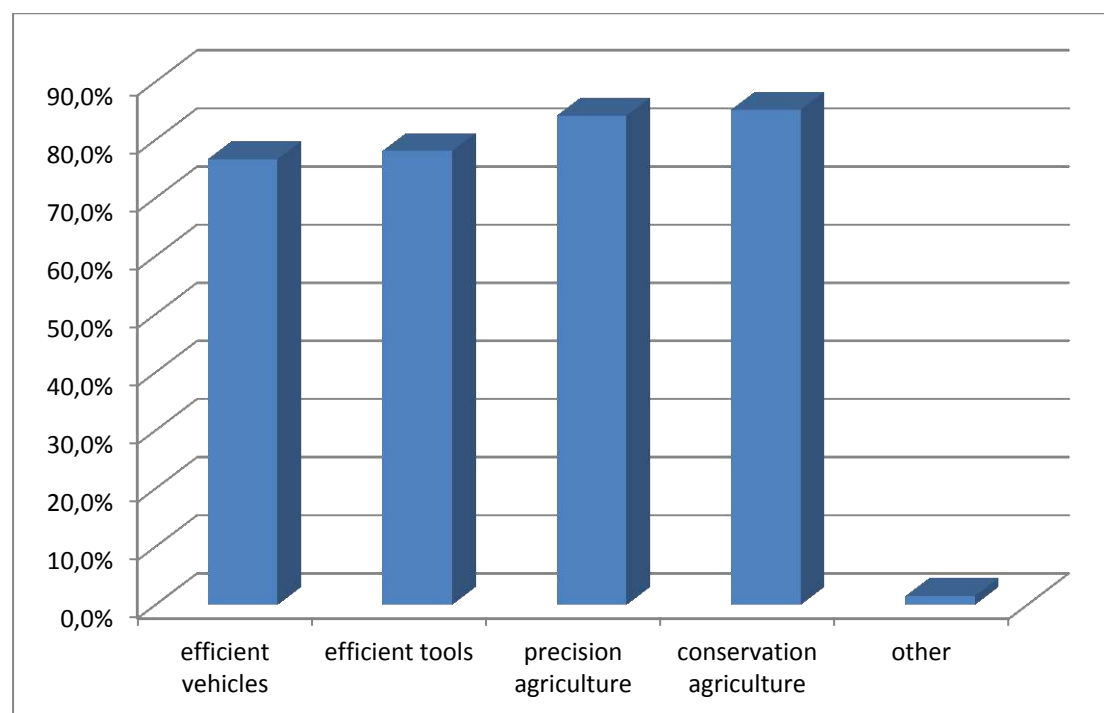


Figure 30: Energy-saving technologies/ practices awareness (open-field farms)

With regard to open-field farms⁷, farmers claimed that they are well aware about conservation and precision agriculture (85.2% and 84.2%, respectively) as well as about energy efficient tools and vehicle (78.1% and 76.7%, respectively).

⁷ Arable (i.e. cereals, open field vegetables, root crops, etc), permanent (i.e. vineyards, orchards, etc) and other (i.e. permanent grassland, etc.) crop production systems

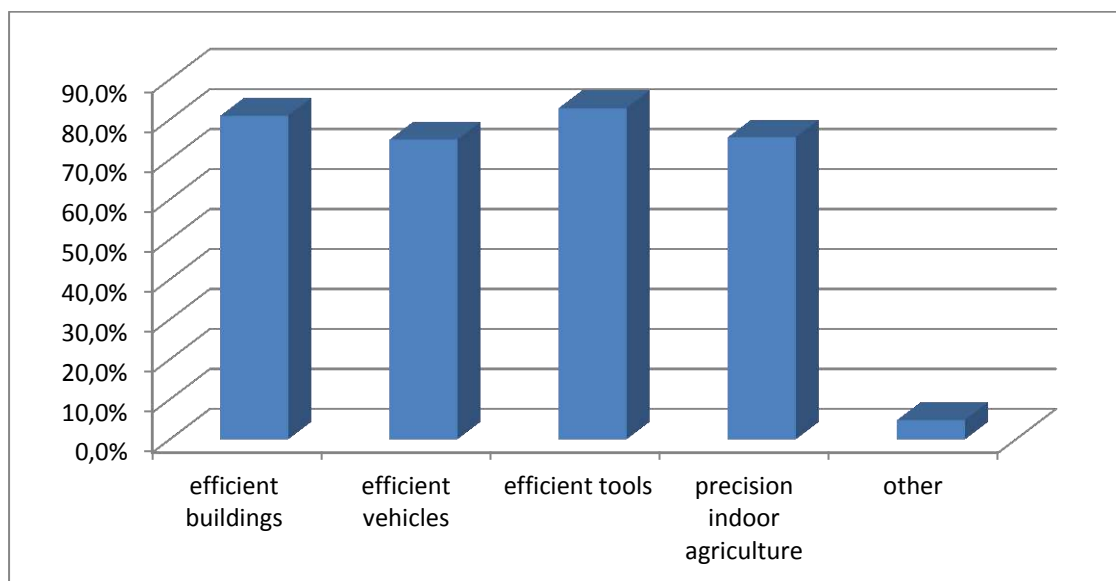


Figure 31: Energy-saving technologies/ practices awareness (greenhouses)

Farmers with greenhouses said they are aware of energy efficient tools and buildings (82.9% and 81%, respectively) as well as of (indoors) precision agriculture (75.6%) and efficient vehicles (75%).

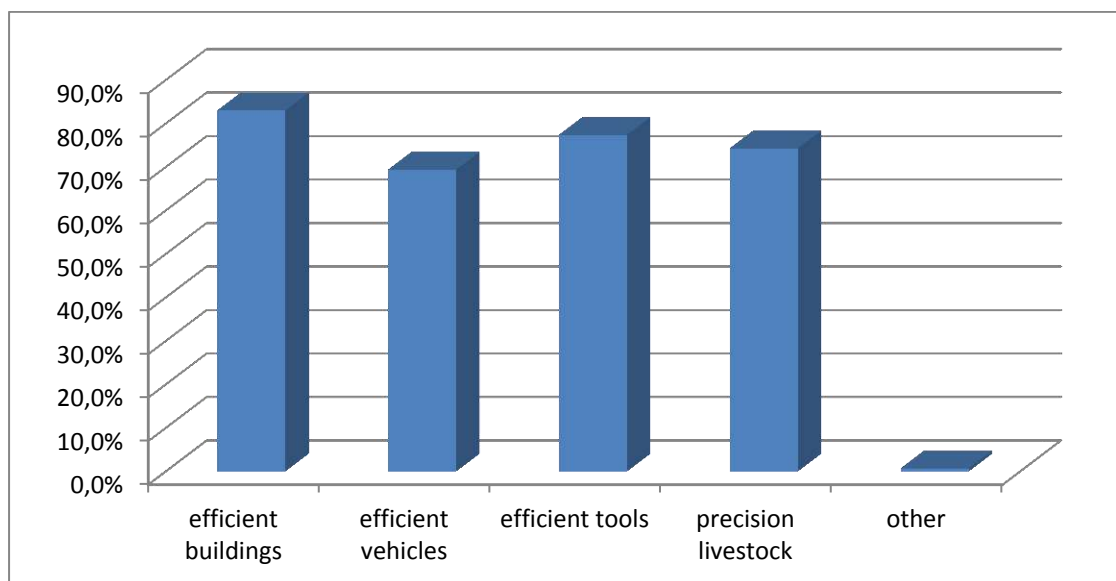


Figure 32: Energy-saving technologies/ practices awareness (livestock)

On their part, livestock farmers asserted that they are aware of efficient buildings (83%) as well as of energy efficient tools (77.4%) and precision livestock (74.3%) and to a lesser degree of efficient vehicles (69.4%).

Overall, 84.3% of the sample farmers have heard about at least one energy-efficient technology and/or practice. Awareness is highest in The Netherlands (98.2%), Italy (96.8%), Greece (95.2%) and Denmark (94.2%).

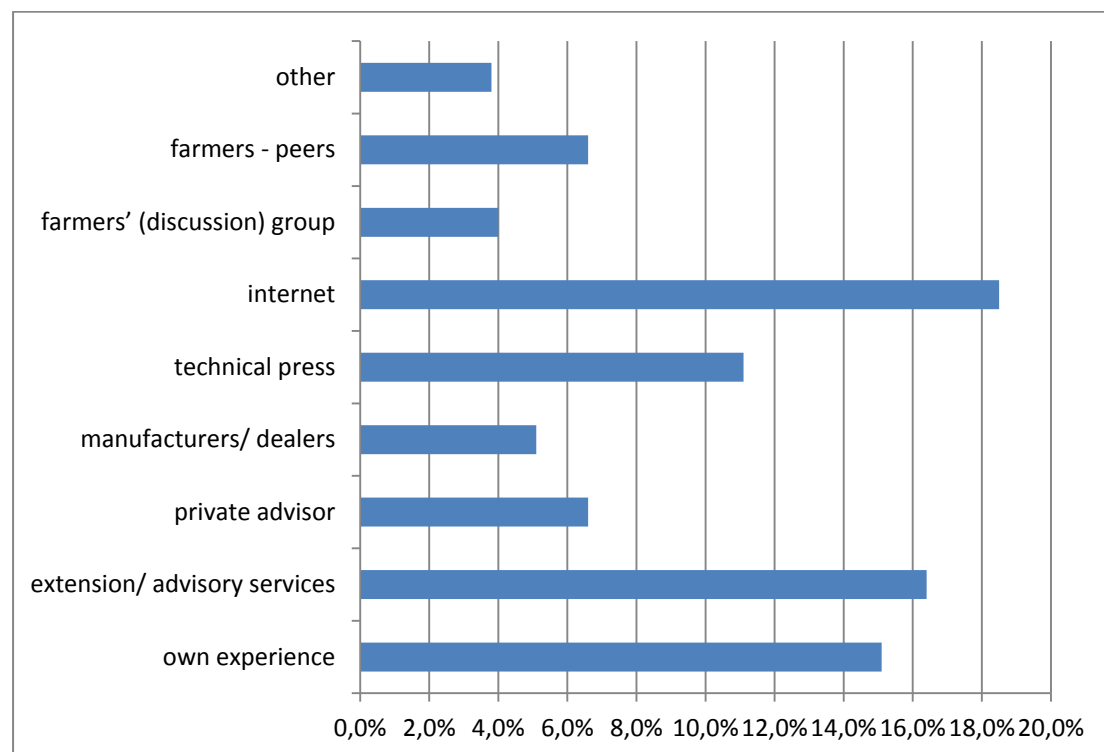


Figure 33: Most important source of information on energy efficient technologies/ practices

As far as farmers' most important *source of knowledge/ awareness* on energy efficient technologies/ practices is concerned, farmers said that they rely on the Internet (18.5%), national or regional agricultural (public, cooperative) extension/advisory services (16.4%), their own experience (15.1%) and the technical press (11.1%) and. More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (26.9%), technical press (15.4%), the Internet (13.5%) other farmers (13.5%)
- Germany: own experience (30.5%) and the Internet (22%)
- Greece: the Internet (39.7%), private advisors (12.9%) and other farmers (11.3%), technology manufacturers/ dealers (11.3%)
- Italy: national or regional agricultural (public, cooperative) extension/advisory services (41.9%), own experience (19.4%), farmers discussion groups (12.9%) and private advisors (11.3%)
- Ireland: the Internet (18%)
- The Netherlands: technical press (41.4%) and own experience (19.6%) and private advisors (10.7%)
- Poland: the Internet (28.7%), national or regional agricultural (public, cooperative) extension/advisory services (21.3%) and other sources (11.5%)
- Spain: own experience (28.1%), the Internet (15.8%), other farmers (15.8%), technical press (12.3%), national or regional agricultural (public, cooperative) and extension/advisory services (10.5%) along with other sources (10.5%).

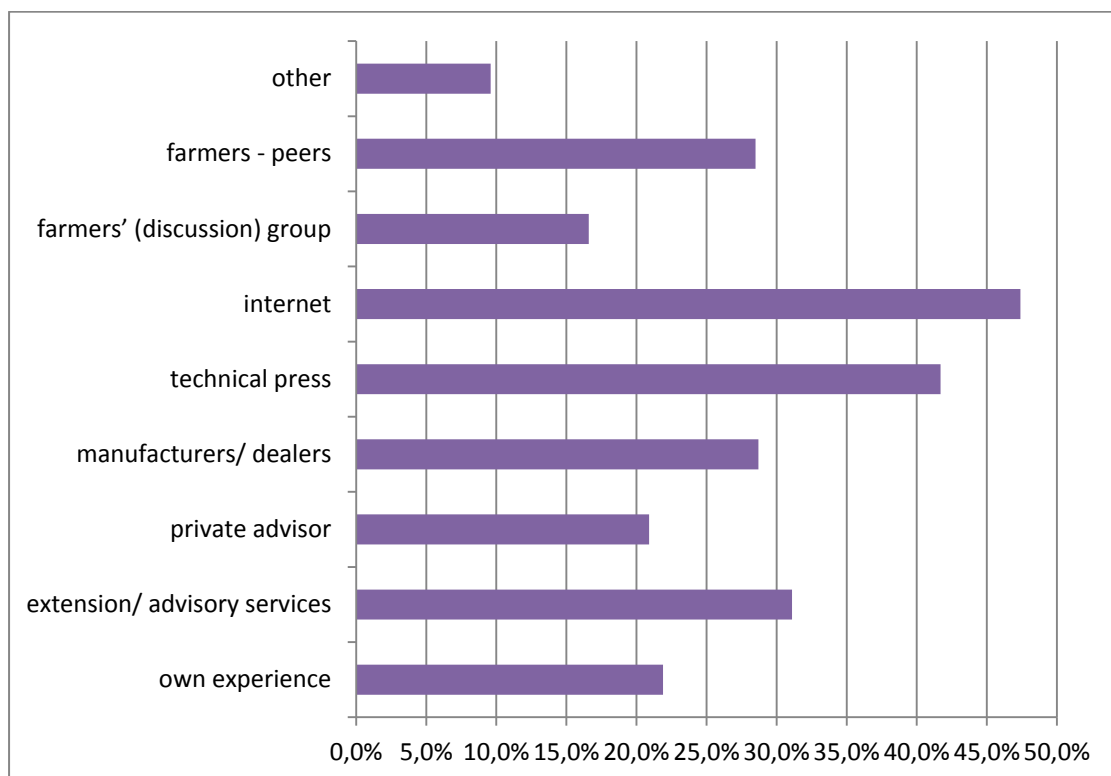


Figure 34: Three most important sources of information on energy efficient technologies/ practices

When the three most important sources of information are analysed together, the Internet (47.4%) and technical press (41.7%) predominate followed by national or regional agricultural (public, cooperative) extension/advisory services (31.1%). Additionally, technology manufacturers and dealers (28.7%), other farmers (28.5%), farmers' own experience (21.9%), private advisors (20.9%) are also playing a role in raising farmers' awareness on energy efficient technologies/ practices.

2.6 Adopters of energy-efficient technologies/ practices

Out of the 396 interviewees (84.3% of the sample) who were aware of energy efficient technologies/ practices, 236 (59.6%) claimed that they use such solutions on their farms.

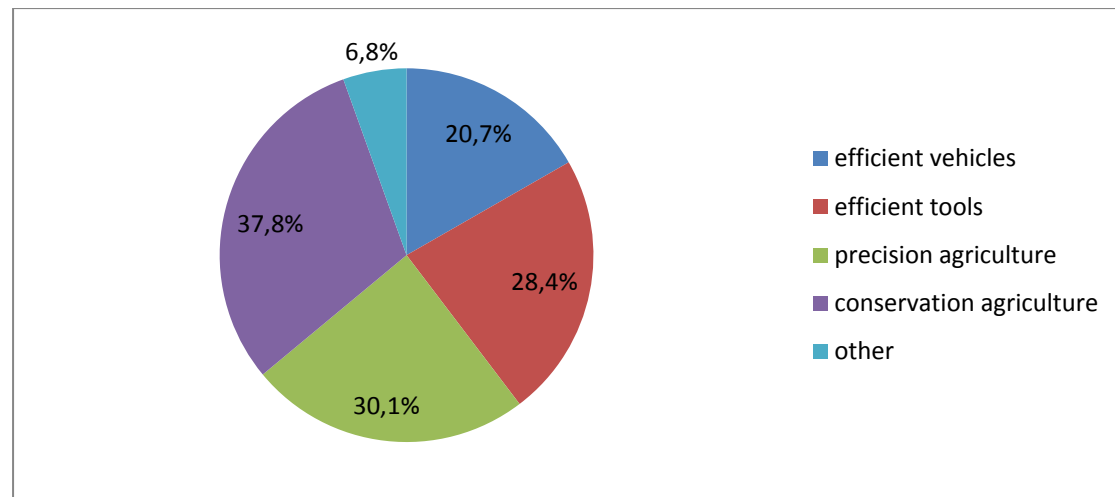


Figure 35: Three most used energy-saving technologies/ practices (open-field farms)

With regard to open-field farms⁸, farmers claimed that they have mostly adopted/ they mostly use conservation and precision agriculture technologies/ practices (37.8% and 30.1% of the energy-efficient technologies/ practices adopters, respectively) followed by energy-efficient tools and vehicles (28.4% and 20.7%, respectively).

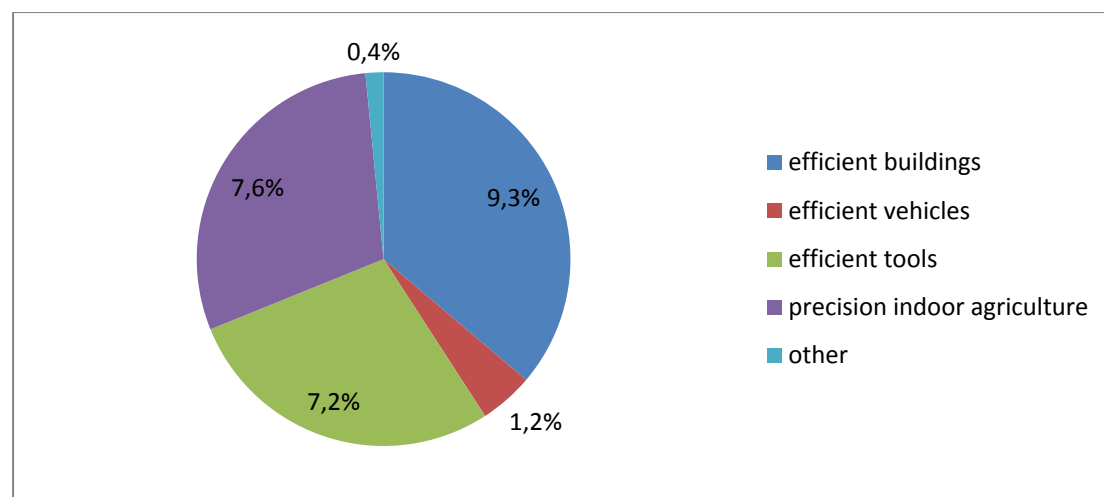


Figure 36: Three most used energy-saving technologies/ practices (greenhouses)

Regarding greenhouses, farmers said that they have mostly adopted/ they mostly use energy-efficient technologies/ practices with regard to efficient buildings (9.3% of the energy-efficient technologies/ practices adopters) followed by precision agriculture (7.6%) and energy-efficient tools (7.2%); efficient vehicles are used to a much lesser extent (1.2%).

⁸ I.e. arable (i.e. cereals, open field vegetables, root crops, etc), permanent (i.e. vineyards, orchards, etc) and other (i.e. permanent grassland, etc.) crop production systems

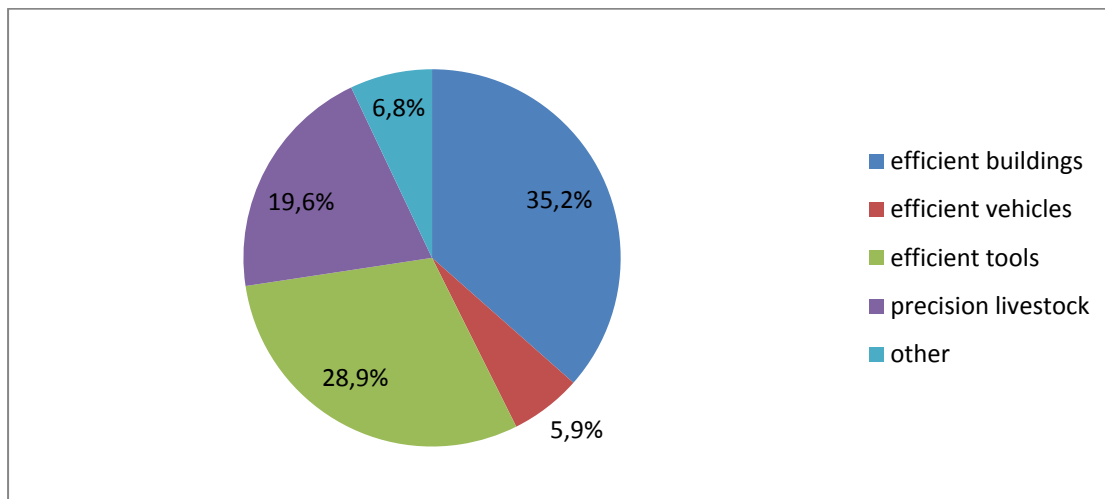


Figure 37: Three most used energy-saving technologies/ practices (livestock)

In livestock farming, farmers asserted that they have mostly adopted/ they mostly use energy-efficient technologies/ practices with regard to efficient buildings (35.2% of the energy-efficient technologies/ practices adopters) followed by efficient tools (28.9%) and precision livestock (19.6%); efficient vehicles are used to a much lesser extent (5.9%). The majority of adopters (58.5%) had seen (demonstration/ other farmer) or tested the energy saving technology or practice before getting/purchasing it.

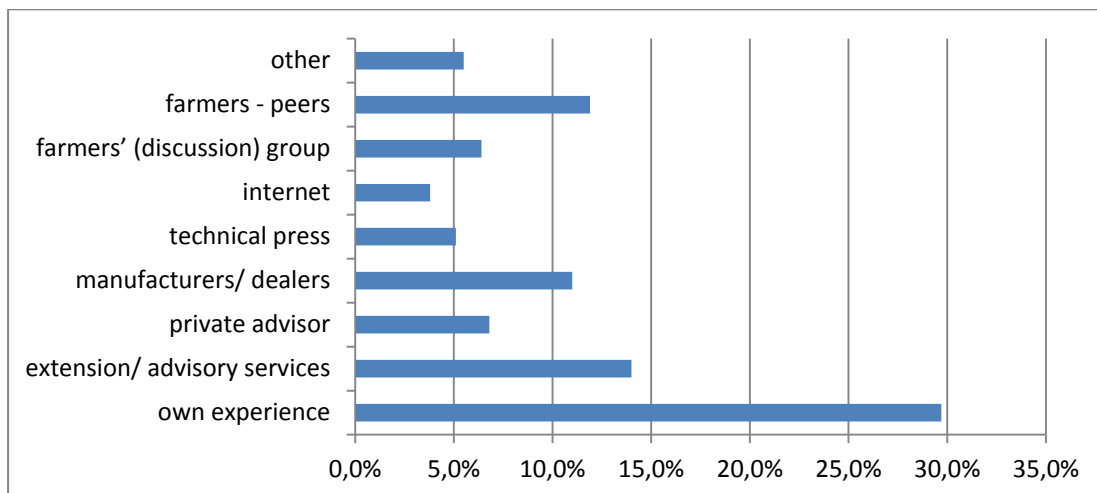


Figure 38: Most important source of information/support for energy efficient technologies/ practices' assessment

The most important farmers' source of information/ support on the assessment of energy efficient/ energy saving technologies/ practices is farmers' own experience (29.7%) followed by national or regional agricultural (public, cooperative) extension services (14%), other farmers/ peers (11.9%) and manufacturers/dealers (11%). All the other sources of information account for less than 10% each.

More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (25.7%), technology manufacturers/ dealers (20%), farmers' discussion groups (17.1%) and other farmers (14.3%)

- Germany: farmers' own experience (35.9%), private advisors (10.3%) and farmers' discussion groups (10.3%) and other farmers (10.3%) along with other sources (10.3%)
- Greece: other farmers (22.2%), technology manufacturers/ dealers (18.5%), the Internet (11.1%) and farmers' own experience (11.1%)
- Italy: national or regional agricultural (public, cooperative) extension/advisory services (34.3%), farmers' own experience (17.1%), private advisors (14.3%) and technology manufacturers/ dealers (14.3%)
- Ireland: farmers' own experience (20%), national or regional agricultural (public, cooperative) extension/advisory services (20%), technology manufacturers/ dealers (10%), technical press (10%) as well as farmers' discussion groups (10%) and other farmers (10%) along with other sources (10%)
- The Netherlands: own experience (76.9%)
- Poland: national or regional agricultural (public, cooperative) extension/advisory services (20%), farmers' own experience (20%), other farmers (20%) and technical press (10%)
- Spain: farmers' own experience (35.5%), technology manufacturers/ dealers (16.1%) along with other sources (12.9%)

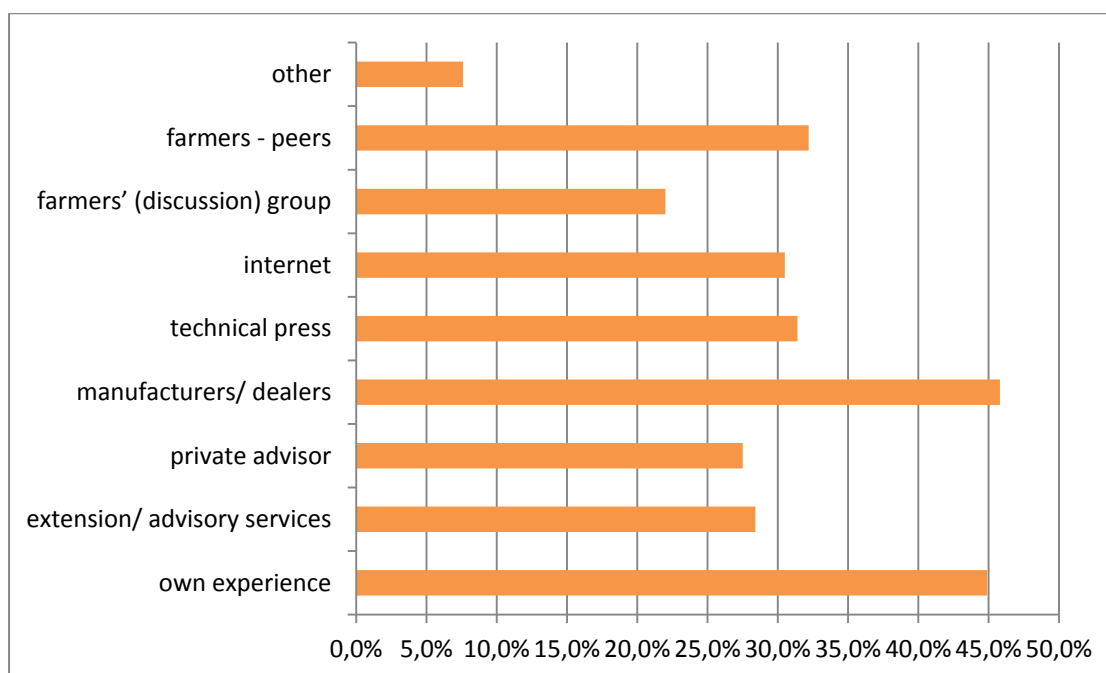


Figure 39: Three most important sources of information/support for energy efficient technologies/ practices' assessment

Farmers said that the three most important sources of information/ support on the assessment of energy efficient technologies/ practices were manufacturers/ local dealers (45.8%) along with their own experience (44.9%). Other farmers/peers (32.2%), technical press (31.4%) and the Internet (30.5%) along with national or regional agricultural (public, cooperative) extension services (28.4%), private advisors (27.5%) and farmers groups (22%) also assist farmers to assess energy saving technologies/ practices before establishing them on their farm.

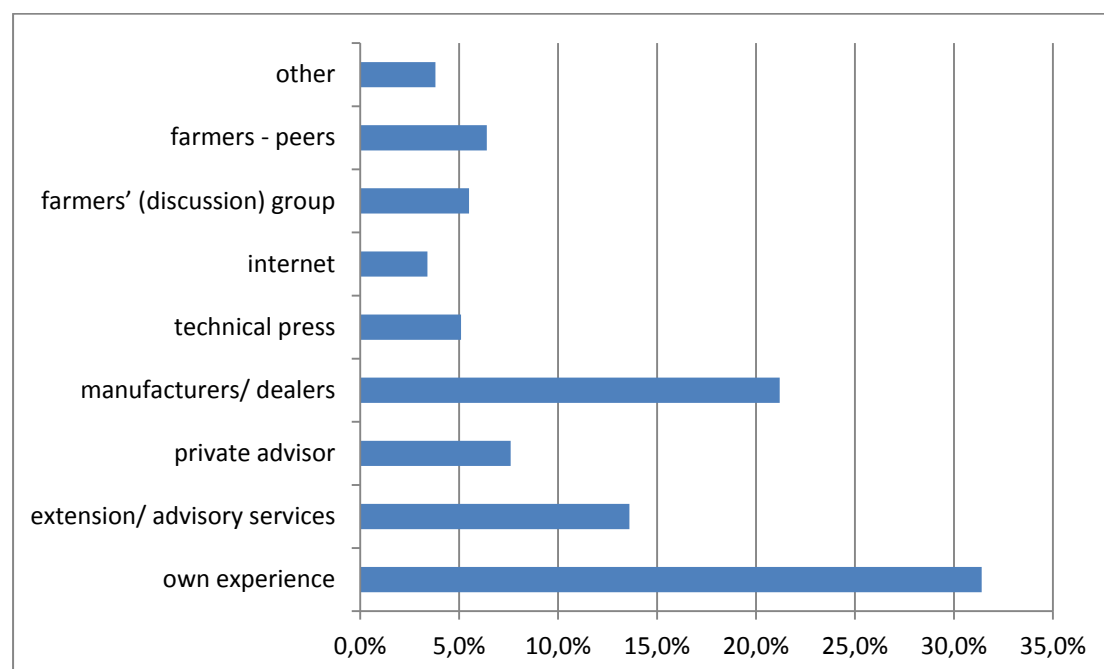


Figure 40: Most important source of information/support for energy efficient technologies/ practices' establishment and use

The most important farmers' source of information/ support on the establishment and use of energy efficient technologies/ practices is farmers' own experience (31.4%) followed by manufacturers/dealers (21.2%) and national or regional agricultural (public, cooperative) extension services (13.6%). All the other sources of information account for less than 10% each.

More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (31.4%), technology manufacturers/ dealers (17.1%), farmers' discussion groups (17.1%) and other farmers (11.4%)
- Germany: farmers' own experience (25.6%), technology manufacturers/ dealers (25.6%) and private advisors (23.1%)
- Greece: technology manufacturers/ dealers (77.7%), and farmers' own experience (11.1%)
- Italy: farmers' own experience (31.4%), national or regional agricultural (public, cooperative) extension/advisory services (22.9%), technology manufacturers/ dealers (14.3%) and farmers' discussion groups (14.3%)
- Ireland: farmers' own experience (30%), national or regional agricultural (public, cooperative) extension/advisory services (30%), technology manufacturers/ dealers (10%), technical press (10%) as well as farmers' discussion groups (10%)
- The Netherlands: own experience (74.4%)
- Poland: national or regional agricultural (public, cooperative) extension/advisory services (15%), farmers' own experience (15%), other farmers (15%), technical press (15%) and the Internet (15%) other sources (15%)
- Spain: farmers' own experience (45.2%), technology manufacturers/ dealers (16.1%) along with other farmers (16.1%) other sources (12.9%)

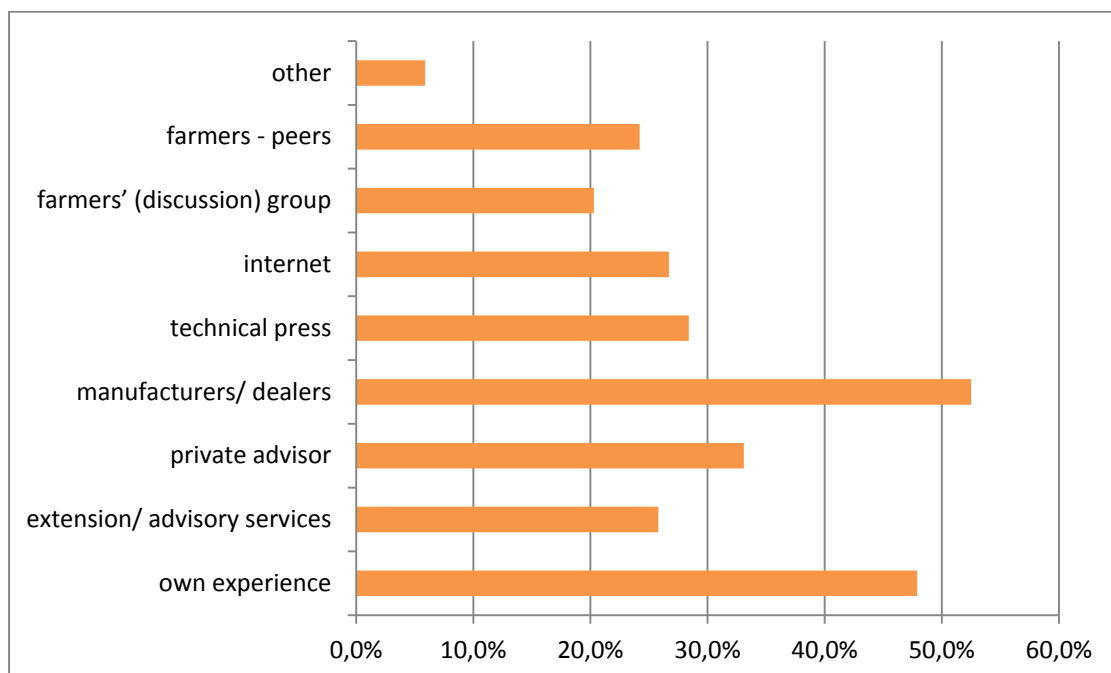


Figure 41: Three most important sources of information/support for energy efficient technologies/ practices' establishment and use

Farmers said that the three most important sources of information/ support on the assessment of energy efficient technologies/ practices were manufacturers/ local dealers (52.5%) along with their own experience (47.9%) and private advisors (33.1%). Technical press (28.4%), the Internet (26.7%), and national or regional agricultural (public, cooperative) extension services (25.8%) along with other farmers/peers (24.2%) and farmers groups (20.3%) also assist farmers to establish and use energy saving technologies/ practices on their farm.

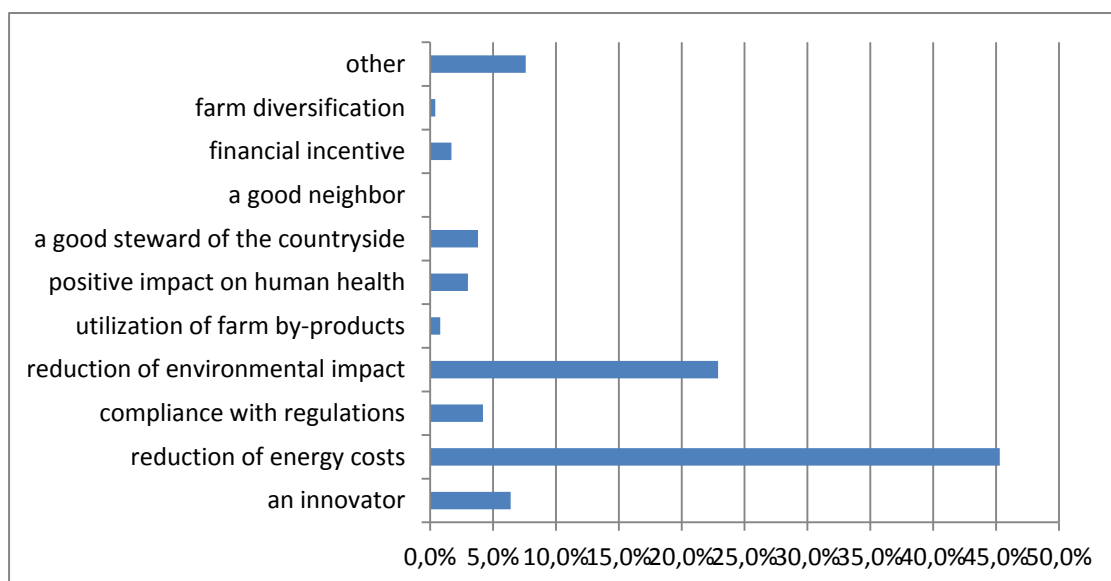


Figure 42: Main motivation for the adoption of energy efficient technologies/ practices

Economic reasons, i.e. the reduction of energy costs, were referred to as the main motivation of energy saving technologies/ practices' adopters (45.3%) with the reduction of environmental impact being also declared as a primary motivation by 22.9% of the adopters. In all countries, more than one third of the farmers (with the exception of Poland and Spain: 25% and 29% respectively) are primarily motivated by their effort to reduce energy costs; this predominates especially in Ireland (69%), Greece (59.3%) and Denmark (51.4%). Environmental concerns were mentioned by at least 10% of the farmers in each country (with the exception of Greece: 7.4%); they are strong mainly in Spain (45.2%) followed by Germany (30.8%). The innovative profile of the farmer is somewhat important in Greece (14.8%), The Netherlands (12.8%) and Ireland (10%). Finally, compliance with EU Regulations, as well as concern for human health, are considered important among the Danish farmers (17.9% and 11.4%, respectively).

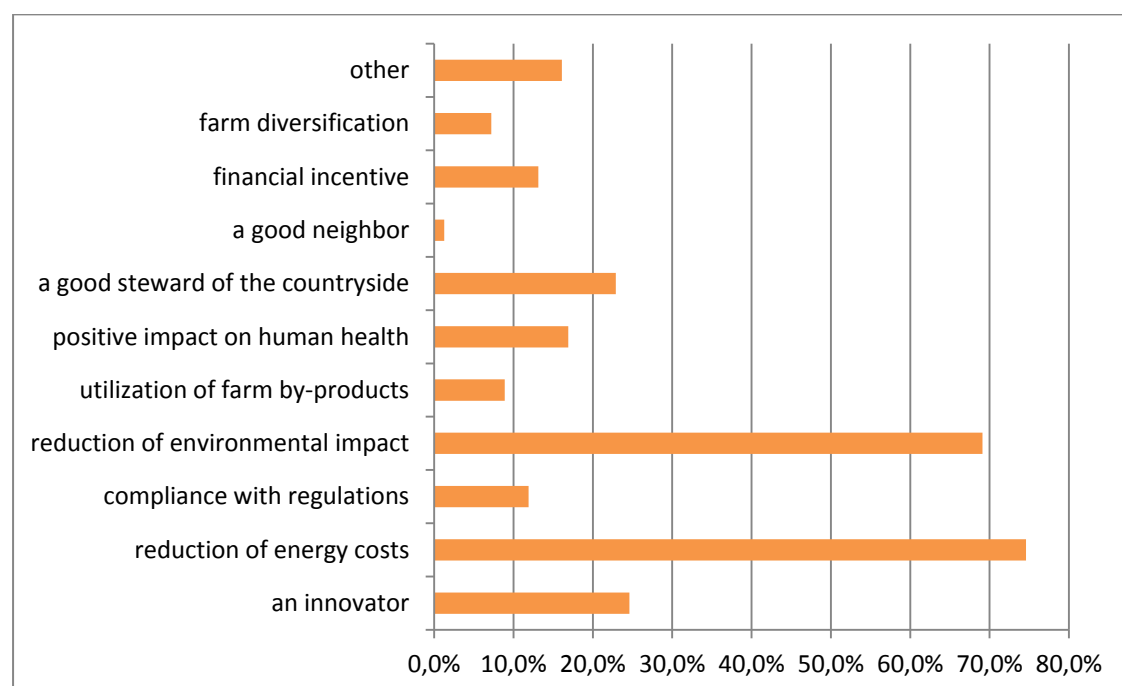


Figure 43: Farmers' three main motivations for the adoption of energy efficient technologies/ practices

With regard to the three most important farmers' motivations concerning the adoption of energy efficient technologies/ practices on their farm, interviewees seem to prioritize again economic incentives, i.e. reduction of energy costs (74.6%), followed again by the reduction of environmental impact (22.9%). Farmers' self-esteem – i.e. being an innovator (25.1%) and/or being a good steward of the countryside (22.9%) – along with the availability of some financial incentive - subsidy (13.1%) and compliance with Regulations (11.9%) are also quite important motivations for the adoption of energy saving technologies/ practices.

Furthermore, only 1 out of 3 adopters said that a specific subsidy gave them the opportunity to invest in energy efficient technologies/ practices on their farm. This is especially so for Greek (63%) and Polish adopters (60%).

On the other hand, 60.2% of the adopters said that the adoption of energy efficient technologies/ practices on their farm changed the way they farm.

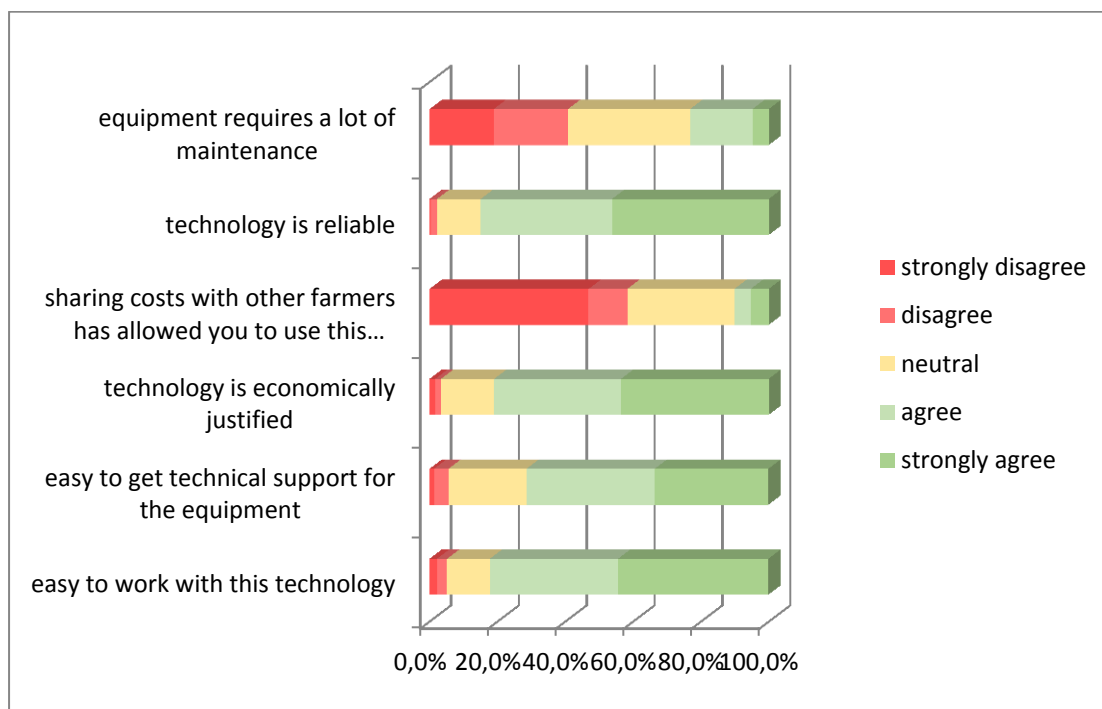


Figure 44: Adopter's opinions on the energy efficient technologies/ practices they have/use

In general, adopters state that energy efficient technologies/ practices are reliable (84.9%), easy to work with (82.1%) and economically justified (80.9%); additionally, according to interviewed adopters it is easy to get technical support for their equipment (71.3%) which, in parallel, does not seem to require a lot of maintenance (40.8% plus 36% neutral). Finally, farmers disagree with the statement that "sharing costs with other farmers has allowed you to use such a technology/ practice" (58.3%).

2.7 Non-adopters of energy-efficient technologies/ practices

The non-adopters of energy efficient technologies/ practices are 160 interviewees accounting for 40.4% of those aware about such technologies/ practices⁹.

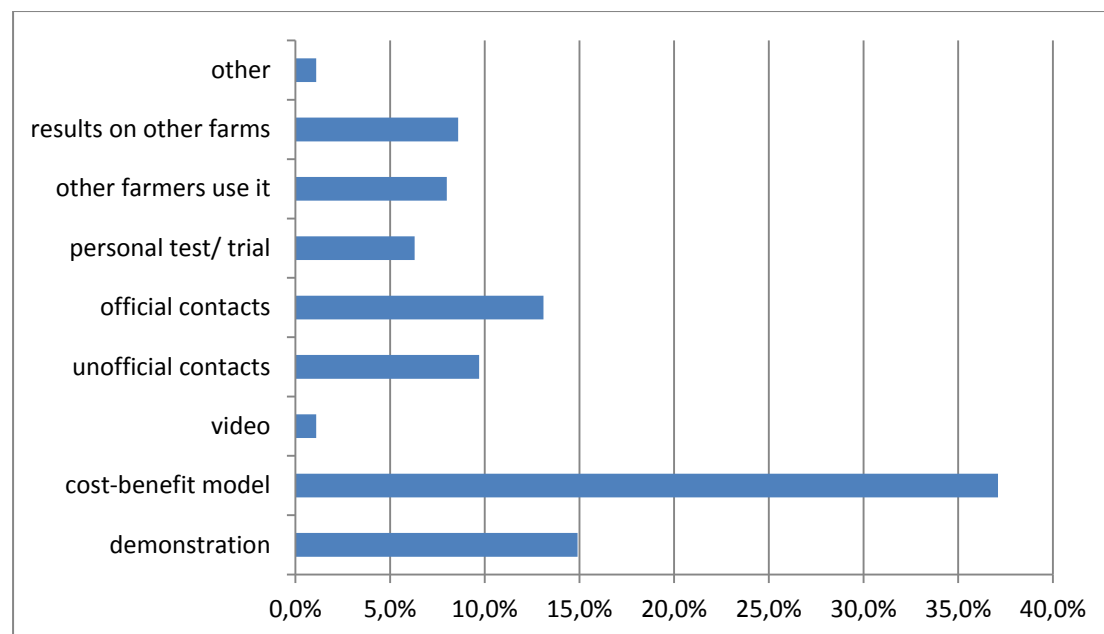


Figure 45: Information source farmers trust the most before deciding to establish (buy/use) energy efficient technologies/ practices

These non-adopters declared that the most important source of information they would trust before deciding to adopt/ use energy efficient technologies/ practices are a cost-benefit model tailored to their farm (37.1%), demonstrations (14.9%) and official contacts (with an advisor, official or someone paid for their service) (13.1%).

Polish (38.7%), Danish (29.4%) and Spanish farmers (22.7%) are in favour of demonstrations, followed by the Irish (10%). With the exception of Danish farmers, more than 10% of the farmers in all countries said they would be convinced by a cost benefit model that would reflect their farm specifics; this is especially true for Italian and Dutch farmers (88.9% and 87.5%, respectively) followed by the Irish (35%) and Polish farmers (32.3%). Unofficial contacts with neighbours and peers are important for German and Spanish farmers (40% and 27.3%, respectively), followed by the Danish (17.6%) and the Dutch (12.5%). On the other hand, official contacts with advisors/consultants etc. are important for the Greeks (46.9%) followed by the Danish (11.8%) and the Germans (10%). Personal trials/tests of new technologies/ practices are important for the German and the Irish farmers (30% and 20% respectively). Seeing other farmers using candidate technologies/ practices are important for Spanish (18.2%) as well as for Greek and Irish (15.6% and 15%, respectively) along with German farmers (10%). In parallel, the Danish farmers are keen to see results of new technologies/ practices in other/ peers' farms (35.3%) followed by Greek and Irish farmers (12.5% and 10%, respectively).

⁹ As aforementioned aware of energy efficient technologies/ practices were 396 interviewees (84.3% of the total sample).

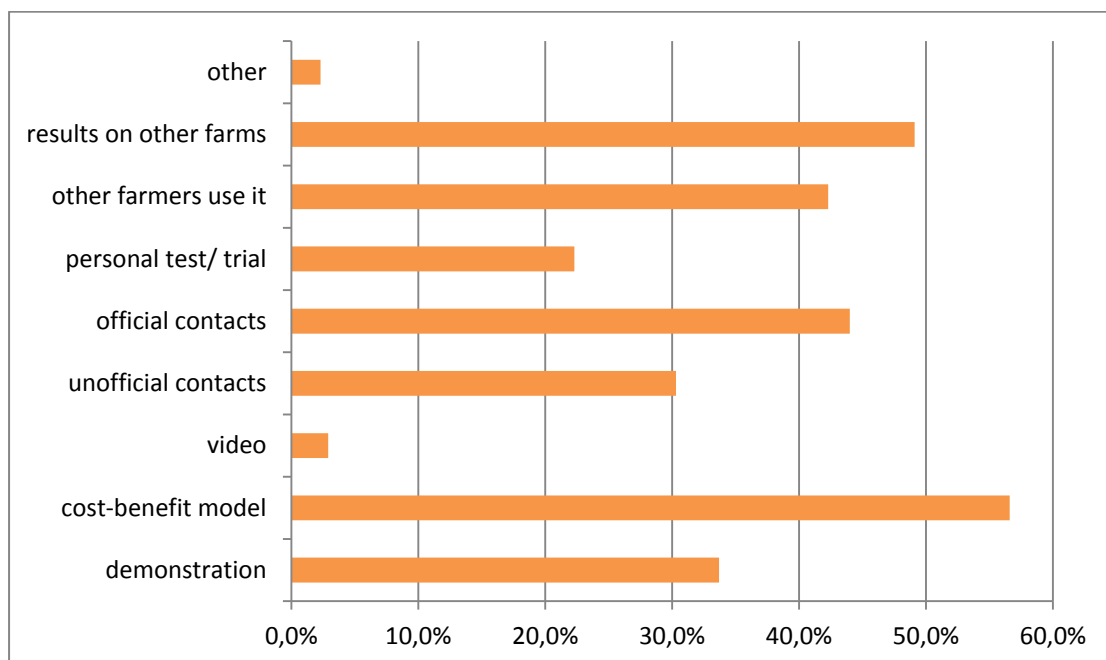


Figure 46: Three information sources farmers trust the most before deciding to establish (buy/use) energy efficient technologies/ practices

When it comes to the three most important sources of information they would trust before deciding to use energy efficient technologies/ practices on their farm, these are a cost-benefit model tailored to their farms still leads (56.6%), followed by results on other farms (49.1%), official contacts (44%) and seeing that 'other farmers use such technologies/ practices' (42.3%). Demonstrations (33.9%) and unofficial contacts with neighbours and/or other farmers (30.3%) along with personal tests/ trials (22.3%) are also important.

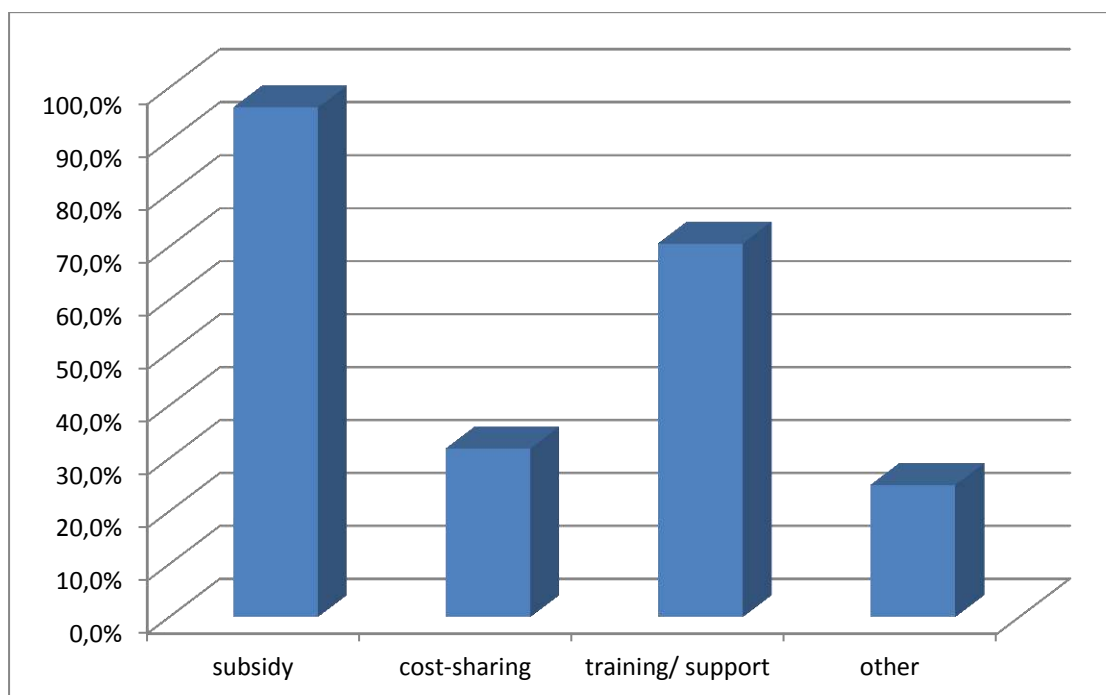


Figure 47: Incentives for adopting energy efficient technologies/ practices

Non-adopters claim that they would use energy efficient technologies/ practices if they would get a subsidy (96.3%) as well as relevant training (70.6%) and to a much lesser degree if they could share initial (purchase) costs (31.9%; Figure 47).

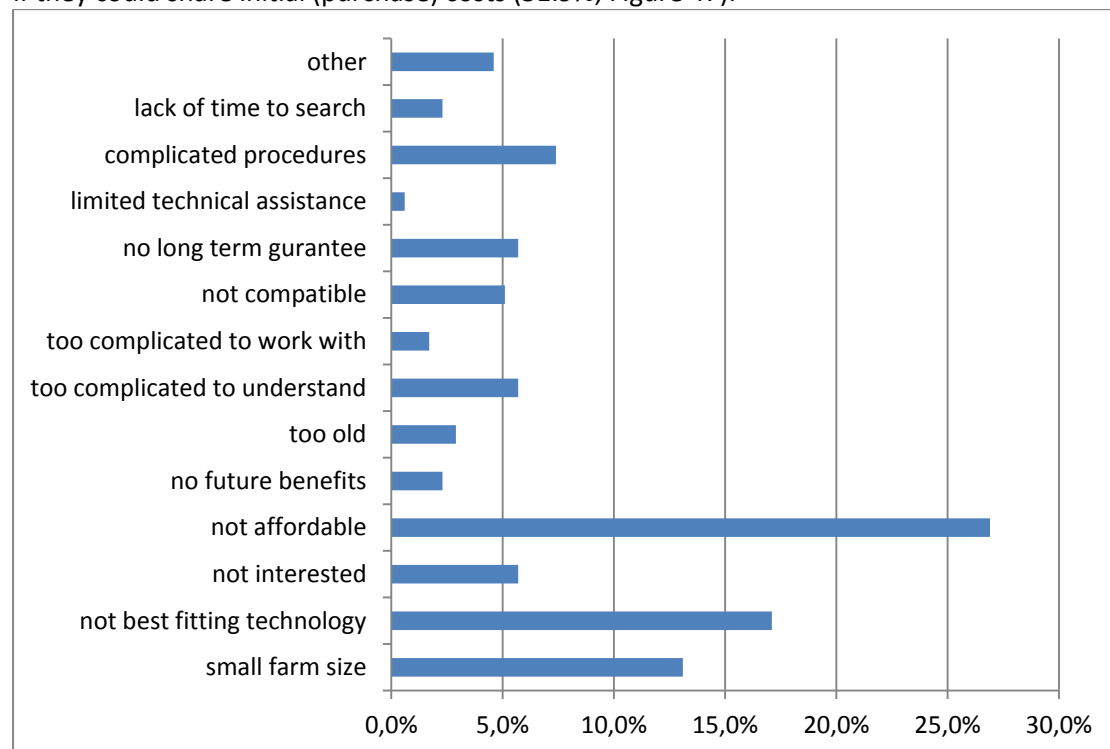


Figure 48: Most important reason for non-adopting energy efficient technologies/ practices

According to non-adopters, the main reason for not having/ using such technologies/ practices on their farms mainly owes to their claim that they cannot afford it (26.9%). Their consideration that the best fitting technology (tailored to their situation/ production system) is not available yet or that the available technology is not compatible with existing technology/ machinery/ equipment in their farm (17.1% and 5.1% respectively) follows along with the small farm size (13.1%).

Small farm size has been mainly mentioned by Danish and Polish farmers (47.1% and 25.8%) followed by the German farmers (10%). The lack of technologies tailored to farmers' specific situation/ cultivation systems (i.e. lack of best fitting technology) is important for more than 10% for farmers from all countries but Poland and Greece; such a lack seems to be especially important is for the Irish and Dutch farmers (40% and 31.3%, respectively) followed by farmers in other countries (between 10% and 20%). In parallel, the issue of compatibility of new technologies/ practices with existing on the farm equipment/ machinery is raised by Irish (20%) and German farmers (10%). Affordability is put forward by more than 10% of the farmers in all countries, especially for the Spanish, Greek, Polish and German farmers (between 30% and 40%). Difficulties in understanding such technologies/ practices were expressed by some Italian, Danish and German farmers (between 10% and 15%). Complicated procedures (i.e. (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.) were mentioned by Italian and Greek farmers (22.2% and 15.6%, respectively) while the lack of time to search, consider, apply for, and implement such technology/ practice was mentioned by the Germans (20%). Finally 18.8% of the Dutch, 12.5% of the Greek and 11.1% of the Italian farmers maintained that they are not interested in such technologies/practices (all other countries being at 0%).

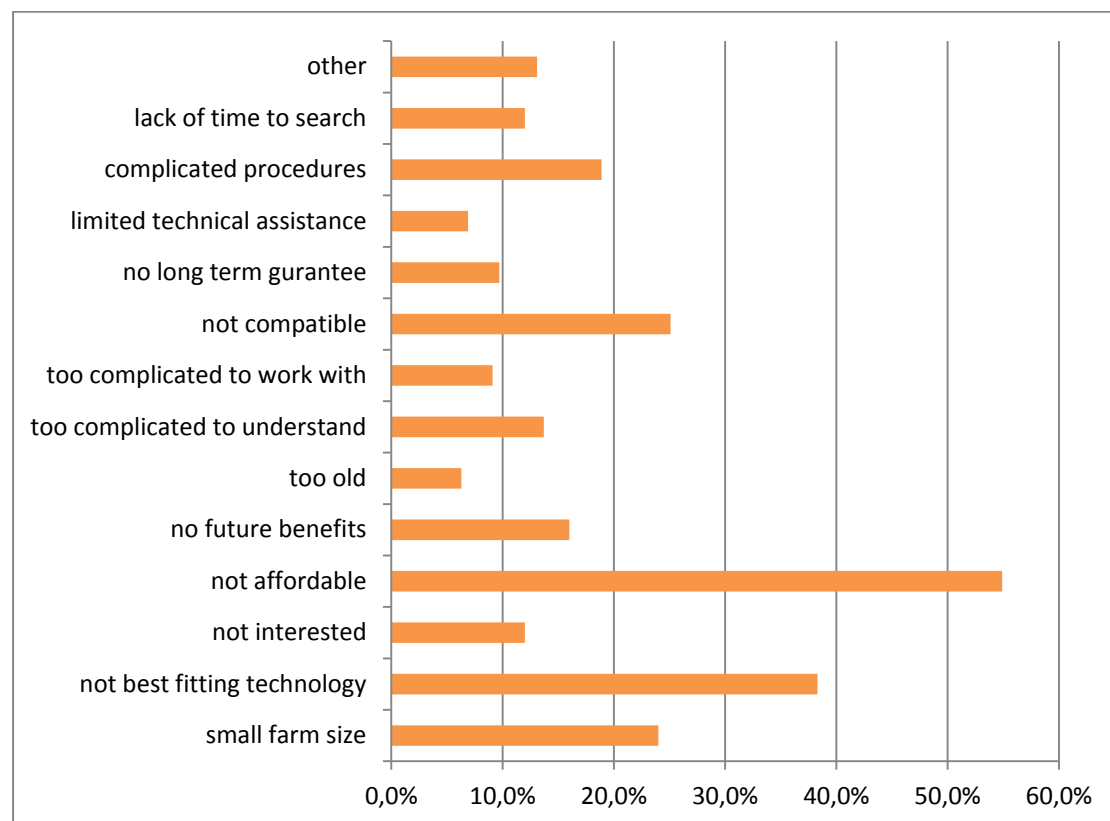


Figure 49: Reasons for non-adopting energy efficient technologies/ practices

When all three reasons for non-adoption are aggregated, the issue of affordability prevails again (54.9%) followed by the lack of appropriate technology, i.e. the best fitting technology (tailored to their situation/ production system) is not available yet or that the available technology is not compatible with existing technology/ machinery/ equipment in their farm (38.3% and 25.1% respectively). Other important factors are the (small) farm size (24%), the complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.) for establishing/ using energy efficient/ saving technologies/ practices (18.9%) as well as farmers' perception of no future benefits (16%), the lack of interest (12%) and the lack of time to search, consider, apply for, and implement such technology/ practice (12%); the complexity of such technologies/ practices which makes them difficult to understand or use is mentioned by 13.7% and 9.1%, respectively, of non-adopters.

Among the 93 non-adopters who have seen other farmers using energy efficient technologies/ practices, 63.4% have seen precision farming systems (re: crop and/or livestock production), 44.1% energy-efficient tools, and 40.6% energy-efficient buildings; 35.5% have seen energy-efficient vehicles. Two thirds out of those farmers claimed that such an experience raised their interest in such an energy efficient technology/ practice.

2.8 Carbon sequestration

Farmers with land¹⁰ said they are largely aware of carbon sequestration related practices. More specifically, farmers are aware of manuring and fertilizing practices (96.1%) and cover crops and crop rotations (93.3%) followed by conservation tillage (89.4%) and crops residue management (88.5%).

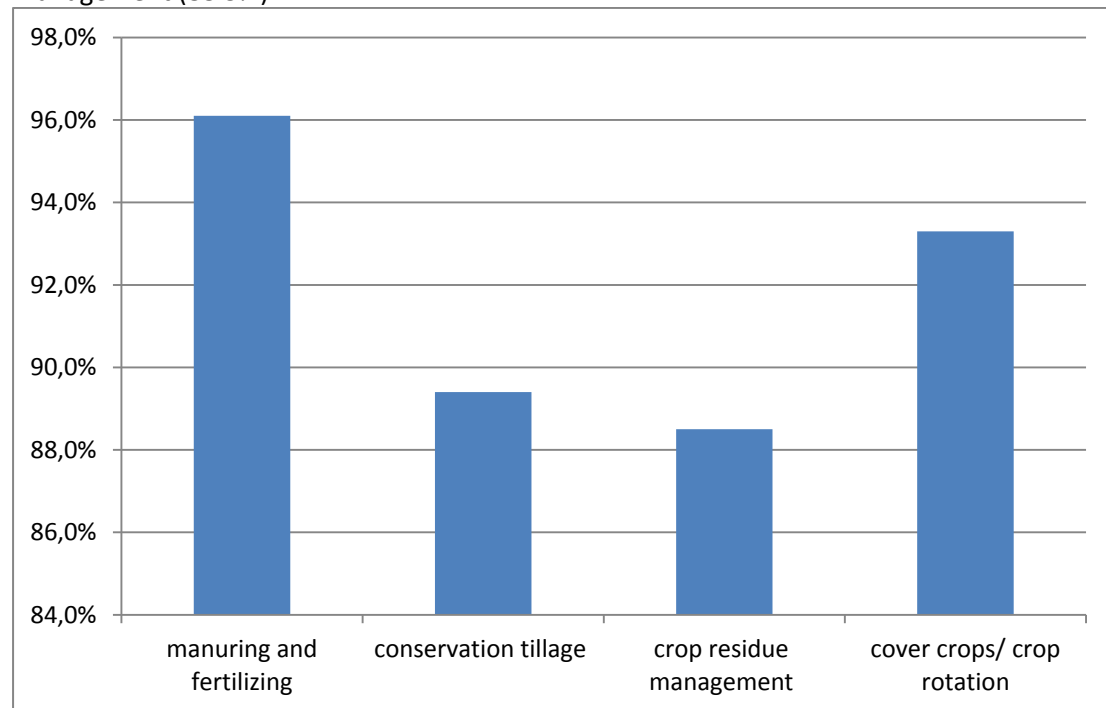


Figure 50: Farmers' awareness of carbon sequestration practices

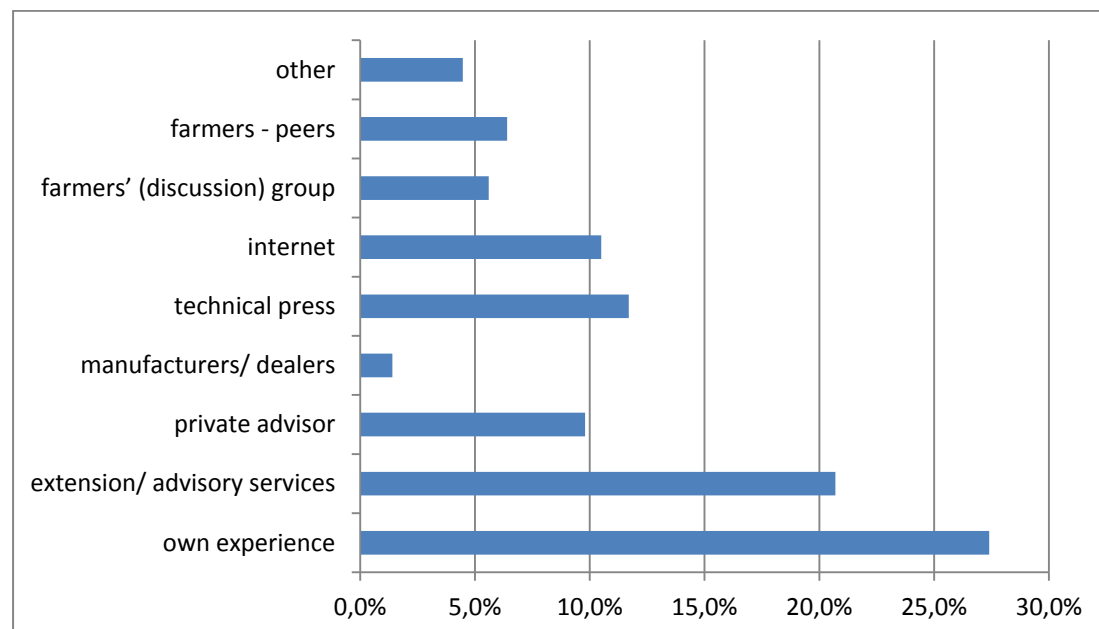


Figure 51: Most important source of information/awareness for carbon sequestration practices

¹⁰ I.e. arable (i.e. cereals, open field vegetables, root crops, etc), permanent (i.e. vineyards, orchards, etc) and other (i.e. permanent grassland, etc.) crop production systems.

The most important farmers' source of information/ awareness concerning carbon sequestration practices is farmers' own experience (27.4%) and national or regional agricultural (public, cooperative) extension services (20.7%) followed by technical press (11.7%) and the Internet (10.5%). All the other sources of information account for less than 10% each (Figure 51).

More specifically, the situation per country is as follows:

- Denmark: national or regional agricultural (public, cooperative) extension/advisory services (42.9%), technical press (16.3%) and private consultants (14.3%)
- Germany: farmers' own experience (46.4%), farmers' discussion groups (14.3%), technical press (12.5%) and national or regional agricultural (public, cooperative) extension/advisory services (10.7%)
- Greece: farmers' own experience (27.8%), private consultants (25%) and the Internet (16.7%)
- Italy: national or regional agricultural (public, cooperative) extension/advisory services (36.2%), farmers' own experience (21.3%), private consultants (14.9%), and farmers' discussion groups (10.6%)
- Ireland: the Internet (30.3%), farmers' own experience (12.1%), national or regional agricultural (public, cooperative) extension/advisory services (24.2%), private consultants (15.2%) and technical press (12.1%)
- The Netherlands: own experience (38.5%), technical press (38.5%), private consultants (12.8%)
- Poland: national or regional agricultural (public, cooperative) extension/advisory services (28.3%), the Internet (22.6%), farmers' own experience (13.2%), other farmers (13.2%), and other sources (13.2%)
- Spain: farmers' own experience (51.1%), national or regional agricultural (public, cooperative) extension/advisory services (11.1%) and other sources (15.6%).

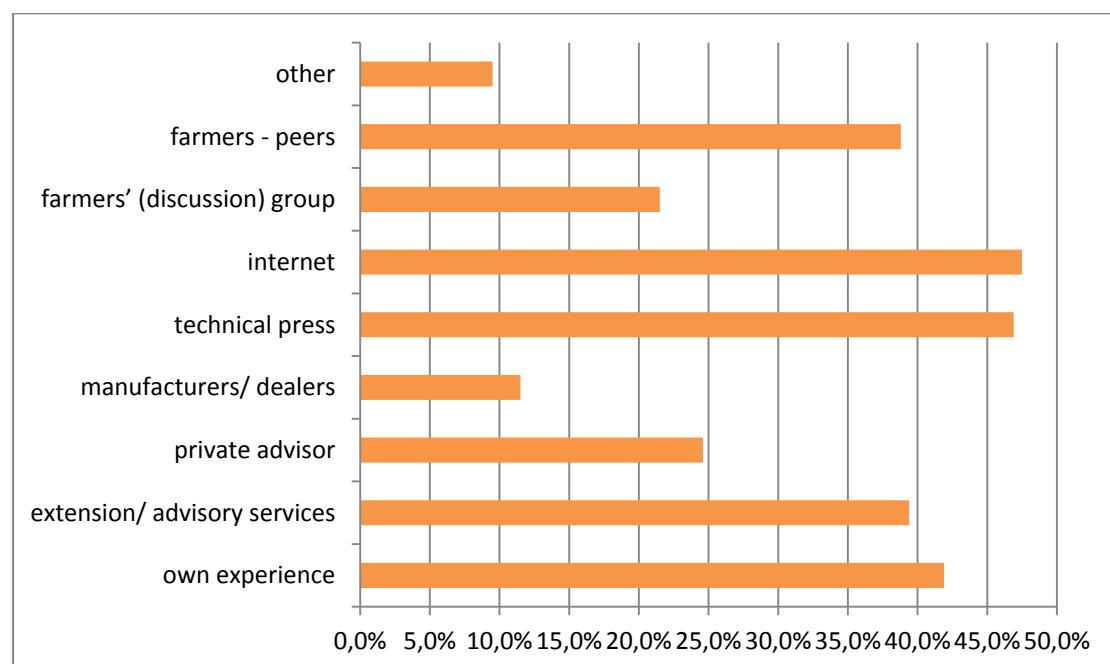


Figure 52: Three most important sources of information/awareness for carbon sequestration practices

Farmers said that the three most important sources of information/ awareness concerning carbon sequestration practices are the Internet and technical press (47.5% and 46.9%, respectively) along with their own experience (41.9%), national or regional agricultural (public, cooperative) extension services (39.4%) and other farmers/ peers (38.8%). Private advisors (24.6%) and farmers' discussion groups (21.5%) along with manufacturers/ dealers (11.5%) also assist farmers' awareness concerning carbon sequestration practices. More than 3 out of 4 of the interviewees (ca. 77%) said they utilize such practices in their farms.

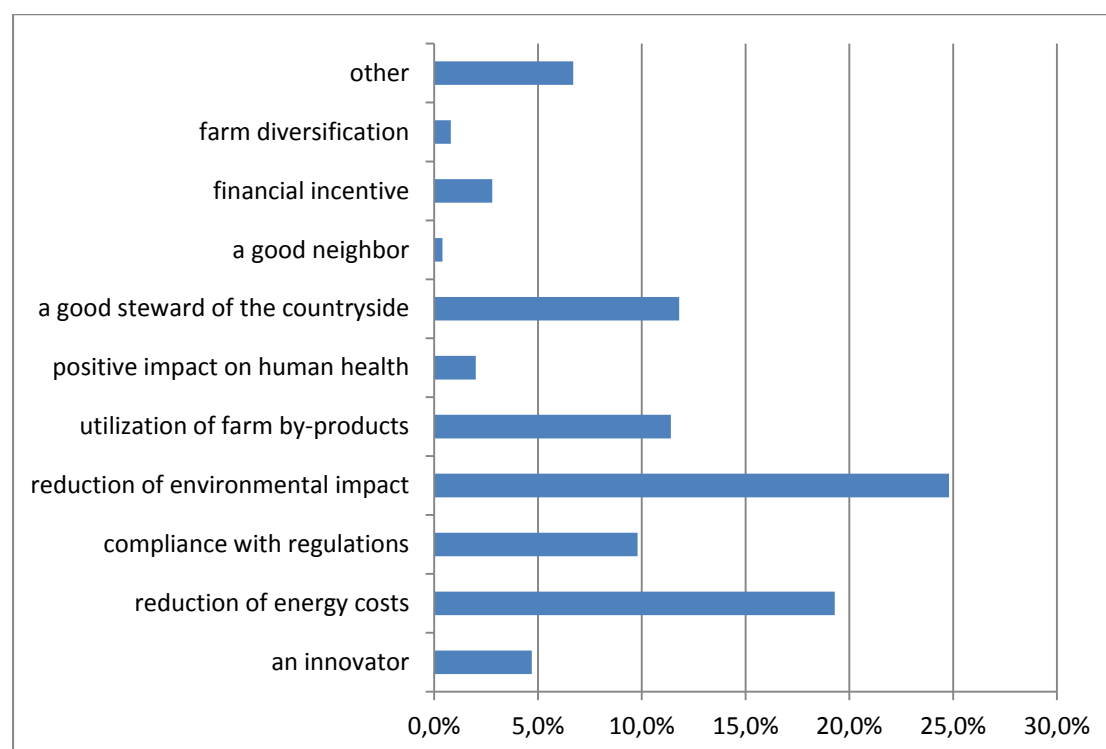


Figure 53: Farmers' main motivation for the adoption of carbon sequestration practices

The reduction of the environmental impact of farming (24.8%), the reduction of energy costs (19.3%) along with "being a good steward of the countryside" (11.8%), the utilization of farm by-products (11.4%) and compliance with Regulations (9.8%) are farmers' main motivations for adopting carbon sequestration practices.

In all countries, more than 15% of the farmers (but Greece: 26.7%) are primarily motivated by their effort to reduce energy costs; this is especially true in The Netherlands (35.5%) and Denmark (23.8%). Environmental concerns (reduction of environmental impact of farming) were mentioned by at least 10% of the farmers in each country (with the exception of Greece and Denmark: 7.4% and 4.8% respectively); they are stronger in Ireland (57.1%), Germany (45.8%) and Spain (43.9%). On the other hand, compliance with Regulations is strong among the Danish farmers (28.6%) and Dutch farmers (22.6%). The innovative profile of the farmer is somewhat important among the Irish farmers (14.3%) with the good stewardship of the countryside being important for the Danish (23.8%), Greeks (16.7%) and Spanish farmers (12.2%). Finally, the utilization of farm by-products seems important for the Greek (30%), Polish (24.2%) and Italian farmers (18.2%).

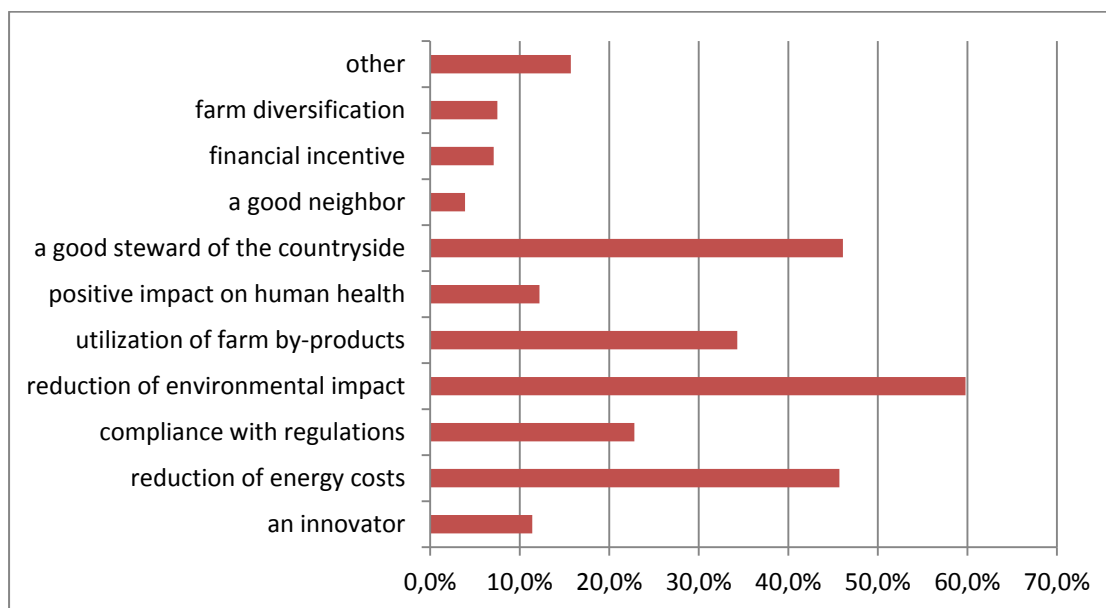


Figure 54: Farmers' three main motivations for the adoption of carbon sequestration practices

With regard to the three most important farmers' motivations concerning the adoption of energy efficient technologies/ practices on their farm, interviewees seem to prioritize again economic incentives, i.e. reduction of energy costs (74.6%), followed again by the reduction of environmental impact (69.1%). Farmers' self-esteem – i.e. being an innovator (25.1%) and/or being a good steward of the countryside (22.9%) – along with the availability of some financial incentive - subsidy (13.1%) and compliance with Regulations (11.9%) are also quite important motivations for the adoption of energy saving technologies/ practices

The great majority of the adopters (87.1%) stated that they did not utilize any specific external subsidy in order to invest in/ apply such practices.

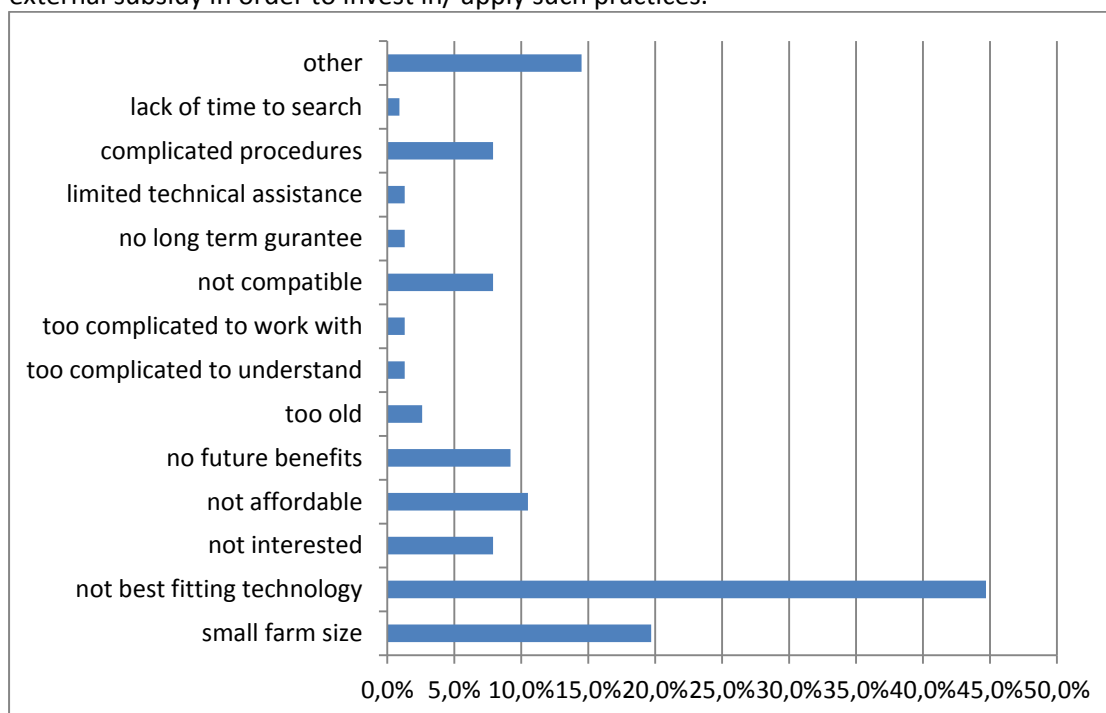


Figure 55: Most important reason for non-adopting carbon sequestration practices

Farmers claim that the lack of appropriate/ best fitting technologies/ practices is the main reason (44.7%) for not adopting carbon sequestration practices. The small farm size (19.7%) and non-affordability (10.5%) were also mentioned.

The small size of farms is mainly mentioned in Poland (40%) and Denmark (28.6%) followed by Germany and The Netherlands (12.5% each). More than 10% of farmers in all countries (except Spain) claimed that currently there is lack of technology tailored to their situation/ cultivation system (i.e. of best fitting technology), especially in The Netherlands (50%), Ireland (42.3%) and Italy (34.6%). Additionally, compatibility with existing technology/ machinery/ equipment was mentioned by Danish, German and Irish farmers (between 10% and 15%). Non affordability was mentioned by Spanish famers (25%) as well as by Danish (14.3%), Dutch (12.5%) and Irish (11.5%). Doubts about the future profitability of such technologies/ practices are expressed by the Greek (22.2%) and the Irish farmers (11.5%). The complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.) were mentioned by Italian (19.2%) and German farmers (12.5%). Finally, age was mentioned by one fourth of the Spanish while 12.5% of the Dutch farmers note that such technologies/ practices are complicated to work with/ they are not user friendly.

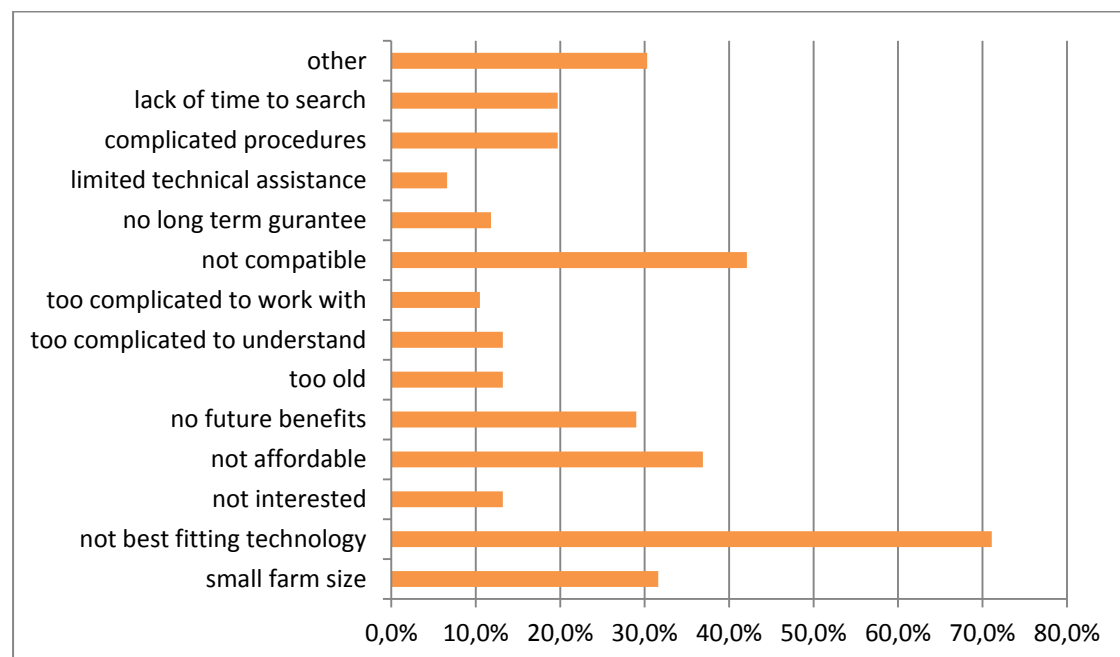


Figure 56: Reasons for non-adopting carbon sequestration practices

When all three reasons for non-adoption are aggregated the issue of the lack of appropriate/ best fitting technologies/ practices prevails again (71.1%) along with farmers' claim that the technology/practice is not compatible with existing technology/ machinery/ equipment in their farms (42.1%). Non affordability (36.9%) and the small farm size (31.6%) were also mentioned by substantial numbers of farmers. Other reasons were farmers' perception of no future benefits from adoption of such practices (29%), the complicated procedures required and/or the lack of time to search, consider, apply for, and implement such technology/ practice (19.7% each); relatively few said that they are not interested (13.2%) while 13.2% claim that such practices are difficult to understand and 10.5% difficult to work with.

Over 80% of non-adopters agreed that a subsidy and technical assistance would motivate them to apply carbon sequestration practices in their farms.

2.9 Information seeking behaviour

The majority of the farmers said that they visit agricultural fairs, field days/demonstrations, or exhibitions at least once a year (78.3%) – notably 48.5% more than once per year. Only 3.6% said that they have never visited such an event.

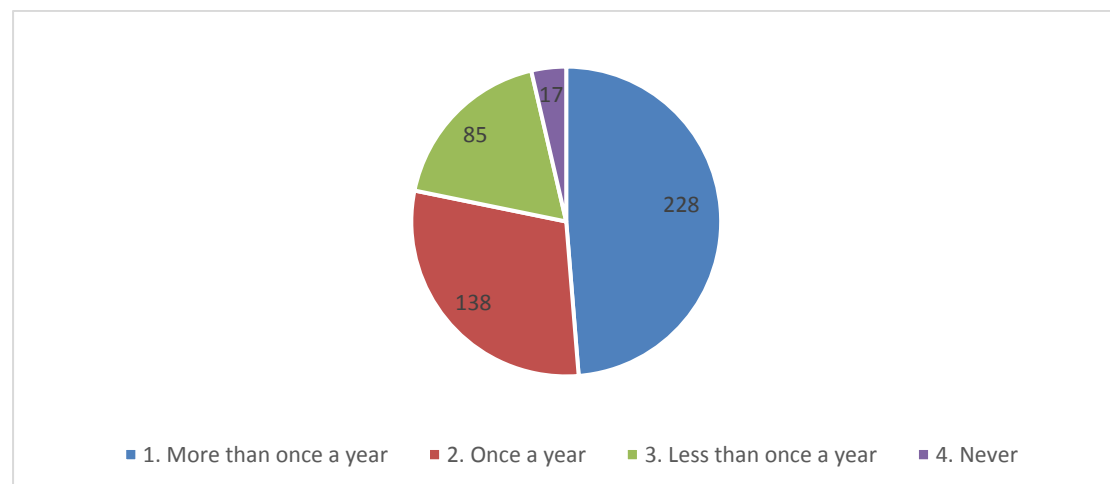


Figure 57: Visits to agricultural fairs, field days/demonstrations or exhibitions (farmers)

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

- Denmark: 0%
- Germany: 3.4%
- Greece: 3.2%
- Italy: 0%
- Ireland: 6.6%
- The Netherlands: 1.8%
- Poland: 1.6%
- Spain: 12.3%

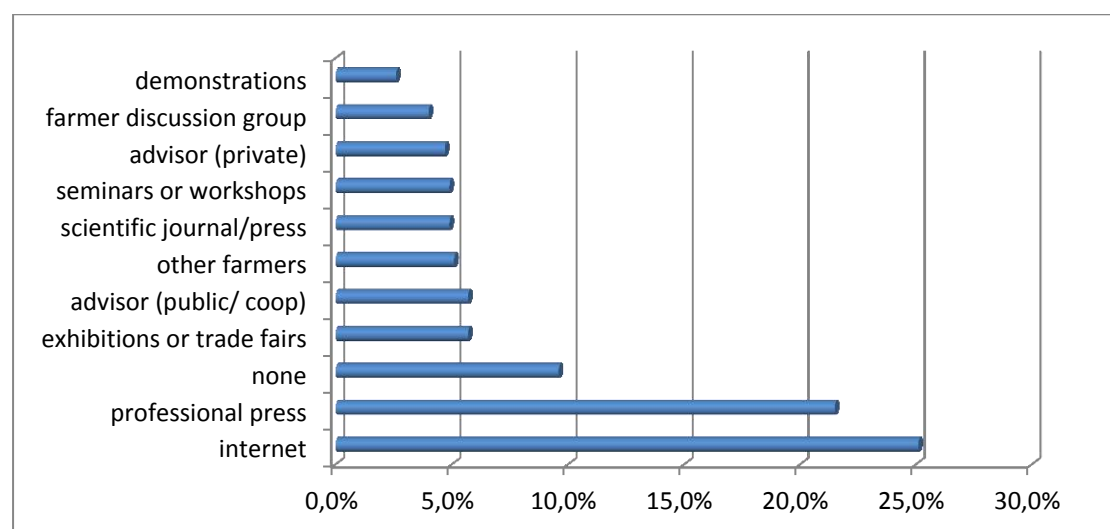


Figure 58: Most recent source of information regarding renewable energy production and energy saving technologies/ practices

Farmers claim that the most recent source of information in which they sought out information in relation to renewable energy production and energy saving technologies/ practices are the Internet (25.1%) and professional press (21.5%), followed by exhibitions and fairs (5.7%), public or coop advisors (5.7%) and other farmers (5.1%). No relevant information during the year of the interview (2021) was sought by 9.6% of the farmers.

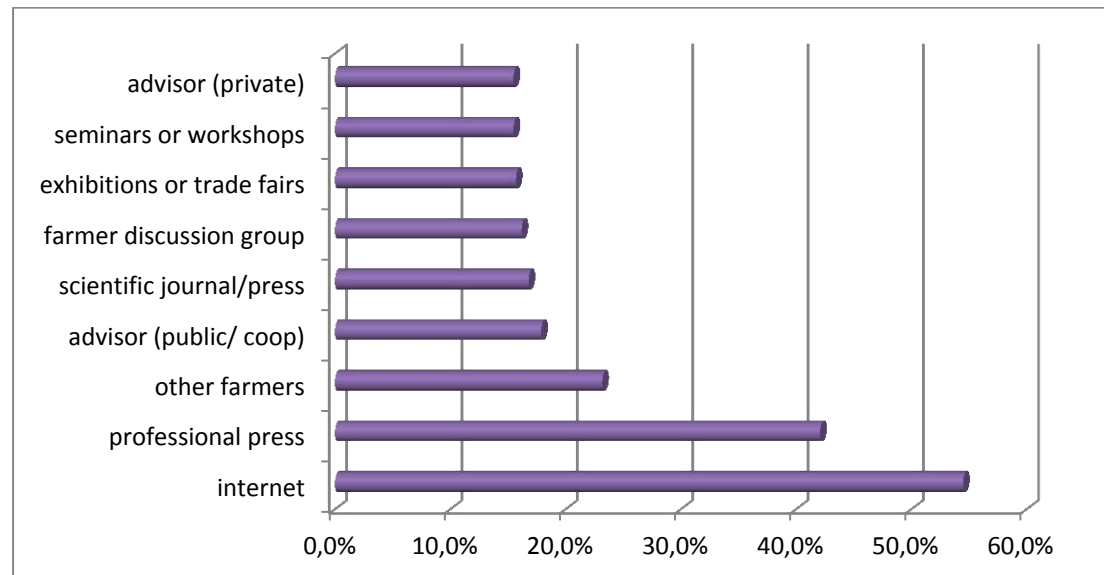


Figure 59: Most recent sources of information regarding renewable energy production and energy saving technologies/ practices

Additionally, farmers claim that the three most recent sources of information in which they sought out information in relation to renewable energy production and energy saving technologies/ practices are the Internet (54.5%), professional press (42.1%) and other farmers/ peers (23.2%), followed by public/coop advisors, scientific journals/press, farmer discussion groups, exhibitions or trade fairs, seminars and workshops and, private advisors (18 – 15% each).

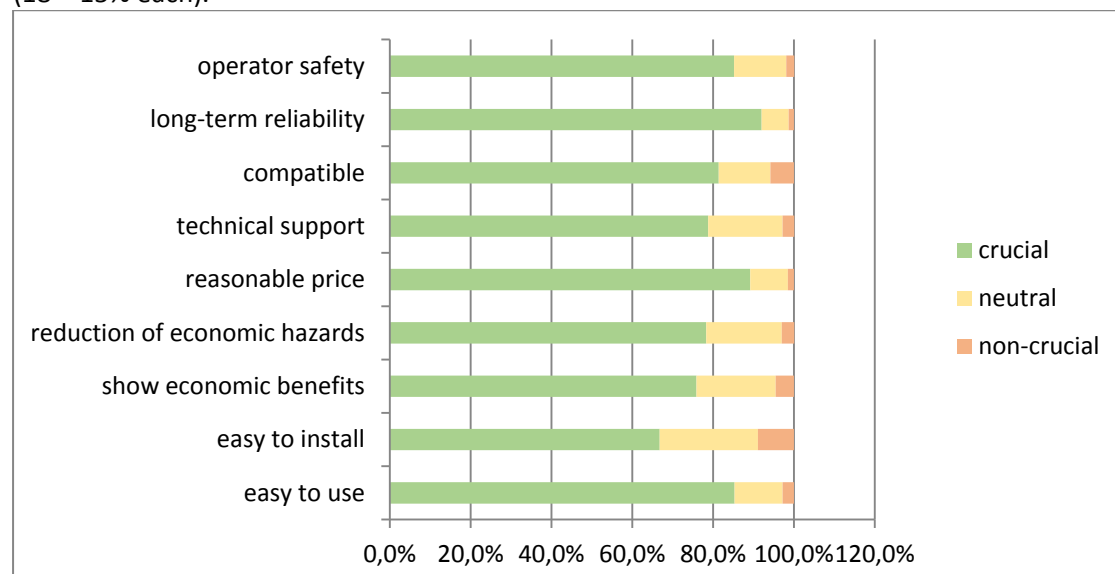


Figure 60: Characteristics that would make RES and energy-efficient technologies/ practices more relevant to farmers' needs

According to the interviewed farmers, the most important RES and energy-efficiency technologies/ practices' characteristics that would make them more relevant to farmers' needs are long term reliability (92%) along with price/ affordability (89.2%), ease of use (85.3%), operator safety (85.2%) and compatibility with existing farm machinery (81.4%). Technical support (78.8%), the reduction of environmental hazards (78.3%), immediate economic benefits (75.9%) and easiness to install the equipment (66.8%) are also important technology/equipment/ practice characteristics for the majority of the farmers.

2.10 Farmers' attitudes towards technology and innovation

Technology, according to the farmers, can contribute to improve farming (94.2%; 68% strongly agree) as well as to assist them in complying with the EU Regulations (86.8%; 49% strongly agree) and to a lesser degree to support the recognition of their work by the wider public (74.8%; 39.9% strongly agree). Crop and mixed production farmers are stronger believers than livestock ones in that 'technology helps them to comply with Regulations'.

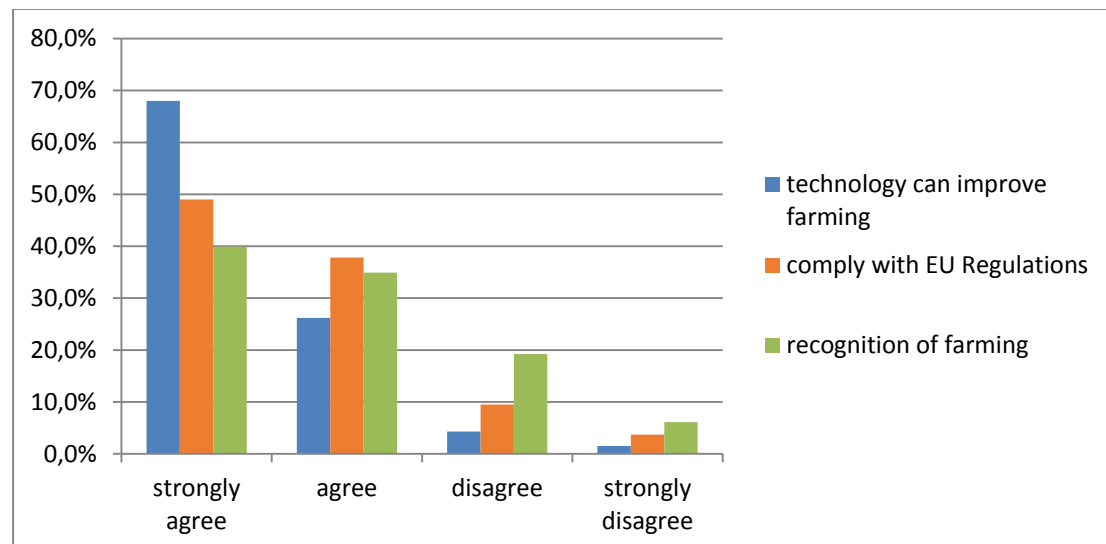


Figure 61: Farmers' attitudes towards technology

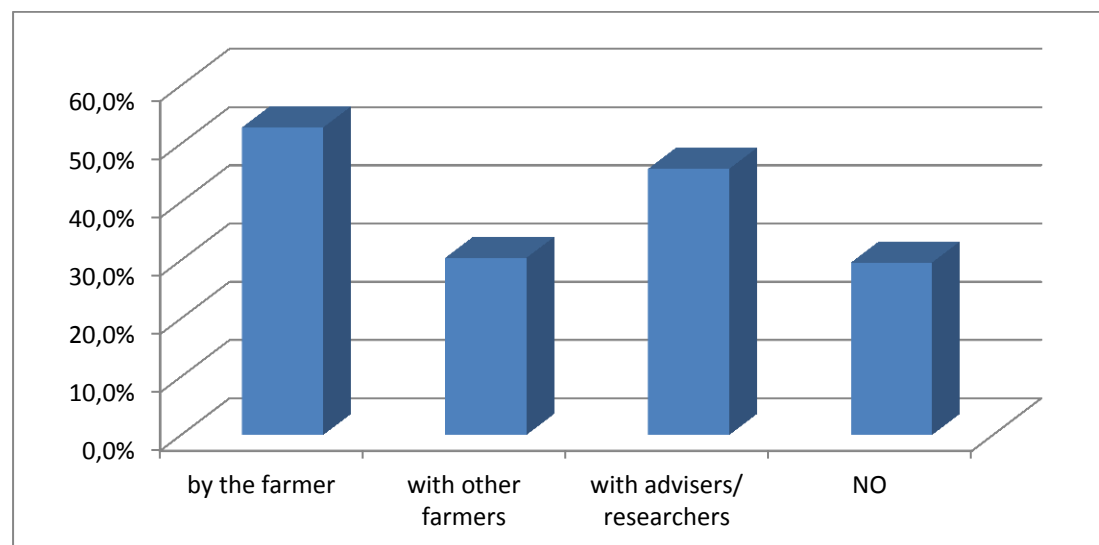


Figure 62: Farmers' experimentation

The majority of the interviewed farmers (70.4%) claim that they experiment on their farms, i.e. trying new technology or practices on the farm before they adopt it at full scale. Most farmers experiment by themselves (52.8%); experimentation with advisors and/or researchers (45.7%) or with their peers (30.4%) is also important.

More specifically, the situation per country, with reference to farmers who do not experiment with new technology or practices on the farm before they adopt it at full scale, is as follows:

- Denmark: 17.3%
- Germany: 39%
- Greece: 19.3%
- Ireland: 39.3%
- Italy: 29.1%
- The Netherlands: 35.7%
- Poland: 26.2%
- Spain: 29.9%

Crop and mixed production farmers are keener to experiment than livestock farmers.

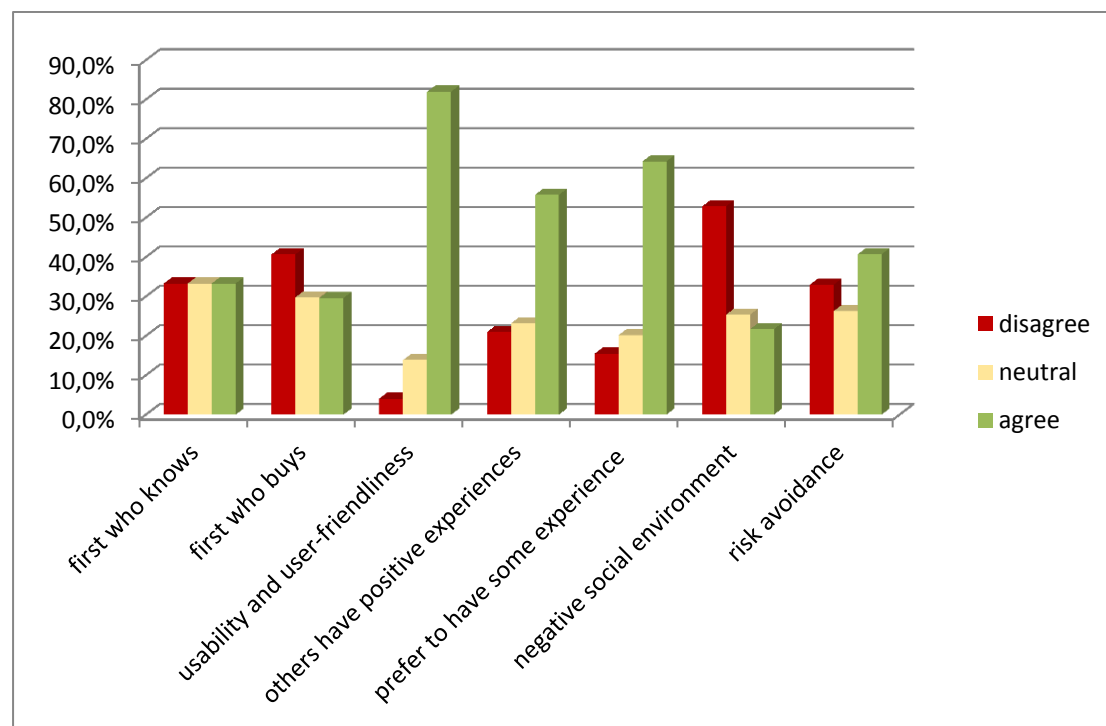


Figure 63: Farmers' innovativeness

The interviewed farmers claim that usability and user-friendliness are important to them when they buy new machinery/ equipment (82%). Furthermore, they prefer to have some experience with something before they buy it (64.3%) and wait to buy new things, until they know that others have positive experiences with it (55.8%). The interviewees are neither the first to know about new technology in their social circles (33.3% claimed that they are the first to know) nor the first to buy it (29.6% claimed that they are the first to buy). In general, they don't like taking risks with their farming business (40.7%). On the other hand, they would buy new equipment even if their (social) environment would be negative on it (52.9%).

Livestock farmers seem to be more 'conservative' in terms of knowing and using new technologies/ practices first ($P < 0.010$ and $P < 0.05$, respectively) and waiting to see other farmers/ peers to use them ($P < 0.010$).

Farmers were also asked about the incentives they would like to see in future policies to facilitate the adoption of RES and energy saving technologies/ practices. Out of the 340 interviewees who responded (72.3% of the total survey sample), 263 farmers (77.4% of responses) ask for some kind of financial support, especially for subsidies and grants relating to the initial capital investment aiming at making such an investment (and the farm business) viable. Other financial incentives, albeit with few supporters, include higher/fair prices for their produces (17), lower input costs (14) and tax reductions (9).

The reduction of the bureaucratic procedures involved in relevant schemes is also an important issue for one out of four respondents. In this regard, on the one hand, farmers ask for "simplified" (less complicated) regulations and, on the other hand, for less complicated, faster and transparent procedures (in general, less administrative burden).

Another 48 farmers referred to policies which they claim should be reliable in the long-term (for example, not to change when the government changes) and take into account farmers' needs, so that farmers feel more secure when making such long-term investments. Additionally, another 19 farmers request more financial incentives and support specifically for small farms.

Furthermore, one out of eight respondents asked for the provision of more (as well as of more accurate and reliable) information on such technologies including tests/demonstrations under real farm conditions, exchange of experiences with adopters, cost-benefit analyses and the like. On top of this, one out of ten respondents underlines the need for training on such technologies.

Finally, 19 respondents referred to the need for improved, simpler and more "suitable" (tailor-made) technologies so that they will satisfy farmers' needs and farm specificities, while 9 respondents referred to the need to improve the image of farming among consumers (disseminate information about the contribution of farming in terms of sustainability enhancement).

2.11 Adopters vs. non-adopters of RES

Adopters and non-adopters of RES do not show any statistically significant difference in terms of age. On the other hand, they differ in terms of gender (in favour of men; $P < 0.10$), level of general (in favour of the more educated; $P = 0.000$) as well as occupational education (in favour of those holding Green/Farming Certificate¹¹; $P < 0.10$), digital skills and the frequency of Internet use ($P = 0.000$ and $P < 0.01$, respectively), farm size (in favour of bigger farms; $P = 0.000$)¹², the existence of a successor ($P < 0.01$), years/ experience in farming (in favour of less years; $P < 0.10$) and interviewees' participation in collectivities like farmer cooperatives, association, unions, etc. ($P = 0.000$). Adopters are also more likely to be full-time farmers ($P = 0.001$), more satisfied from farming ($P = 0.000$) as well as to be engaged in diversified on-farm activities ($P = 0.000$), certification schemes ($P < 0.05$) and participate in CAP Pillar II projects ($P < 0.05$); in parallel, they visit agricultural fairs, field days/demonstrations, or exhibitions more often than non-adopters ($P = 0.000$). Additionally, non-family farms (companies, cooperatives) are more likely to use RES in comparison to family farms ($P < 0.05$).

¹¹ I.e. equivalent to, at least, two years of professional/occupational agricultural education/training after the completion of compulsory education (including Higher Education).

¹² Despite the effort to neutralize the effect of farm size differences.

Non-adopters are most likely to be involved in farming due to family tradition ($P=0.10$) as well as to be less dependent in terms of the contribution of agriculture into the family income ($P=0.001$). No difference was detected with reference to the % of the plain area of the farm or the production system (plant, livestock or mixed).

Adopters and non-adopters consider different sources of knowledge/awareness on RES as being the most important one to them ($P<0.05$). Adopters seem to use more (as compared to non-adopters) the sources 'own experience', 'private advisors' and 'industry/ technology manufactures' while non-adopters use more (as compared to adopters) the sources 'Internet', 'technical press' and 'peers'.

With reference to the characteristics of RES that would make them more relevant to farmers' needs, adopters seem to put less emphasis on the ease-of-use and installation of such technologies ($P=0.000$ and $P<0.010$, respectively), the expectation for immediate economic benefits ($P<0.05$), the reduction of environmental hazards ($P<0.010$), reasonable acquisition prices/ affordability ($P<0.10$), technical support ($P=0.000$), compatibility with existing on the farm machinery/equipment ($P<0.10$) and operator safety ($P=0.000$).

Adopters seems not to be stronger believers compared to non-adopters in terms of the capability of technology to improve farming, to assist farmers in complying with EU Regulations as well as the recognition of farmers' work by the public. On the other hand, adopters are more likely to experiment on their farms, i.e. trying new technologies or practices on the farm before they adopt it at full scale ($P<0.010$). Furthermore, 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 ($P<0.010$ and $P=0.000$, respectively), they would buy something new despite the negative attitude of their social environment ($P=0.000$) and are not afraid of taking risks in farming ($P<0.05$). On the other hand, non-adopters are more likely to wait to buy new things, until they know others have positive experiences with it ($P=0.000$) and prefer to have some experience with something before they buy it ($P<0.010$) as compared to adopters.

2.12 Adopters vs. non-adopters of energy-efficiency technologies/ practices

Adopters and non-adopters of energy efficiency technologies/ practices do not show any statistically significant difference in terms of age and gender. On the other hand, they differ in terms of general (in favour of the more educated; $P=0.000$), but not occupational education level, digital skills and the frequency of Internet use ($P=0.000$ and $P=0.000$, respectively), farm size (in favour of bigger farms; $P=0.000$), the existence of a successor ($P=0.001$), years/ experience in farming (in favour of less years; $P=0.05$) and interviewees' participation in collectivities like farmer cooperatives, association, unions, etc. ($P=0.001$). Adopters are also more likely to be full-time farmers ($P<0.010$), to be more satisfied from farming ($P=0.000$) as well as to be engaged in diversified on-farm activities ($P=0.001$), certification schemes ($P=0.005$) and participate in CAP Pillar II projects ($P<0.10$); in parallel, they visit agricultural fairs, field days/demonstrations, or exhibitions more often than non-adopters ($P=0.001$). Furthermore, non-family farms (companies, cooperatives) are more likely to use energy saving technologies/ practices in comparison to family farms ($P<0.05$).

Non-adopters do not differ from adopters in terms of the reasons why they engaged in farming, but they (non-adopters) are less dependent in terms of the contribution of agriculture into the family income ($P=0.001$).

No difference was detected with reference to the % of the plain area of the farm; however, differences are detected ($P<0.10$) between production systems (more adopters: mixed > livestock > plant production).

Adopters and non-adopters seem to consider different sources of knowledge/awareness on energy saving technologies/ practices as being the most important one to them ($P < 0.05$). Adopters seem to use more (as compared to non-adopters) the sources 'technical press' and 'farmers' groups' while non-adopters use more (as compared to adopters) the sources 'own experience', 'Internet', and 'other farmers'.

With reference to the characteristics of energy saving technologies/ practices that would make them more relevant to farmers' needs, adopters seem to put less emphasis on the ease-of-use and installation of such technologies ($P < 0.05$ and $P < 0.05$, respectively), the expectation for immediate economic benefits ($P < 0.10$), the reduction of environmental hazards ($P < 0.05$), reasonable acquisition prices/ affordability ($P < 0.010$), technical support ($P = 0.000$), compatibility with existing on the farm machinery/equipment ($P < 0.10$), long-term reliability ($P < 0.010$) and operator safety ($P = 0.000$).

Adopters are stronger believers compared to non-adopters in terms of the capability of technology to improve farming ($P = 0.000$), to assist farmers in complying with Regulations ($P < 0.05$), but do not differ with regard to the contribution of technology in terms of the recognition of farmers' work by the public. Furthermore, adopters are keener to experiment on their farms, i.e. to try new technology or practices on the farm before they adopt it at full scale ($P = 0.001$). Additionally, 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 ($P = 0.000$ and $P = 0.000$, respectively) and are not afraid of taking risks in farming ($P < 0.05$). On the other hand, non-adopters are more likely to wait to buy new things, until they know others have positive experiences with it ($P = 0.000$) as compared to adopters.

Finally, adopters of energy efficiency technologies/ practices are more likely to be adopters of RES as well ($P = 0.000$).

2.13 Adopters vs. non-adopters of carbon sequestration practices

Adopters and non-adopters of carbon sequestration practices do not show any statistically significant difference in terms of gender and farm size. On the other hand, they differ in terms of age (in favour of younger farmers; $P < 0.05$), level of general (in favour of the more educated; $P = 0.005$) – but not occupational education, the frequency of Internet use ($P = 0.001$) – but not the level of digital skills, years/ experience in farming (in favour of less years; $P < 0.05$) and interviewees' participation in collectivities like farmer cooperatives, association, unions, etc. ($P < 0.05$). Adopters are also more satisfied from farming ($P = 0.001$), engage in diversified on-farm activities ($P = 0.000$), certification schemes ($P = 0.005$) and participate in CAP Pillar II projects ($P < 0.05$). Difference was detected with reference to the % of the plain area of the farm (in favour of lower than 50%; $P < 0.10$) as well as to the production system (mixed > plant production).

Non-adopters are most likely to be involved in farming due to family tradition ($P = 0.10$) as well as to be less dependent in terms of the contribution of agriculture into the family income ($P < 0.010$).

Adopters and non-adopters do not differ in terms of occupational status, i.e. full-time vs. part-time farmers or the existence (or not) of a successor. In parallel, non-family farms (companies, cooperatives) are not more likely to use carbon sequestration practices in comparison to family farms. Furthermore, adopters do not differ as compared to non-adopters in the frequency of visits to agricultural fairs, field days/demonstrations, or exhibitions. In addition, adopters and non-adopters do not seem to consider different sources of knowledge/know-how on the use and operation of their spraying equipment as being the most important to them.

Adopters are not stronger believers as compared to non-adopters in terms of the capability of technology to improve farming and/or to assist farmers in complying with Regulations. Nevertheless, adopters believe that technology supports the recognition of farmers' work by the public ($P < 0.010$). Adopters are keener to experiment on their farms, i.e. to try new technology or practices on the farm before they adopt it at full scale ($P < 0.05$). Furthermore, adopters are more likely to be the first in their social circle of friends and relatives to know about new technology ($P < 0.010$) – but not to buy. On the other hand, non-adopters are more likely to wait to buy new things, until they know others have positive experiences with it ($P = 0.005$) and prefer to have some experience with something before they buy it ($P = 0.005$) as compared to adopters. Finally, adopters and non-adopters do not differ as far as the taking of risks in their farming business and taking into account the opinion of their social environment vis-à-vis the adoption of new technology/ practices are concerned. Finally, adopters of carbon sequestration practices are more likely to be adopters of both RES and energy efficiency technologies/ practices too ($P = 0.000$ in both cases).

3. Expert's interviews

3.1 Challenges and the role of RES and energy-saving technologies/ practices

3.1.1 Challenges

Notwithstanding differences in the emphasis put onto the three pillars of sustainability, *advisors* from all countries agree that striking the balance between economy, society and the environment is the main challenge European agriculture faces nowadays. In this respect, advisors referred to (combinations of) quite a number of issues such as sustaining a productive (and/or resilient) agricultural sector, ensuring food security and quality, reducing production costs - including the reduction of energy costs (and/or dependence on fossil fuels), increasing farmers' income, improving farmers' working conditions, meeting environmental constraints and relevant legislation (Green Deal; Farm to Fork), mitigating climate change/ crisis – including clean energy, as well as improving farming's image in the urban populations/ public opinion, and increasing competitiveness in relation to non-EU countries. Of course, some advisors also referred to specific problems their own countries face such as the small and fragmented farms and the possibilities for greening as well as for digitization in Greece, the UN call for reduction of livestock farming and Brexit in Ireland, the transformation of large farms into 'industrial PV farms' in Spain, and the lack of farm labour in Denmark; the abandonment of rural areas, especially by youngsters, was also referred to by most advisors.

Researchers/Academics agree, more or less, with advisors and stress the 'difficult position' of agriculture vis-à-vis the satisfaction of diverse needs and conflicting interests (increase food production, preserve the environment, combat climate change, reduce energy costs and the consumption of fossil fuels, provide fair income to farmers, etc.). In this respect, a main challenge for the European agriculture concerns the CAP design and the need to restructure/ retarget subsidies so as to vigorously promote agricultural technologies and practices that support sustainable farming and climate change mitigation.

Farmers' representatives focus on the economic problems farmers face along with the abandonment of the rural areas while *industry representatives* see the introduction of new technologies (autonomous vehicles, robots, etc.) and clean energy production as major challenges. They further argue that it is difficult for farmers to specifically care for the environment (although they are proud when they use environmental-friendly technologies/ practices) when their main concern is their economic survival.

3.1.2 The role of RES and energy-saving technologies/practices

Advisors agree, in general, that RES and energy-saving technologies/ practices have a central role in overcoming the aforementioned challenges, since they can help in reducing the negative impact of agriculture on the climate change including reducing the CO₂ and other GHG emissions, energy consumption, etc. Advisors argue that such technologies/ practices can be beneficial both in economic terms as well as in terms of environmental sustainability; furthermore, they do not only help in achieving farmers' self-efficiency and reducing their dependence on non-renewable fossil fuels, but also in improving the public image of farmers as well.

According to the Irish advisors, such technologies can also contribute to efforts towards farm diversification, as well as in the generation of employment through the establishment of large biomass heat and power plants in rural areas (which, nevertheless, may have a negative CO₂ balance). Some advisors proposed that energy-saving/ efficiency should be prioritized. For them, the aim is firstly to reduce energy consumption (through the use of

relevant practices and technology), while attention to RES should follow; this way RES will not be utilized to cover the excessive ('irrational and wasteful') use of energy in agriculture, but they will be employed to reduce the costs of the (already reduced) energy used on farms. Further, advisors argue that the proven economically viable technologies should be adapted to the specific characteristics and needs of each farm. Again, national concerns are also highlighted as in the case of Greece. For the Greek advisors RES can play a major role in farm electrification (and thus, modernization) as in rural areas connection to the grid is very expensive. In such a case though, maximum possible subsidization is a prerequisite, since autonomous systems are very expensive and are not affordable by the majority of the small and medium sized farms (especially, extensive livestock systems). Finally, according to the Danish advisors, some energy saving technologies can reduce the need for manpower and thereby reduce the need for workers (which, as already mentioned, is a problem in their country).

According to *researchers/academics*, RES for self-consumption, when not competing for land that can be utilized for food production, can mainly help in overcoming farmers' dependency on fossil fuels. And if RES and energy-efficient technologies and practices will help farmers to save money, farmers are more likely not to abandon their lands, but instead to take care of their farms and consequently of the environment and the landscape. RES are seen as having a dual nature: 'chance and threat'¹³. Therefore the need for 'systemic measures' vis-à-vis their use to the benefit of rural areas; moreover, since agriculture is and will be an important RES provider as well as RES consumer, the CAP should also consider/integrate RES and energy saving.

Farmers' representatives argue that RES play a central role in facing major challenges by offering additional incomes, contributing to farm diversification, reducing farm operating costs (cheaper energy) and decentralizing energy supply. Finally, *industry representatives* agree that RES are largely beneficial insofar as they do not compete for land aiming at food production and underline the benefits of energy efficient vehicles.

3.2 Pressures upon farmers to adopt RES and energy-saving technologies/ practices

3.2.1 Environment

According to *advisors*, environmental degradation, including greenhouse gas emissions and climate change, incurs costs for both the EU and the Member-States. As the Italians put it, for a climate neutral agriculture energy efficiency is 'sine qua non' which, in turn, implies the utilization of RES and energy-saving technologies/ practices. In this respect, for example, the Irish advisors stressed the fact that livestock production is under increasing scrutiny regarding its impacts on the environment and its wider role in climate change. Furthermore, according to the German and Dutch advisors farmers are aware of environmental challenges and the fact that CO₂ emissions are a major contributor to global warming and wish to prevent their negative effects on farming. On the other hand, the Greek advisors said that farmers cannot immediately note/see some of the negative environmental effects of farming as well as that although they may be aware, in general, of environmental pollution they do not relate/ identify the solution of the problem with RES.

Researchers/academics underline the fact that the environment and climate change seriously affects farming, so farmers have to do something about it. However, according to a

¹³ The threat concerns the competition for land.

German researcher individual actions have limited impact (in all sectors) and relevant policies need to be in place.

Farmers' representatives argue that farmers take care of their environment as their livelihoods depend on it; nevertheless, *industry representatives* said that environmental pressures have a rather small influence onto farmers.

3.2.2 Policy

Advisors agree on the need to establish a legally binding framework with clear targets and commitments and make certain that the necessary structures and processes are put in place to ensure the achievement of national, EU and international climate goals and obligations both in the short and the long term. Advisors comment that the European Union has set ambitious targets with respect to energy produced from RES, but in the absence of rigorous relevant policy and mechanisms the EU countries may not achieve their renewable energy and decarbonization targets; on the other hand, EU countries that sufficiently and consistently incentivized the use of RES have been successful in achieving high adoption levels of RES in farming. In this respect, it is expected that the new EU strategies, "Green Deal" and "Farm to Fork", will foster the transition towards the decarbonization of the energy system. Additionally, advisors agree that for the adoption of RES and energy saving technologies and practices in agriculture, the relevant policy has to be reliable on the long-term basis (i.e. not to change often as this creates insecurity to farmers), provide sufficient financial incentives (so that the investment will prove profitable) and ensure the timely dissemination of reliable information. Finally, the Greeks call attention to the need for the synergy of policies as for example the policies concerning cross-compliance and GAEC (Good Agricultural and Environment Conditions), energy (including the pricing of electricity), investments on farms (for example, targeted subsidization of energy-efficient vehicles and buildings), digitization, etc.

As aforementioned, *researchers/academics* underline that with respect to the environment and climate change individual actions, despite being important, have limited overall impact; thus relevant policies need to be in place. Only strong policies that either support sustainable energy practices or penalize non-sustainable ones can ensure high impact and the fair treatment of farmers. However, inconsistent policies maintain non-sustainable practices in farming. Currently various measures of the CAP can be utilized for investments in RES and energy-efficiency (e.g. modernization of agricultural holdings, the installation of young farmers, employment generation opportunities in rural areas especially through social and cooperative economy schemes), but these could to be better targeted. Long-term policy reliability was also mentioned by the Polish as being important for farmers in order to adopt/ invest in RES. Finally, the need for consultation on policies is highlighted; in this respect it is argued that it is not fair for farmers and the agrofood industry in general to be obliged just to follow decisions taken by politicians - who often are not knowledgeable of the difficulties of such changes/ transitions.

For *farmers' representatives* policies are extremely important as can be seen in the case of Germany. *Industry representatives* also notice the need for stable, long-term policies as well as for more radical policies in the sense that policies should stop promoting/ subsidizing 'old' and more widely known technologies which rather keep farmers doing what they have always done in favor of newer/ innovative ones. According to the Danish, carbon credits will be a real game changer; if a farmer can be paid for CO₂ reductions and Carbon storage that would accelerate the implementation of RES and energy efficient technologies/ practices. Finally, the Polish note that often the policy works to the disadvantage of small (energy) producers.

3.2.3 Economy

Advisors argue that the economic advantage (reduction of energy costs) is the main driver for most farmers to adopt RES and this becomes important due to the fact that power from new RES is, in most places/ cases, now cheaper than power from new fossil fuels. According to the Irish, the fundamental driver of this is that with each doubling of the cumulative installed capacity of RES the price declines by the same fraction. For the Dutch, it is important that new renewable energy sources replace reliance on natural gas (which for many years is an important energy source in The Netherlands). On their part, the Greeks stress, on the one hand, the difficulties/ very high costs incurred in obtaining access to the grid (farm electrification) and, on the other hand, the increase of the price of electricity and fossil fuels for farming purposes in the country. The Danish further note that big food processing companies are pushing farmers towards RES and energy efficiency in order to satisfy consumers' demands for products with low environmental and carbon footprints. Farm diversification has also been mentioned as an important incentive for farmers to adopt RES.

Researchers/academics also stress that the implementation of RES and energy efficiency needs to be always economically viable and attractive for farmers; only a few pioneer farmers will invest on alternative energy if its profitability is not proven. Therefore, such changes have to be steered by policies. The role of the processing industry is underlined again on the part of the Danish.

According to *farmers' representatives* it is important that energy costs will be reduced through the use of RES and energy efficient technology (such as efficient vehicles). *Industry representatives* also maintain that since the primary sector works with very low margins, any savings thanks to RES or energy-saving technologies/ practices would decrease the costs related to energy and, thus, farmers could increase their profit margin.

3.2.4 Society

Advisors agree that there are, albeit in different degrees in each country, public pressures towards farmers for 'greener' (sustainable and environmental friendlier) production. This is especially true, for example, in the Dutch case. The Dutch advisors mention that 'greening' is very important for farmers who by using RES and energy-saving technologies show that they contribute towards a green and modern society and gain social acceptance/ recognition. In this respect, especially solar panels on farm (e.g. on barn) roofs and wind turbines are very visible, while PV panels on agricultural land and (large) wind turbines (due to their impact on the landscape) are quite controversial among both farmers and the society at large. The same controversies are also noted in Greece. According to the German advisors social pressure is more evident in the case of consumers demanding 'green' products which, in turn, they are willing to buy at higher prices. In the same vein, the Irish advisors mention that consumers increasingly demand food which is produced and processed in an environmentally friendly way with stricter sustainability criteria, including low emission options and, therefore, farmers deployed on-farm energy use. However, most of the interviewed advisors highlight that while a minority of farmers may be influenced by the social pressure in improving their sustainability, the vast majority look at the financial implications of making such a change and make their decision (to change or not) based firstly on financial payback – i.e. consideration of societal benefits and pressures follow. It is also interesting to note the Greek argument that RES and energy-efficiency technologies/ practices, and in general sustainable practices, are more likely to be found in agricultural areas neighbouring to touristic or second-home residential areas visited or inhabited by people with higher educational level and/or environmental concerns. Finally, the argument

of the Polish advisors that younger (farmer) generations, with better educational level, are keener to adopt the use of renewable energy on farms as compared to elder farmers is worth mentioning.

Researchers/academics argue that social pressures on the whole primary sector are increasing. This is especially so on the part of consumers; it is foreseen that labels referring to RES use may appear side by side with existing labels as, for example, organic farming. They also take notice of the potential of the younger and better educated farmers' generation.

The *farmers' representatives* argue that although farming is 'very individual' most farmers know that they are responsible for nature and this is in line with societal demands. *Industry representatives* agree with advisors that consumers nowadays are more environmentally aware. Marketing and branding can thus play a major role in promoting RES and energy efficiency. On the other hand, industry representatives argue that many farmers are not affected by social concerns/pressures as they are used to them; social pressures mainly affect politicians who, in turn, make up rules for farmers.

3.3 Advantages and disadvantages of RES and energy-saving technologies/practices

According to the interviewed *advisors*, RES and energy-saving technologies/ practices have many advantages which prevail over disadvantages. All advisors agree on the long-term economic advantages of such technologies/ practices for farmers (reduction of energy costs as well as sales to the electrical grid) as well as on the environmental (reduction of greenhouse gas emissions and of the exploitation of non-renewable resources) and social benefits (improvement of public image of farmers). With reference to PV systems, for example, the Greeks argue that they are a profitable on-farm investment, do not require higher level management skills by the farmer, are easy to install, do not require a lot of maintenance and the industry offers plenty of alternatives to the farmer. Many advisors add to the aforementioned commonly agreed advantages farm diversification and the potential for the generation of employment opportunities in rural areas. Furthermore, the use of such technologies/ practices may make farmers self-sufficient in terms of energy and, as the Irish point out, reduce the country's dependence on imported fuels. Finally, the prospects for labelling of produces (produced with alternative energy technologies/ practices), and thus for higher prices in the market, is mentioned by the Danish advisors.

On the other hand, advisors unanimously agree that high upfront/investment/installation costs comprise the most important RES disadvantage while, as the Dutch highlight, return on investment may take (depending on the technology used) a long time (10-15 years). Thus the need of financial support to farmers based on a business plan/ feasibility study which will reflect farm specifics and examine if the investment is justified; according to the Greeks, such a business plan is absolutely necessary and should be a pre-condition for RES investments, especially for self-consumption and net metering which depend on the amount of electricity consumed on the farm (usually, low consumption increases the possibility for the investment not to be profitable). To these the Irish and Polish advisors add the seasonal and intermittent nature of some technologies, i.e. the instability of energy production pertaining, for example, wind and solar systems. Societal negativity towards energy projects (re: noise, odors, etc. as well as negative effects on the landscape - aesthetics) creating, in turn, divisions within rural communities was also referred to as a problem. The technical capabilities or the saturation of the electrical grid along with the currently weak and very costly energy storage technology (batteries) were also underlined by most of the advisors. Other disadvantages referred to by advisors concern the policy frameworks which very often

do not match the true policy needs for RES establishment; the fact that land can be tied up for long periods in energy use with no option to revert to food production if there are better economic opportunities to produce food; and, that consumers usually do not pay additional price for agricultural produce, while farmer invested in technologies.

Researchers/academics agree with advisors on the advantages of such technologies/ practices as well as on the fact that high installation costs are their main disadvantage. They also stress the conflicts pertaining land use (e.g. installation of PV systems on arable lands) while the Spanish, in the case of the currently ineffective energy storage systems, also take notice of the fact that, on the one hand, they use the 'non-abundant' material lithium and, on the other hand, there is lack of infrastructure for their collection and recycling.

The farmers' representatives agree with the economic, environmental and social (farmers' reputation) benefits of RES and energy-saving technologies/ practices as mentioned by the advisors as well as that the high installation costs are their major disadvantage. They add that working with RES may be time consuming for the farmer as well as that such installations may require special safety rules which may further burden the farmer. On their part, industry representatives agree with farmers' representatives also noting the increased work load, extra safety regulations, etc. that may be required on the farm. Additionally, the Spanish note the heavy bureaucratic procedures which are a major barrier to the adoption of alternative energy technologies while the Danish argue for a common/ coordinated framework within the EU.

3.4 Adoption and non-adoption of RES and energy-saving technologies/ practices

Advisors unanimously agree that the strongest incentive for farmers to adopt/ use RES and energy-saving technologies/ practices relates to the economic benefits. In this respect, return on investment, i.e. savings on energy costs from the grid as well as supplying back to the grid (selling of energy to external customers), is of great importance. According to the Polish advisors farmers who have decided to install some type of RES are mainly those with high energy consumption on the farm, so it is usually livestock farmers who adopt such technologies. Many advisors also highlighted the importance of continued financial support to the farmers; as the Irish put it, farmers would only invest in renewable energy if it were grant aided. Therefore, the existence of incentives such as attractive (for the farmers) subsidies and/or (good) feed-in tariffs and other financial tools, such as low interest loans, long repayment time, etc. are considered crucial for adoption. A further incentive according to both the Polish and Greek advisors, concerns the possibility that farmers using alternative technologies would gain additional points when applying for access to various agricultural programs (policy pressure). Furthermore, advisors underscore the importance of the reduction of the environmental impact of farming as an incentive insofar as the financial benefit has been secured/ guaranteed. Greeks also mention the utilization of livestock waste whose management may be/ become a major problem for the farmer. The social demand for the greening of farming is particularly stressed by the Dutch advisors; along with the German advisors, they consider the issue of the public image of farmers (and thus public pressures) as an essential driver with regard to the adoption of alternative technologies. Advisors also referred to the diversification of farming as being an important incentive especially, as the Irish advisors argue, for the younger generation/ successors who may not have any interest in mainly livestock or crop based enterprises but see energy as a more attractive prospect. The Greeks also take notice of the need for extension/ advisory services to inform and motivate farmers, given the considerable lack of such services in the country.

Researchers/academics also unanimously agree that the most important motivation for RES and energy-saving technologies/ practices' adoption is the improvement of the farm economy (including subsidization and taxation). In this respect, the Polish and Spanish argue for the need for information campaigns, training and advisory support so that farmers will realize the full range of benefits of alternative technologies and get rid of misconceptions. In the Danish case, being a pioneer and reducing work load through the use of innovative machinery, such as new electric vehicles, also motivates farmers.

Farmers' representatives also argue that the reduction of energy costs or the earning of extra income are the main farmers' incentives. Political pressures are also important in Germany. *Industry representatives* also agree with the primacy of economic motivation among farmers. The Danish assert that higher prices of farm products also motivate farmers to use RES (and energy-saving practices) on their farms, especially farmers with high value produces for which consumers are already paying a premium price while the mass of producers is expected to follow as far as a Regulation will be imposed.

Regarding the characteristics of adopters of RES and energy-saving technologies/ practices, *advisors* point to their age (adopters are often younger); education (adopters are well-educated and usually follow continuous education/ training courses); decision-making and problem-solving skills or, in general, entrepreneurial skills, open-mindedness and innovative attitude; concern for the environment, interest in new technologies and/or sensitivity to public opinion; the existence of a successor; availability of capital and good economic prospects of their business; and participation in a strong collectivity/ cooperative. Adoption is also influenced by the farm size (bigger and non-fragmented farms are more keen adopters) and production system (crops and/or animals, intensive or extensive), thus its energy demands, the available infrastructure/ facilities as well as, depending on the technology used, their location.

Researchers/academics are in line with advisors with the Germans mentioning that, despite high investment risks, in their country the adoption of RES and energy-saving technologies is widespread with non-adopters being usually conservative farmers and those who do not want to change their current practices. In Spain, it is noted that young people, more conscious towards environmental issues, who usually own smaller farms and are actively seeking opportunities, can be RES adopters as well.

Farmers' representatives along with *industry representatives* also agree with the opinions of advisors and researchers/academics regarding adopters' characteristics and attitudes as well as their farms' characteristics. Additionally, according to the Spanish, farms with multiple crops that directly sell to the markets seem to be more flexible to use RES as compared to single-crop large industrialized farms.

The main constraint vis-à-vis the adoption of RES and energy-saving technologies, according to *advisors*, is the fact that farmers cannot afford them (high upfront costs, no access to credit, long term payback period of the investment); the lack of or difficulty to access/ utilize grants and subsidies further aggravates the situation. This is especially so for small and medium farms (for example, the majority of Greek farms) but it also depends on the farm's production system and on whether the owner is full- or part-time farmer (the latter may face capital and time availability constraints). As aforementioned the lack of credible information and/or of relevant farmers' (occupational/ agricultural) training and support (extension/ advisory services), misinformation and negative beliefs about such technologies may hamper their adoption and is underlined once more by the German and Greek advisors. The Irish advisors also repeat their argument that a serious disincentive is the negative social opinion as follows: "receiving support from the local community has proved the most challenging aspect of on-farm renewable energy generation; more work could be done in educating the wider public about that potential". The Dutch and the Greek advisors also

point to the incompatibility of the farm's location, infrastructure and machinery with such technologies as well as the capabilities and constraints and/or saturation of electrical grids. Advisors also mention the discouraging effects of, on the one hand, unreliable policies/ changes in policy goals/frameworks (highlighted by the Germans and the Greeks) and, on the other hand, cumbersome procedures (underlined by the Greeks and Irish). Further barriers referred to by the advisors concern the unwillingness of farmers to change their working habits/ routines; their distrust towards everything but their own experience (especially when results are not instantly visible); the fact that some are just not convinced or interested in new technologies; bad experiences or technophobia. The Greek advisors add that the bad experiences with collapsed cooperatives in the near past and the current lack of strong ones which might take the driver seat are also hindering adoption.

From a *research/ academic* point of view the constraints farmers face are more or less the ones referred to by the advisors: economic/financial pertaining such investments; lack of premium prices for energy-efficiently produced food in the markets; regulatory/ legislative and administrative/ bureaucratic barriers; informational/ knowledge gaps; small farm size along with production system and energy needs (for example the Spanish claim that fruit production is a seasonal and not energy demanding business, and thus, there is no need to use RES).

Farmers' representatives are in line with advisors, with the Germans suggesting that adoption is mainly correlated to farmers' personal attitudes and openness towards new technologies while for the Greeks difficulty to connect with the (saturated) grid and unreliable policy precede other reasons related to non-adoption. *Industry representatives* argue that, beyond the economic/ financial constraints, main barriers resulting in non-adoption are technical barriers in rural areas (Polish), limited offer of suitable technologies by the industry and bureaucratic burden (Spanish) and farmers' expectations for higher grants/ subsidies in the future (Danish).

3.5 The development of technologies

According to most of the *advisors*, farmers are in general not really involved in technology development; instead they are consumers of products that the industry offers to them. However, the Danish advisors maintain that farmers' needs are taken into account in the design of innovations for green energy; this is the case of innovative and passionate for new technologies farmers who join green energy projects and thus contribute to technologies being more relevant to farmers' situation. In parallel, some of the German advisors claim that many technologies are adjusted to farmers' needs. Additionally, according to the Dutch advisors, farmers can customize energy systems to their needs by themselves and/or with the technical support of the industry while also providing feedback to technology producers. The Polish advisers assert that although farmers are invited to trainings and study tours, their needs are not fully taken into account in shaping the energy technologies and/or policies; thus, the potential of farms to utilize renewable energy technologies remains untapped. In the same vein, the Irish advisors highlight the importance of involving farmers and local communities in bioenergy development through pilot projects that encourage collaboration in suitable technology testing; when proved successful, these may provide positive templates that could be subsequently taken up in other locations. On their part, the Greek advisers argue that the industry that develops/ provides technologies is having in mind specific farm types/ target groups; it follows that such technologies may well not fit the interested-to-adopt farmers' circumstances.

Researchers/ academics claim that farmers do not actually participate in technology development and that their needs are communicated through their representatives mainly

to decision-makers (policy). In this respect, it is important to refer to a Spanish researcher's opinion that "the most effective way to include farmers in the development of innovations is the EIP-AGRI Operational Groups". On the other hand, a German researcher argued that this (i.e. farmers' participation in technology development) is not an issue, since it is only innovations that are useful to farmers that become widely adopted.

According to *farmers' representatives*, although it is in the industry's interest to include the user/ farmer in technology development, this is often not the case. The Polish and Spanish *industry representatives* agree that farmers are not involved in technology development. On the contrary, the Danish representative claims that farmers are involved in technology development and that their needs and demands are taken into account as well as that the industry employs technicians with farming or agronomic background.

With reference to existing technologies, according to the interviewed *advisors*, despite the availability of RES and energy-saving technologies in the market, these need to be further developed. The Polish advisors, for example, point to the need for more research on energy storage, i.e. for cheap and high capacity batteries, along with the development of hybrid energy systems utilizing diversified energy sources and overcoming grid failures. According to the Irish advisors there is both the scope and need for continual improvements across a range of RES and as these improvements happen in terms of technologies such as solar, wind and heat pumps, information on potential gains must be accessible for both advisors and farmers; therefore all advisors agree that ongoing awareness raising and knowledge transfer through extension and training are necessary. As expected, advisors also agreed on the need to reduce upfront costs.

Researchers/ academics assert that although, currently, there are many technologies that meet the needs of farmers, there is a need for further developments especially, as the Polish argue, towards technologies that can be utilized in smaller farms (although these may prove to be quite expensive for the farmer). The Spanish point towards the need for batteries that would be more sustainable and last longer; according to the Danish such batteries, when implemented in large scale, will revolutionize the electrification of agriculture. On the contrary, framework conditions and non-technical issues were primarily stressed by the Germans.

The German *farmers' representative* claims that the development of small scale on-farm energy systems is a necessity along with the reduction of taxation of energy produced by RES. The Greek highlighted the high upfront costs and low capacity of energy storage devices (batteries). Among the *industry representatives*, the Spanish stressed the user-friendliness of equipment and the possibility that the services/ companies supporting farmers will cater for farm needs concerning both agricultural machinery and energy systems.

As far as farmers' knowledge and skills are concerned, the German *advisors* claim that, in their country, most farmers have good knowledge about RES and energy saving technologies (and if for some technologies detailed knowledge is necessary farmers are able to adapt). On the other hand, the Dutch and Polish claim that farmers do not need to have detailed knowledge since relevant service providers can fill in for the farmers' knowledge gap; the Danish similarly argue that in case of knowledge and/or skills deficiencies it is usual that the companies/ technology providers train their farmers/ clients. According to the Irish advisors in the near future the way farmers monitor and manage their energy use will change towards a type of 'precision farming' (more monitoring and greater awareness of energy use); in this sense, farmers will have to have a better understanding of where their energy is being used and related costs - with advisors having a role in enhancing farmers' relevant skills and knowledge. On the other hand, the Greek advisors assert that the great majority of the Greek farmers are not familiar with such or related/ similar technologies (e.g. precision

farming); the lack of agricultural extension and education services in the country is crucial in this respect.

Researchers/academics agree that there are certain knowledge and skills required for RES and energy-saving technologies' adoption/ proper use. Thus farmers should be educated/ trained in understanding and handling such technologies; furthermore, it is suggested that such training should be integrated in the curricula of agricultural/ professional education programs. As the Danish said, today the average farmer is not able to choose the appropriate technology and implement it on his/her farm which, in turn, requires a lot of support from the provider of technologies.

Farmers' representatives agree for the need to educate/ train farmers while *industry representatives* also argue that the lack of technical skills on the part of the farmers is, in general, a barrier for implementing RES and energy saving technologies – despite the fact that relevant needs can be satisfied by the technology providers.

3.6 The role of research and advice

According to the *advisors*, the role of both research and advisory services is of major importance ('fundamental' as the Italians express it). According to the 'conventional approach' the role of research is to develop new technologies while advisory services disseminate these technologies to farmers (information campaigns for the provision of reliable information, demonstrations, training courses and trips, etc.), help farmers to choose the best technology and/or adapt such technologies to fit their circumstances. Furthermore, according to the Dutch advisors, researchers in The Netherlands are also involved in projects with farmers, which is important in exposing new technologies to farmers. According to the Polish advisors, despite the current advances in technology, there is still plenty of room for scientific research to develop new, innovative solutions. The Irish advisors underscore, on the one hand, the potential of peer to peer learning via farmers' discussion groups (facilitated by advisors) and, on the other hand, that greater emphasis should be given to the potential of EIP-AGRI Operational Groups (aligning farmers, researchers, advisors and the industry/ technology developers/providers) to support renewable energy deployment; overall, knowledge transfer is envisaged to have an important role in promoting RES and energy-saving practices. On their part, the Greek advisors underline the extremely weak connections between research and farmers owed, among others, to the lack of robust extension services in the country.

Researchers/academics also agree that both research and extension/advisory services are important for RES and energy-saving practices development and promotion, but they claim that for farmers advisory services are more important. According to the Polish, farmers are a specific target-group in the sense that if, in the past, they had negative experiences with an issue/ topic, it is difficult to convince them on a later stage. Thus extension/ advisory services are needed to provide reliable information, transfer knowledge and dispel false information/ conceptions, so as to convince farmers with both reliable data and showcasing of good practices. Furthermore, Polish and Danish scientists agree that advisors should be able to show which technologies are best for each farmer under the specific conditions prevailing at his/her farm. It is interesting to note that according to Spanish and Danish researchers, research can play the role of the 'intermediary' between farmers and the industry/ technology developers; through experimental farms research can show how a technology can be best implemented on (large numbers of) farms and provide feedback to farmers and tech providers.

Farmers' representatives also agree for the crucial role played by research and extension/ advisory services and underline the need to be accessible for farmers, close to practice, and

offer tailor-made options for each farm. *Industry representatives* also agree, but they also notice that there are still a few 'conservatives' especially among advisors.

3.6.1 The Agricultural Knowledge and Innovation System (AKIS)

Advisors do not agree on the functioning of AKIS, i.e. the cooperation between actors (stakeholders) such as policy, research, extension, farmers, industry, etc., with respect to RES and energy-efficient technologies/ practices. For example, the German advisors are divided into those who claim that there is cooperation among stakeholders and those who assert that such cooperation does not take place, but mostly on bilateral level which is not sufficient in reaching the expected impact. The Dutch advisors said that the government, given their favourable stance towards RES and 'greening' in general, invite farmers to contribute in policy design concerning RES and energy-saving topics; however, no other cooperation among stakeholders was mentioned. In Poland the only visible cooperation, as mentioned by the Polish advisors, is that between entrepreneurs and research. On the contrary, the Irish advisors stress the continuously increasing cooperation between the multiple stakeholders of the 'AKIS family' (farmers, advisors, researchers, education and training providers, input suppliers, retailers, media services, ministries); for example farmers, industry specialists, advisors and researchers cooperate in coming up with unique solutions to meet on the ground challenges. Cooperation is expected to increase significantly more in the trajectory towards zero carbon emissions in energy and food systems; in this respect, the Irish underline that innovations necessary for change are not just technical, they are also social. The Danish also claim that there is strong cooperation between AKIS actors in their country while in Italy and Greece no examples of cooperation are known by advisors.

Researchers/ academics also differ in their views concerning AKIS. The Germans underscore the power and role of large industrial players' lobbying in all aspects of technology development and policy formulation. The Polish researcher declares that there is no cooperation and especially farmers are either neglected by other actors (science and policy) or very cautious towards such cooperation. In Spain there seems to be some cooperation between actors, especially in the framework of EIP-AGRI Operational Groups. In Denmark there is good cooperation between stakeholders which, nevertheless, can and should be improved.

Farmers' representatives have different views as in Bavaria (Germany) farmers' association is a strong lobbyist towards the other AKIS actors while in Greece cooperation is temporary/opportunistic. *Industry representatives* also hold different views as in Poland that there is no cooperation between AKIS actors, with farmers being particularly neglected, while in Denmark there is cooperation which needs to be improved so as to overcome conservative attitudes and choosing convenience over innovation.

3.7 The role of policy

According to the Polish *advisors*, policies or regulations and relevant subsidies play a crucial role in the dissemination of RES; these need to be attractive, reliable and implemented (without changes) for a long period. The Dutch advisors' point of view is that subsidies are essential for farmers in order to adopt (especially the more expensive) RES technology; for them, such subsidies should aim at closing the gap between the costs incurred for the production of energy with RES and possible returns. The Irish argue that subsidies should intend to address market failures; furthermore they underscore that subsidies should aim not only to the direct increase of clean energy generation but also to support further innovations that will improve its efficiency and viability as well; the latter is very important in terms of reducing greenhouse gas emissions and restricting global temperature rise. For the Italian advisors, support should not be only financial but also in terms of the provision of

services (pilot/ demonstration projects, advisory and training services) to farmers in order to promote and enhance energy saving practices. In the same vein, the Greeks further note that besides direct subsidies to cover, for example, high upfront costs, other policies (e.g. favourable taxation, cheap/ low interest credit and long-term repayment period, guarantees/ insurance in case of damages, co-financing of the costs of feasibility studies, etc.) along with the loosening of the (heavy) bureaucratic procedures should be in place to assist adoption. This, in turn, points to the overall need for coordinated policies to promote RES and energy-efficient technologies and practices.

Most of the *researchers/academics* claim that policies/ regulations and especially suitable subsidies are of utmost importance in enabling farmers to introduce RES on their farms. According to a German researcher, subsidization is justified as RES contribute to the mitigation of climate change while, at the same time, externalities are not included in prices of fossil fuels and the energy produced from them. On the other hand, it is noted that subsidies should be either better targeted towards innovations (Denmark) or, even, abolished due to farmers' obsession with/ addiction to them (Spain). Furthermore, a Spanish researcher stresses the need for an agency/ service that will collect existing knowledge and know-how and provide reliable information to farmers.

According to *farmers' representatives*, financial incentives are extremely important for helping farmers in making investments in RES and energy-efficient technologies. For Germans, policies have set very demanding goals, so they also have to provide for measures/ actions offering support to farmers to reach such goals and make new technologies known and available to farmers. On his part, the Greek underlined the need to take care of small and medium size farmers (constituting the great majority of farmers in the country) in terms of prioritization to grid connection since, so far, it is big investors and energy communities the ones who benefit. The *industry representatives* agree that subsidies are good instrument to promote RES and energy-saving technologies/ practices insofar as the effectiveness of these technologies/ practices is secured/ proved. Finally, the Polish would like to see lower subsidies being available to more farmers and on a longer term basis.

4. Summary

In the first place, it has to be noted that the sample comprises farmers with all kinds of production systems (crop production, animal production and mixed production) who are either adopters or non-adopters of a range of RES and/or energy-saving technologies/practices (see: Deliverable 1.2 and survey questionnaire). The sample farmers are mainly men (87%); between 40 and 59 years old (61%); with good educational level (secondary 19% and technical 52%); one out of four holds a Green Certificate; three out of four use the Internet on a daily basis while more than half claimed very good/ excellent digital skills; are full-time farmers (82%); satisfied/very satisfied from farming (89%); half of them have identified a successor; with small and medium size farms (23% and 41%, respectively); with farms mainly located in plain areas; owners of family farms (73%); three out of four earn more than half of their income from agriculture (which for half of the total sample is more than 90%). Additionally, one out of three is engaged in on-farm non-agricultural activities (diversification); more than half of the sample participates in a certification scheme; receive direct payments (85%) and participate in Pillar II schemes (53%); specific to Renewable Energy or energy-saving measures subsidies received 26.6% of the interviewees. The majority of the interviewed farmers (78%) said that they visit agricultural fairs, field days/ demonstrations, or exhibitions at least once a year.

In general, the sample farmers are *aware about RES*; less than 7% of the interviewees have not heard about RES. The most well-known ones are solar (94%) and biomass (89%) followed by wind turbines (84%) and heat pumps (78%). Farmers' main source of information (awareness) about RES are (>15% of farmers) the Internet, the technical press and national or regional agricultural (public, cooperative) extension/advisory services.

Out of those aware of RES 45% claimed that they *use RES* on their farms. Solar energy is by far the most used RES on the farms (76% of RES adopters/users), followed by biomass/biofuels/biogas (36%). Around two thirds of RES adopters said they had seen (demonstration/ other farmer) or tested the technology before getting/purchasing it. Adopters' most important source of information/ support on the *assessment* of RES are (>15% of farmers) their own experience followed by manufacturers/dealers and private advisors. The same is true concerning their most important source of information/ support on the *establishment and use* of RES. The most common use of the energy produced with RES concerns the heating and cooling of buildings (72%) and lighting (66%) with the use of energy for farm machinery and vehicles and farming practices being quite lower (31% and 24% respectively). The majority of adopters also sell energy to external consumers (62%).

More than half of the adopters said that they were motivated to use RES primarily for economic reasons (reduction of energy costs and price of energy sold to others/ outside the farm); reduction of environmental hazards follows. Furthermore, more than two out of three adopters said that a specific subsidy gave them the opportunity to invest in RES on their farms. In general, adopters state that RES are easy to work with (82%), reliable (81%) and economically justified (79%). For RES maintenance and, when necessary, repairs farmers mainly rely on the manufacturer/ retailers (79%), their own experience (58%) and independent service providers (49%).

Non-adopters assert that the main reason for not having/ using RES on their farms mainly owes to the fact that they cannot afford it (40%) followed by their consideration that the available technology is either not the best fitting technology for them or is not compatible with existing technology/ machinery/ equipment in their farm (19%). Furthermore, they claim that they would use RES if they would get a subsidy (90%) as well as relevant training (66%). They also said that the most important source of information they would trust before deciding to adopt/ use RES technology are (>10% of farmers) a cost-benefit model tailored to their farm, official contacts (with an advisor, official or someone paid for their service)

and personal trial. Most non-adopters have seen other farms using RES as well as that this experience raised their interest in alternative energy production.

Interviewees were further asked if they are *aware of a range of energy-saving technologies and practices*. Overall, 84% of the sample farmers have heard about at least one of them. Farmers' most important *source of knowledge/ awareness* on the topic are (>15% of farmers) the Internet, national or regional agricultural (public, cooperative) extension/advisory services and their own experience.

Out of those aware, 60% claimed that they *use energy-saving technologies/ practices* on their farms. The majority of adopters (59%) had seen (demonstration/ other farmer) or tested the technology or practice before getting/purchasing it. The most important farmers' source of information/ support on the *assessment* of these technologies/ practices are (>10% of farmers) farmers' own experience, national or regional agricultural (public, cooperative) extension services, other farmers/ peers and manufacturers/dealers. When it comes to the *establishment and use* of energy efficient technologies/ practices farmers are based (>10% of farmers) on their own experience, manufacturers/dealers and national or regional agricultural (public, cooperative) extension services.

Economic reasons, i.e. the reduction of energy costs, was referred to as the main motivation of energy saving technologies/ practices' adopters (45%) followed by the reduction of environmental impact (23%) of the adopters. Only 1 out of 3 adopters said that a specific subsidy gave them the opportunity to invest in such technologies/ practices on their farm. In general, adopters state that energy efficient technologies/ practices are reliable (85%), easy to work with (82%) and economically justified (81%).

On their part, non-adopters stated that the main reason for not having/ using energy saving technologies/ practices on their farms mainly owes to the fact that they cannot afford it (27%), followed by their perception that the best, tailored to their situation/ production system, technology is not available yet (22%) and the small farm size (13%). Around two thirds of non-adopters have seen Non-adopters claim that they would use energy efficient technologies/ practices if they would get a subsidy (96%) as well as relevant training (71%). According to non-adopters the most important source of information they would trust before deciding to adopt/ use energy efficient technologies/ practices are (>10% of farmers) a cost-benefit model tailored to their farm, demonstrations and official contacts (with an advisor, official or someone paid for their service). Two thirds of non-adopters who have seen other farmers using energy efficient technologies/ practices claimed that this raised their interest in the respective technology/ practice.

Finally, the survey briefly dealt with issues concerning *carbon sequestration*. The majority of farmers (>88%) have heard about relevant practices: manuring and fertilizing practices, cover crops and crop rotations, conservation tillage and crops residue management (>88% each). The most important farmers' source of *information/ awareness* concerning carbon sequestration practices are (>10% of farmers) farmers' own experience, national or regional agricultural (public, cooperative) extension services, technical press and the Internet.

More than 3 out of 4 of the interviewees (ca. 77%) said they *utilize such practices* in their farms with their main motivation being (>19% of farmers) the reduction of the environmental impact of farming, the reduction of energy costs, "being a good steward of the countryside" and the utilization of farm by-products. The great majority of the adopters (87%) maintained that they did not utilize any specific external subsidy in order to invest in/ apply such practices.

On their part, non-adopters claim that the main reasons for not adopting carbon sequestration practices are the lack of appropriate/ best fitting technologies/ practices is the main reason (45%), small farm size and non-affordability (11%). Over 80% of them agreed

that a subsidy and technical assistance would motivate them to apply carbon sequestration practices in their farms.

According to the interviewed farmers, the most important RES and energy-efficiency technologies/ practices' characteristics that would make them more relevant to farmers' needs are (>80% of farmers) long term reliability, price/ affordability, ease of use, operator safety and compatibility with existing farm machinery.

Technology, according to the interviewees, can contribute to the improvement of farming (94%), assist farmers in complying with the EU Regulations (87%) and support the recognition of their work by the wider public (75%). In parallel, the majority of the interviewed farmers (70%) claim that they experiment on their farms, i.e. trying new technology or practices on the farm before they adopt it at full scale. Almost two thirds of the farmers said that they prefer to have some experience with something before they buy it; more than half claimed that they wait to buy new things, until they know that others have positive experiences with it. Thus, the majority of them are neither the first to know about new technology in their social circles nor the first to buy it; most said they don't like taking risks with their farming business (41%). Nevertheless, just over 50% would buy new equipment even if their (social) environment would be negative on it.

Adopters and non-adopters of RES differ, among others, in terms of level of general and occupational education, digital skills and the frequency of Internet use, farm size, the existence of a successor, years in farming and interviewees' participation in collectivities (farmer cooperatives, association, unions, etc.). Furthermore, adopters are more likely to be full-time farmers, to have chosen agriculture as their profession (vs. family tradition), dependent in terms of the contribution of agriculture into the family income, to be more satisfied from farming as well as to be engaged in diversified on-farm activities, certification schemes and participate in CAP Pillar II projects. Additionally, adopters visit agricultural fairs, field days/demonstrations, or exhibitions more often than non-adopters. In parallel, adopters and non-adopters seem to consider different sources of awareness as being the most important to them.

Adopters put less emphasis than non-adopters in their evaluation of the importance of the characteristics of RES that would make them more relevant to farmers' needs. Although adopters are not stronger believers in technology, they are keener to experiment on their farms. Moreover, they are more likely to be the first in their social circle both to know about and buy new machinery/ technology and they would buy something new despite the negative attitude of their social environment and are not afraid of taking risks in farming.

The same differences hold, more or less, also in the case of *adopters vs. non-adopters of energy efficiency technologies/ practices*. In this case, though, adopters seem to be stronger believers in technology (but not in its contribution to the recognition of farmers' work by the public).

Most of these differences are found in the case of *adopters vs. non-adopters of carbon sequestration practices* as well. In this case though, for example, adopters are younger, believe that technology supports the recognition of farmers' work by the public and while they are more likely to be the first in their social circle to know about new technology/ practices they are not the first to buy. Adopters and non-adopters do not differ in terms of farm size, occupational status (full-time vs. part-time farmers), the identification (or not) of a successor, the frequency of visits to agricultural fairs, field days/demonstrations or exhibitions, the sources of awareness as being the most important to them or their attitudes towards risk aversion.

Finally, it has to be underlined that the adoption of RES, energy efficiency technologies/ practices and carbon sequestration practices are correlated.

On their part, the interviewed experts (mainly advisors) argue in favour of RES and energy-saving technologies/ practices in facing the current problems of farming and the society at large. Experts agree that such technologies/ practices are beneficial to farmers in terms of both economic viability and environmental sustainability as well in improving the public image of farmers; they also assist in farm diversification and the generation of employment in rural areas. For the adoption of RES and energy saving technologies and practices in agriculture the relevant mix of policies has to be reliable in the long-term (i.e. not to change often as this creates insecurity to farmers), provide sufficient financial incentives (so that the investment will prove profitable) and take care of the dissemination of reliable information (including extension/ advisory and educational/ training services for farmers); avoidance of cumbersome procedures is also strongly recommended. It is noted that, while relevant policies must either support sustainable energy practices or penalize non-sustainable ones, currently not fully suitable policies still maintain some non-sustainable practices in farming. Overall, experts argue that while environmental and societal pressures may be important, it is the economic advantage (reduction of energy costs or energy sales to external consumers) which is the main driver for most farmers to adopt RES and energy saving technologies/ practices. On the other hand, experts agree that high upfront/investment/installation costs comprise the most important RES disadvantage along with the fact that return on investment may take (depending on the technology used) a long time. This is the main reason that makes experts agree (among themselves as well as with farmers) on the need to financially support farmers, especially the small and medium ones.

Experts identified, more or less, the same differences between adopters and non-adopters identified in the preceding (survey) analysis. Furthermore, they assert that despite the availability of RES and energy-saving technologies in the market, these need to be further developed. On the other hand, while the role of both research and advisory services is highlighted as of major importance in the field, in most cases farmers are not involved being just consumers of products that the industry offers to them. Moreover, it is acknowledged that in most of the countries represented here by the interviewed experts farmers are largely neglected within the national AKIS with the exception of some cases in which farmers' representatives lobbying politicians/ decision-makers for relevant legislation. Such a lack of functional AKIS/ innovation platform(s) in the field of RES and energy efficient technologies/ practices has to be underlined.

5. Appendices

- A. Farmers' questionnaire
- B. Experts' interview guide

A. Farmer's questionnaire

ONLINE VERSION: <https://forms.gle/PQup6CPv9QsSbgYC6>

Country:

Questionnaire Code:

Questionnaire

Intro:

Name _____

Telephone number _____

Email _____

Farm

1. Region:

2. How would you describe the places where your fields are located?

1. Flat (% of fields)
2. Hilly (% of fields)
3. Mountainous (% of fields)

3. **A. Production system**

1. Plant production
2. Animal production
3. Mixed

B. Please specify number of hectares/animal heads and other activities (if any) according to production system selected (multiple selection possible)

1. Arable (i.e. cereals, open field vegetables, root crops, etc) _____ ha.
2. Permanent crops (i.e. vineyards, orchards, etc) _____ ha.
3. Other land (i.e. permanent grassland, etc) _____ ha.
4. Greenhouse _____ ha.
5. Dairy cows: _____ number of heads
6. Beef - meat production: _____ number of heads
7. Sheep: _____ number of heads
8. Goats: _____ number of heads
9. Breeding sows: _____ number of heads

10. Laying hens: _____ number of heads
11. Broilers (Poultry): _____ number of heads
12. Farm-based added-value/diversification activities, i.e. packaging and/or other processing unit, agrotourism (hostel, rooms, restaurant), etc.
 1. Yes (Please specify: _____)
 0. No

☐ Other useful info? _____

4. How do you characterize the farm as compared to the country average?

(Interviewer's estimation)

1. Very small
2. Small
3. Medium
4. Big
5. Very big

5. Legal status of farm:

1. Family farm
2. Company
3. Cooperative farm
4. Other _____

(Only if "family farm" was chosen in Question above answer Q6; if not, go to Q7)

6. The agricultural/farming income's contribution to the household income is estimated at about: _____%

7. Total area cultivated (ha): _____

8. Of which:

1. Land owned (ha): _____
2. Land rented in (ha): _____
3. Land rented out (ha): _____
4. Other: _____

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

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

10. Does the farm receive direct payments? (Pillar 1 of the CAP)

- ☐ 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 (Please specify: _____)
- ☐ No

12. Does the farm receive any subsidies related to RES and/or energy-saving measures?

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

Renewable Energy Sources (RES)

13. For which of the following on-farm energy production technologies have you heard about?

1. Solar (PV, PVT, thermal)
2. Wind turbines
3. Biomass/biofuels/biogas
4. Heat pumps (Geothermal or aerothermal or hydrothermal)
5. Hydro
6. Any energy storage system
7. Other (please specify)

If S/HE HAS HEARD [if NONE -> Q36]

14. Which are the three most important sources of information, from which you **heard about** such on-farm energy production technologies?

14.1 Most important: _____

14.2 Second most important: _____

14.3 Third most important: _____

MEMO (possible answers to Q14)

1	On my own experience
2	National or regional agricultural (public, cooperative) extension/advisory services
3	Private advisor
4	Technology manufacturers/ dealers
5	Technical press
6	Internet
7	Farmers' (discussion) group
8	Other farmers/peers (not including farmers' group)
9	Other (please specify)

15. Do you **use any of these technologies on your farm?**

Yes

No

If YES [if NO -> Q 31]

Adopters (Users)

16. If YES, which one(s)? (numbers)

16.1 _____

16.2 _____

16.3 _____

17. Did you see (demonstration/ other farmer) or test the technology before getting/purchasing it?

- ☐ Yes
- ☐ No

18. Which were the most important sources of information/support for its **assessment** (evaluation which led to adoption/use) [incl. your own experience]?

18.1 Most important: _____

18.2 Second most important: _____

18.3 Third most important: _____

19. Which were the most important sources of information/support for its **establishment and use** [incl. your own experience]? Same as above (Q18)

19.1 Most important: _____

19.2 Second most important: _____

19.3 Third most important: _____

MEMO (possible answers to Q18 & 19):

1	On my own experience
2	National or regional agricultural (public, cooperative) extension services
3	Private advisors
4	Technology manufacturers/ dealers
5	Technical press
6	Internet
7	Farmers' (discussion) group
8	Other farmers/peers (not including farmers' group)
9	Other (please specify)

20. How/where do you use the energy produced on your farm?

1. Heating and cooling of buildings
2. Lighting
3. Farming field practices
4. Agricultural machinery and vehicles
5. Sales to external consumers

6. Other

21. Did the introduction of energy producing technology change the way you practice farming?

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

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

(1=Strongly Disagree, 2=Disagree, 3=neutral 4=Agree, 5=Strongly Agree)

22.	It is easy to work with this technology.	1	2	3	4	5
23.	It is easy to get technical support for the equipment.	1	2	3	4	5
24.	This technology is economically justified / the cost-benefit of this technology is as you expected.	1	2	3	4	5
25.	Sharing costs with other farmers has allowed you to use this technology.	1	2	3	4	5
26.	This technology is reliable.	1	2	3	4	5
27.	The equipment requires a lot of maintenance.	1	2	3	4	5

28. Who repairs and maintains the equipment? *(Tick all that apply)*

- 28.1 You (farmer being interviewed) [Yes=1, No=2]
- 28.2 Supplier/retailer/maker of equipment [Yes=1, No=2]
- 28.3 Independent company [Yes=1, No=2]
- 28.4 Public service [Yes=1, No=2]
- 28.5 Other farmer [Yes=1, No=2]
- 28.6 Other _____

29. Which are the three most important reasons **that motivated you** to use this technology?

- 29.1 Most important _____
- 29.2 Second most important _____
- 29.3 Third most important _____

MEMO (possible answers to Q29):

1	Being an innovator	
2	Save money through the reduction of energy costs	
3	Compliance with regulations	
4	Reduce environmental impact	
5	Utilize farm by-products	
6	Positive impact on human health	
7	Being a good steward of the countryside	
8	Being a good neighbor	
9	Financial incentive: Subsidy and/or tax exemption	
10	Financial incentive: price (I sell energy to others)	

11	Farm diversification	
12	Other (please specify):	

30. Did a specific external subsidy for RES give you the opportunity to invest in the selected technology?

1. Yes (which _____)
2. No

Non-Adopters (Non-Users)

31. Which of the following **information/tests would you trust** before deciding to establish (buy/use) such a technology?

31.1 Most important _____

31.2 Second most important _____

31.3 Third most important _____

MEMO (possible answers to Q31):

1	Demonstration
2	Cost benefit model to reflect farm specifics
3	Video
4	Conversations with unofficial contact (neighbour, 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):

32. What would be the main reasons/incentives/motivation to apply such a practice? Multiple answers possible.

32.1 subsidy or other financial incentive [Yes=1, No=2]

32.2 sharing costs with others [Yes=1, No=2]

32.3 getting training/support on how to use it [Yes=1, No=2]

32.4 Other (please specify) _____ [Yes=1, No=2]

33. What are your **(three)** most important reasons for **NOT** adopting such a technology? **(1= most important; 5= least important)**

33.1 Most important _____

33.2 Second most important _____

33.3 Third most important _____

MEMO (possible answers to Q33):

1	Land is too small
2	Not the best fitting technology available yet (tailored to my situation/ cultivation system)
3	Not interested
4	Not affordable (due to high upfront costs)
5	Do not see future profit benefit
6	I am too old (to change)
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/practice is not compatible with existing technology/ machinery/ equipment in my farm
10	The guarantee of long term efficiency of the technologies/practices is limited
11	Limited guarantee of (technical) assistance when asked/needed
12	Very complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.)
13	Do not have time to search, consider, apply for, and implement such technology/ practice
14	Other (please specify):

34. Have you watched other farmers using any such technology on his/her farm?

[Yes= number No=0]

- 34.1 Yes (Which _____ **continue with QUESTION35**)
 34.2 Yes (Which _____ **continue with QUESTION35**)
 34.3 Yes (Which _____ **continue with QUESTION35**)
 No **(continue with QUESTION 36)**

35. (Only if “yes” was chosen in QUESTION 34): Did this raise your interest in any such technology? [Yes= number No=0]

- 35.1 Yes (which one: _____)
 35.2 Yes (which one: _____)
 35.3 Yes (which one: _____)

Energy saving Practices/Technologies

36. Have you **heard about energy saving practices/technologies** on your farm, such as:

Practices on Open-field farms relevant with:

- 36.1 Efficient vehicles (biofuels or electricity fuelled, maintenance (e.g. tyre pressure), logistics/planning)
 36.2 Efficient tools (pumps or drip systems for irrigation, conveyors, refrigerators, mills/grinders, dryers)
 36.3 Precision agriculture (seed/fertilizer/pesticide/lime/manure/water reduction)

- 36.4 Conservation agriculture (crop rotation, intercropping, soil coverage, no/minimum tillage)
 36.5 Other

Practices on Greenhouses relevant with:

- 36.6 Efficient buildings (windows, BMS (building management system), lighting)
 36.8 Efficient vehicles (biofuels or electricity fuelled, maintenance (e.g. tyre pressure), logistics/planning)
 36.9 Efficient tools (pumps or drip systems for irrigation, conveyors, refrigerators)
 36.10 Precision indoor agriculture (seed/fertilizer/pesticide/lime/manure/water reduction)
 36.11 Other

Practices on Livestock facilities relevant with:

- 36.12 Efficient buildings (windows, BMS (building management system), lighting)
 36.13 Efficient vehicles (biofuels or electricity fuelled, maintenance (e.g. tyre pressure), logistics/planning)
 36.14 Efficient tools (milking machines, feeding equipment, conveyors, refrigerators, mills/grinders, dryers)
 36.15 Precision Livestock (feed/medicine/manure reduction, animal healthcare)
 36.16 Other

If YES [if NO -> Q57]

37. Which are the three most important sources of information, from which you **heard about** such energy saving practices?

- 37.1 Most important: _____
 37.2 Second most important: _____
 37.3 Third most important: _____

MEMO (possible answers to Q37)

1	On my own experience
2	National or regional agricultural (public, cooperative) extension/ advisory services
3	Private advisor
4	Technology manufacturers/ dealers
5	Technical press
6	Internet
7	Farmers' (discussion) group
8	Other farmers/peers (not including farmers' group)
9	Other (please specify)

38. Do you **use any of these practices on your farm?**

Yes
 No

If YES (if NO -> Q52)

Adopters (Users)

39. If YES, which one(s)? (numbers)

39.1 _____

39.2 _____

39.3 _____

40. Did you see (demonstration/ other farmer) or test the technology before getting/purchasing it?

☐ Yes

☐ No

41. Which were the most important sources of information/support for its **assessment** (evaluation which led to adoption/use) [incl. your own experience]?

41.1 Most important: _____

41.2 Second most important: _____

41.3 Third most important: _____

42. Which were the most important sources of information/support for its **establishment and use** [incl. your own experience]?

42.2 Most important: _____

42.3 Second most important: _____

42.4 Third most important: _____

MEMO (possible answers to Q41 & 42):

1	On my own experience
2	National or regional agricultural (public, cooperative) extension/ advisory services
3	Private advisor
4	Technology manufacturers/ dealers
5	Technical press
6	Internet
7	Farmers' (discussion) group
8	Other farmers/peers (not including farmers' group)
9	Other (please specify)

43. Which are the three most important reasons that motivated you to apply such a practice/ such practices?

43.1 Most important _____

43.2 Second most important _____

43.3 Third most important _____

MEMO (possible answers to Q43):

1	Being an innovator	
2	Save money through the reduction of energy costs	
3	Compliance with regulations	
4	Reduce environmental impact	
5	Utilize farm by-products	
6	Positive impact on human health	
7	Being a good steward of the countryside	
8	Being a good neighbor	
9	Financial incentive: Subsidy and/or tax exemption	
10	Farm diversification	
11	Other (please specify):	

44. Did a specific external subsidy other than the direct farm payment give you the opportunity to invest in/ apply the selected practice?

3. Yes (which

_____)

4. No

45. Did the introduction of energy saving technology/practice change the way you practice farming?

○ Yes, (How? _____)

○ No, (Why? _____)

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

(1=Strongly Disagree, 2=Disagree, 3=neutral 4=Agree, 5=Strongly Agree)

46	It is easy to work with this technology/practice.	1	2	3	4	5
47	It is easy to get technical support for the equipment.	1	2	3	4	5
48	This technology/practice is economically justified / the cost-benefit of this technology/practice is as you expected.	1	2	3	4	5
49	Sharing costs with other farmers has allowed you to use this technology/practice.	1	2	3	4	5
50	This technology/practice is reliable.	1	2	3	4	5
51	The equipment requires a lot of maintenance.	1	2	3	4	5

Non-Adopters (Non-Users)

52. Which of the following **information/tests would you trust** before deciding to follow (establish/use) such a practice?

52.1 Most important _____

52.2 Second most important _____

52.3 Third most important _____

MEMO (possible answers to Q52):

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):

53. What would be the main reasons/incentives/motivation to apply such a practice? Multiple answers possible.

53.1 subsidy or other financial incentive

53.2 sharing costs with others

53.3 getting training/support on how to use it

53.4 Other (please specify) _____

54. What are your **three** most important reasons for **NOT** following any of the abovementioned practices? (**1= most important; 5= least important**)

54.1 Most important _____

54.2 Second most important _____

54.3 Third most important _____

MEMO (possible answers to Q54):

1	Land is too small
2	Not the best fitting technology available yet (tailored to my situation/ cultivation system)
3	Not interested
4	Not affordable (due to high upfront costs)
5	Do not see future profit benefit
6	I am too old (to change)

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/practice is not compatible with existing technology/ machinery/ equipment in my farm
10	The guarantee of long term efficiency of the technologies/practices is limited
11	Limited guarantee of (technical) assistance when asked/needed
12	Very complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.)
13	Do not have time to search, consider, apply for, and implement such technology/ practice
14	Other (please specify):

55. Have you seen other farmers using any such practice on his/her farm? [Yes= number No=0]

- 55.1 Yes (Which _____ **continue with QUESTION56**)
 55.2 Yes (Which _____ **continue with QUESTION56**)
 55.3 Yes (Which _____ **continue with QUESTION56**)
 No **(continue with QUESTION 57)**

56. (**Only if “yes” was chosen in QUESTION 61**): Did this raise your interest in any such practice(s)? [Yes= number No=0]

- 56.1 Yes (which one: _____)
 56.2 Yes (which one: _____)
 56.3 Yes (which one: _____)

Carbon Sequestration

57. Have you heard about any farming practices concerning

- Manuring and fertilizing (organic)
- Conservation tillage (minimum, zero/no-till)
- Crop residue management
- Cover crops/ crop rotation

If YES (if NO -> Q66)

58. Which are the three most important sources of information, from which you **heard about** such energy efficiency practice?

- 58.1 Most important: _____
 58.2 Second most important: _____
 58.3 Third most important: _____

MEMO (possible answers to Q58)

1	On my own experience
2	National or regional agricultural (public, cooperative) extension/ advisory services
3	Private advisors
4	Technology manufacturers/ dealers
5	Technical press
6	Internet
7	Farmers' (discussion) group
8	Other farmers/peers (not including farmers' group)
9	Other (please specify)

59. Do you **use any of these practices on your farm?**

Yes

No

If YES (if NO -> Q62)

Users

60. Which are the three most important reasons that motivated you to apply such a practice/ such practices?

60.1 Most important _____

60.2 Second most important _____

60.3 Third most important _____

MEMO (possible answers to Q60):

1	Being an innovator	
2	Save money through the reduction of costs	
3	Compliance with regulations	
4	Reduce environmental impact	
5	Utilize farm by-products	
6	Positive impact on human health	
7	Being a good steward of the countryside	
8	Being a good neighbor	
9	Financial incentive: Subsidy and/or tax exemption	
10	Farm diversification	
11	Other (please specify):	

61. Did a specific external subsidy other than the direct farm payment give you the opportunity to invest in/ apply the selected practice?

5. Yes (which _____)

6. No

(Go to Q 66)

Non-Users

62. What are your **(three)** most important reasons for **NOT** following any of the abovementioned practices? **(1= most important; 5= least important)**

62.1 Most important _____

62.2 Second most important _____

62.3 Third most important _____

MEMO (possible answers to Q62):

1	Land is too small
2	Not the best fitting technology available yet (tailored to my situation/ cultivation system)
3	Not interested (or this is not/does not seem to be 'good farming')
4	Not affordable (due to high upfront costs)
5	Do not see future profit benefit (or I am afraid to lose yields)
6	I am too old (to change)
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/practice is not compatible with existing technology/ machinery/ equipment in my farm
10	The guarantee of long term efficiency of the technologies/practices is limited
11	Limited guarantee of (technical) assistance when asked/needed
12	Very complicated procedures (slow, lengthy or opaque processes - re: planning, licensing, permissions, etc.)
13	Do not have time to search, consider, apply for, and implement such technology/ practice
14	Other (please specify):

63 What would be the main reasons/incentives/motivation to apply such a practice? Multiple answers possible.

- | | | |
|------|---|---------------|
| 63.1 | subsidy or other financial incentive | [Yes=1, No=2] |
| 63.2 | sharing costs with others | [Yes=1, No=2] |
| 63.3 | getting training/support on how to use it | [Yes=1, No=2] |
| 63.4 | Other (please specify) _____ | [Yes=1, No=2] |

64 Have you seen other farmers using any such practice on his/her farm? [Yes= number No=0]

- Yes (which _____ **continue with QUESTION65**)
- Yes (which _____ **continue with QUESTION65**)

- c. Yes (which _____ **continue with QUESTION65**)
No **(continue with QUESTION66)**

65 (Only if “yes” was chosen in QUESTION 59): Did this raise your interest in any such practice(s)? [Yes= number No=0]

65.1 Yes (which one: _____)

65.2 Yes (which one: _____)

65.3 Yes (which one: _____)

Farmer's/Farm Manager's attitudes regarding *information seeking on innovations*

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

1. More than once a year
2. Once a year
3. Less than once a year
4. Never

67 Which were the **three most important sources of information** in which you sought out information, *last year*, in relation to **renewable energy production and energy saving technologies/ practices**?

67.1 First most important _____

67.2 Second most important _____

67.3 Third most important _____

MEMO (possible answers to Q67):

1	None
2	Professional press (e.g. farmer association magazines, journals)
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/cooperative)
13	Advisor contact (private)
14	Other:

68 Please rank each of the following characteristics of renewable energy production and energy saving technologies/ practices that would make them more relevant to farmers' needs (1 = not at all crucial ;5 = very crucial)

1	Easy to use	1	2	3	4	5
2	Easy to install	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/Farm Manager's opinions about technology, in general.

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

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

Farmer's/Farm Manager's Innovativeness

72 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 myself
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=neutral 4=Agree, 5=Strongly Agree)

73	In general, I am the first in my social circle of friends and relatives to know about new machinery/technology.	1	2	3	4	5
74	In general, I am among the first of my friends and relatives to buy new machinery/technology.	1	2	3	4	5
75	Usability and user-friendliness are very important to me when I buy new things.	1	2	3	4	5
76	I wait to buy new things, until I know others have	1	2	3	4	5

positive experiences with it.					
77 I prefer to have some experience with something before I buy it.	1	2	3	4	5
78 Even if I am interested, I wouldn't buy if my (social) environment would be negative on it.	1	2	3	4	5
79 In general, when making farm decisions, I don't like taking risks.	1	2	3	4	5

80 What kind of incentives would you like to see in future policies to facilitate the acquisition of renewable energy production and energy-saving technologies/practices?

Farmer/Farm Manager

82 Gender:

1. Male
2. Female

83 What is the highest level of education you completed?

1. Elementary (approximately 4-7 years of general education)
2. Secondary school (approximately 8-12 years of general education)
3. Technical school and/or apprenticeship (approximately 2-4 years follow-up after (Lower) secondary school)
4. University (any level, Bachelor, Master, or PhD)
5. Other: _____

84 Is farming/farm management your primary occupation? [Yes=1, No=2]

- ☐ Yes (full-time)
- ☐ No (part-time)

85 For how long have you been a farmer/farm manager? (years _____)

86 Is there a farm successor or someone who will inherit and/or take over the farm?

1. Yes
2. No
3. Not relevant (not a family farm)

87 Why did you become a farmer?

1. Tradition (family, farm inherited)
2. Profession of choice

3. No other choice
4. Other (please specify) _____
5. Not relevant (farm manager)

88 How would you rank your satisfaction with farming/farm management?

1. Very unsatisfied
2. Unsatisfied
3. Satisfied
4. Very satisfied

89 Do you **hold a Green/Farming Certificate?**

Yes/Duration of training (in months) _____

No = 0

90 Do you use the Internet?

1. Yes, every day
2. Yes, sometimes within the week
3. Yes but not very often (a few times per month)
4. Rarely
5. Not at all

91 How would you rate your information technology skills (5 = excellent, 1 = very poor, 0 = none) _____

92 Do you participate in any farmers' cooperative/association/union, etc.?

1. Yes
2. No
3. Not relevant (cooperative farm)

93 Any other comments you would like to make with regard to the topics discussed?

B. Experts' interview guide

1. Introduction

Description of organization

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

Description of the interviewee

- Could you briefly describe your career and training background?
- What is the RES 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 RES and energy-saving practices in overcoming these challenges?
- 3) What is the role of policy, economic, social and environmental pressures in driving farmers to adopt/ use RES and energy-saving practices?
 - What are the environmental pressures for using RES and energy-saving practices?
 - What are the policy (EU regulations, national/regional legislation, incentives/subsidies, etc.) pressures for using RES (and energy-saving practices)?
 - What are the economic pressures for using RES (and energy-saving practices)?
 - What are the social pressures for using RES and energy-saving practices? (Are there social values/social pressure that force farmers towards a more environmental friendly/ energy-saving agriculture? If yes which? How strong influence do you believe that these have in farmers' decision making?)
- 4) What are, according **to your opinion**, the advantages/ disadvantages for a farmer to use RES and energy-saving practices?
- 5) Can you comment on the situation of RES and energy-saving practices adoption and use in your country? (If you are aware: How does it compare to other EU Member States?)
- 6) What are the main **farmers' motivation and criteria** for which currently they use RES (and energy-saving practices) on their farms?
- 7) What are the major/distinctive personal and farm characteristics of farmers who adopt RES and energy-saving practices? (i.e. are there personal factors, life-stage of farm family as well as farm-specific factors, such as cropping system, size, location/ altitude, etc., on top of policy, social, economic, environmental pressures, etc.)?
- 8) What are the reasons/barriers for which farmers do not adopt RES and energy-saving practices?
- 9) How are farmers' needs and demands taken into account - what is the role of farmers in the development of innovations regarding energy?

- 10) Are there any RES and energy-saving practices characteristics (economic, technical, etc.) which need improvement/ change so that these technologies/practices will become more relevant and affordable to farmers and thus more widely adopted?
- 11) Are there specific demands on farmers' knowledge and skills regarding RES and energy-saving practices?
- 12) What is/ what should be the role of a) research and b) extension/advisory services in promoting RES and energy-saving practices among farmers
 - What is the role and importance of research and advisory services vis-à-vis family and neighbour-level and/or other information sources?
- 13) What is/ what should be the role of subsidies, policies, or regulations in directing the adoption and dissemination of RES and energy-saving practices?
- 14) Can you please comment on the cooperation (or not) between AKIS actors (policy, research, extension, farmers, industry, etc.) in RES (and energy-saving practices) development/ innovation (are there links between actors? how are decisions on technology development taken?)
 - a) in the assessment of farmer's/end user's needs (if any)?
 - b) in the design and production of innovations?
 - c) in terms of complementary actions (regulations, infrastructure, etc.)?