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PRELIMINARY SCREENING OF HIGH SCHOOL STUDENTS PROPENSITY TO PF-ORIENTED CURRICOLA

Results of Questionnaire survey   **May 2022**

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Introduction

In this report we present the results of a questionnaire administered to a sample of students coming from the areas involved in the project Transfarm 4.0, Italy, Slovenia, Hungary, Austria and Poland. This activity is part of a broad engagement and awareness-raising action that aims to bring the topic of precision agriculture closer to educational institutions and professionals.

In fact, the questionnaire aimed in particular to bring the topic of precision agriculture close to students and their professors, drawing attention to these trending topics that are very important for their careers. Reflection on these issues also aimed to be an opportunity for the educational system to adapt its training offer to the needs of the labour market and prepare its students for the future of their profession.

A pool of college / high education institutes has been involved in a verification of students and professors posture to provide specialised curricula and knowledge gaps in 5 areas.

Methodology

Each partner selected a sample of school institutions that offer a study programme related with the project topic to their students.

For Italy, the questionnaire has engaged the 4th and 5th grades of some secondary schools of the Veneto Region. For Slovenia the questionnaire has engaged the 4th (3th in Slovenia) and 5th (4th in Slovenia) grades of some high schools of the Eastern Region. In Hungary, the questionnaire has engaged five Centres of Agricultural Vocational Training along the country. In Poland the questionnaire has engaged the 4th and 5th grades of secondary schools which include in their study plan characterizing subjects and activities relevant for research purposes. In Austria the questionnaire has engaged the 4th and 5th grades of secondary schools of the Regions of Upper Austria and Lower Austria.

The idea was to propose a questionnaire that can be easily filled out, which basically covered 3 macro-themes:

1- General student data: The questionnaire is anonymous, but it was advisable to ask for information on the school attended, study area and class. Also, for consistency with the new GDPR (General Data Protection Regulation), this type of questions is limited to those that are really necessary and not relevant to privacy.
2- What do the guys know and what do they think about Precision Farming? Assuming that all students do not have a correct idea of what is meant by Precision Farming, a definition of the same has been included in the questionnaire only later, so as not to influence the collection of the first answers.
3- Level of interest in Precision Agriculture as a subject of study in relation to one's schooling and working environment.

The questionnaire was prepared in English and subsequently translated into the 5 languages corresponding to the partners' areas, before being administered to the students.
The questionnaire was administered to more than 50 schools in total (Poland's accurate data is missing due to privacy reasons) and 485 replies were received.

1 Questionnaire results in Italy

In Italy the questionnaire has engaged the 4th and 5th grades of some secondary schools of the Veneto Region which include in their study plan characterising subjects and activities relevant for research purposes: agriculture, precision agriculture, mechanics, mechatronics, electronics. and electrical engineering.

To select the classes, a screening was conducted by listing all the high schools in the Veneto, sifting the elements based on compatibility with the topics covered in Transfarm 4.0.

A second filter applied to the selection was to distinguish and prefer the institutions that offer their students a technical-scientific preparation.

The following were therefore identified:

• Agricultural technical institutes and some professional institutes for agriculture and the environment which aim to prepare students for the topics of food production and processing.

• A sample of industrial technical institutes, and in particular those divided into the following sectors:

> 1.Specialized in mechanics and mechatronics, whose purpose is to train professionals capable of designing and building mechanical and electromechanical systems.

> 2.Specialized in electronics and electrical engineering, intended to train professionals in the field of electronics, robotics and industrial automation.

1.1 Participation level

The activity was proposed to a total of 22 schools, of which:
- 10 Agricultural Technical Institutes (ATI)
- 3 Professional Institutes for Agriculture (PIA) and the Environment
- 9 Industrial Technical Institutes (ITI)

The institutes were contacted, on November 22, 2021, with a formal letter from CREA in which the initiative was presented and the actors were invited to participate by distributing the questionnaire among the students of their complex.

This first sending was followed by a telephone contact and, in most cases, a second sending of ordinary e-mail. In some cases, a further telephone reminder was also made to invite the subjects to participate in the initiative.

Overall, the questionnaire remained online and can be filled in from November 15, 2021 to the end of January 2022.

Participation was as follows:

- 4 ATI / PIA institutes (31% of those contacted), for a total of 267 replies received

- there was no response from the ITI, technical institutions of mechatronic, electronics, robotics and industrial automation

- a total of 267 students from the Veneto Region participated in the survey.

A first consideration that can be drawn from the non-participation of the ITIs, is that the Precision Agriculture theme is probably not known and understood, not only by the students of the ITIs, but not even by the teachers and managers. of these schools, which therefore did not consider it relevant to adhere to this type of research. The telephone feedback received during the contact highlights the assertion made. In fact, on several occasions, the interlocutor on the phone was surprised that we intended to involve an industrial technical institute in an activity related to the agricultural sector. Only after introducing the topic of technology applied to agriculture was a summary interest aroused, evidently not sufficient to initiate a process of adequate involvement in the project. Given that, contrary to what is perceived, the development of the precision agriculture sector also requires the professionalism of technicians and designers with specific knowledge in the mechanical and electronic fields, and who know how to develop and improve the solutions to be applied in the agricultural sector, it is essential to find the conditions for fill this gap, or this perceived distance between the two sectors, the technological one and the agro-zootechnical one.

1.2 Knowledge of the topic

Based on the answers to the questionnaire, about two thirds of the respondents had already heard of Precision Farming (Fig. 1). However, less than half of the students (44%) have heard of it at school. Other sources are the specialised magazines, the internet or directly the company (Fig. 2).
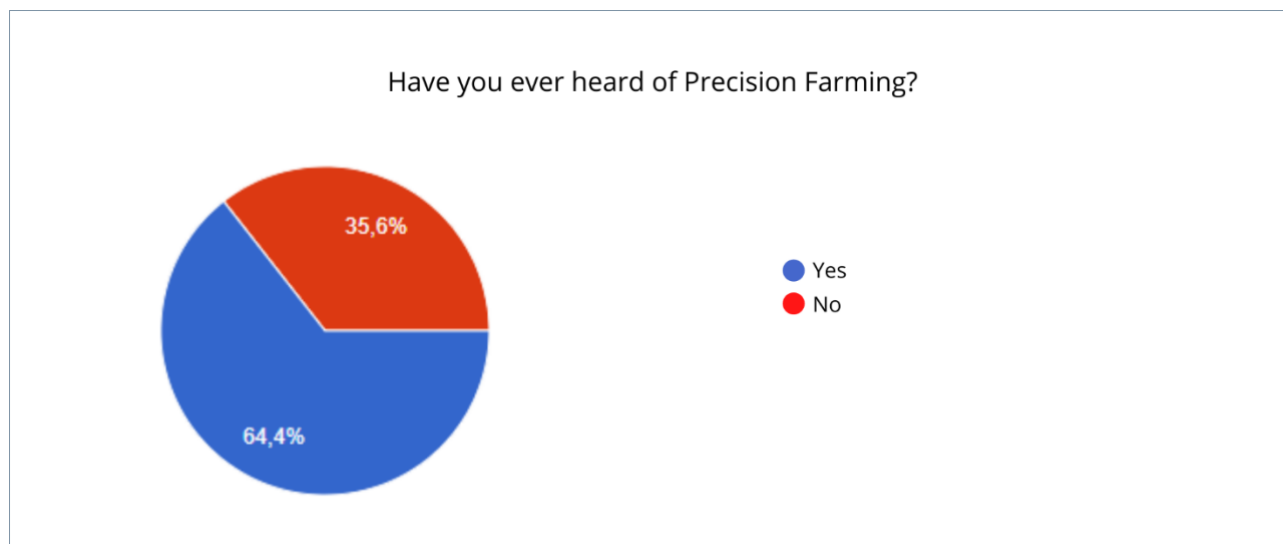

Fig.1 Answers to the question "Have you ever heard of PF?"
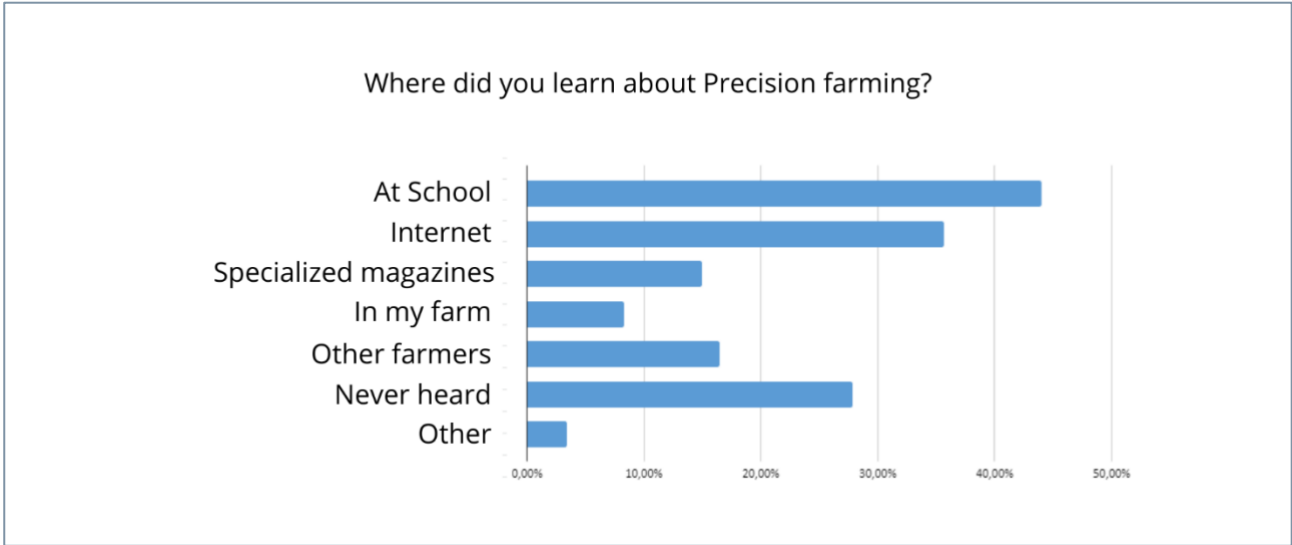
Fig 2 – Answers to the question "Where did you learn about PF?"

The next graph shows how a clear majority of students distinguish Precision Farming, the tools that allow to complete agricultural task with high precision, from Digital Farming, digital services that support farm management and monitoring (fig 3).
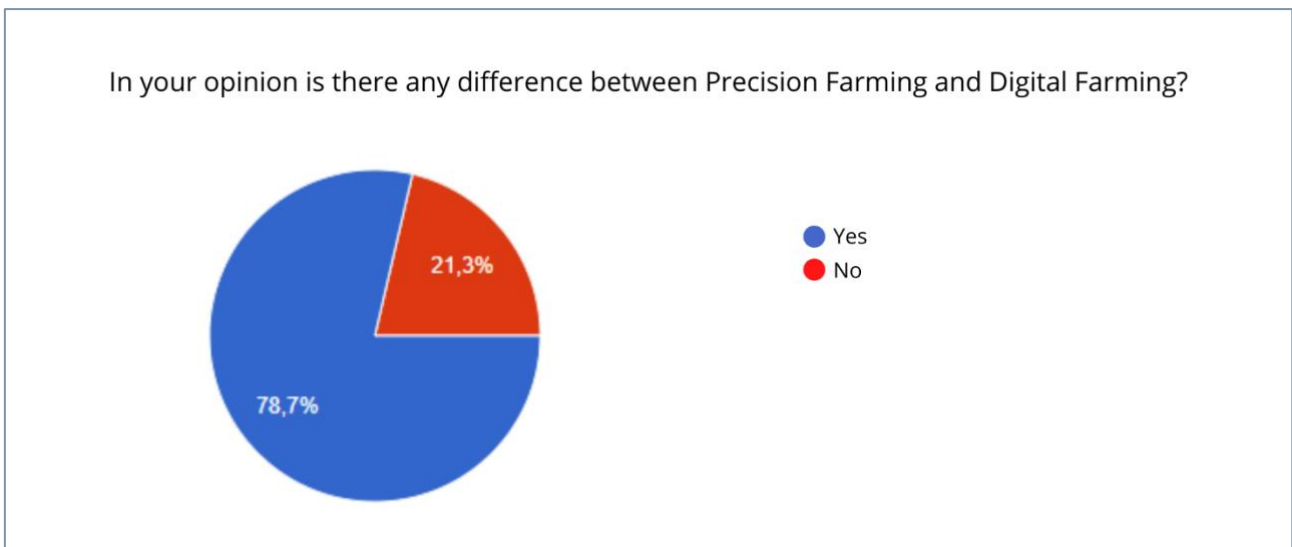

Fig.3 Answers to the question "In your opinion, is there a difference between PF and DF?" in percentage

This trend is also confirmed by the question where students are asked to identify the techniques of Precision Farming (fig. 4): Internet of Things and Big Data Management with Cloud systems tend to receive less confirmation than others techniques such as GPS, remote sensing and the use of sensors.
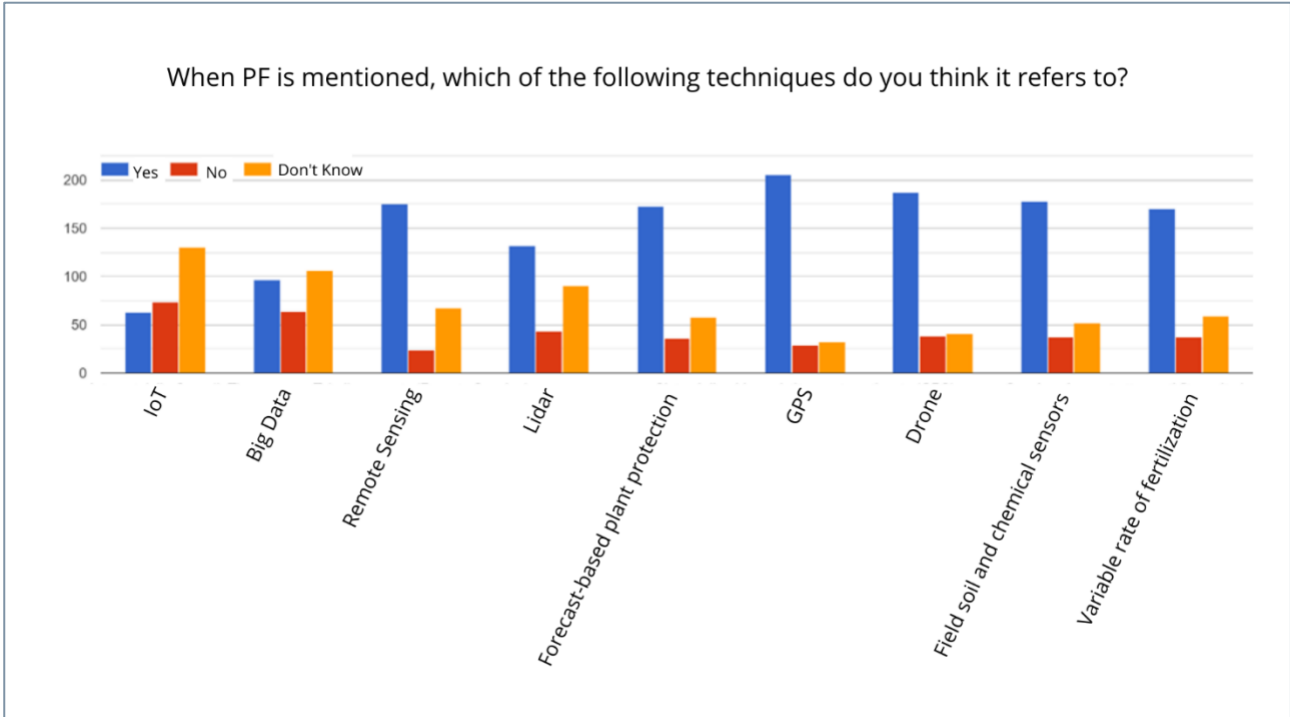
Fig.4 "When we talk about PF, in your opinion, which of the following techniques are we referring to?"

As regards the concrete application of Precision Agriculture techniques (fig. 5), over half of the interviewees (54.7%) believe that all the sectors taken into consideration are interested in PF techniques, while only a few (1.5%) are those who do not consider the development of the PF to be applicable in any field.
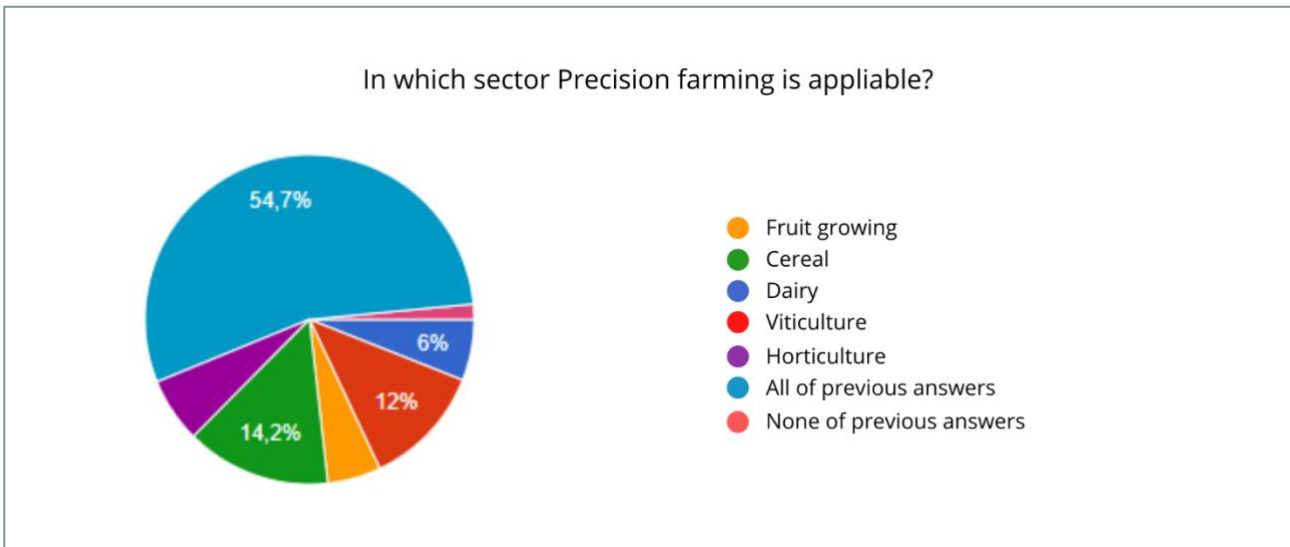

Fig.5 Statistics Graph: "In which sector do you think the PF is applicable"

The usefulness of applying precision farming techniques is a substantially well supported topic by the majority of students (Fig. 6) and shows the awareness of students on its possible applications to improve actual farming practices. Some uncertainties are shows on the usefulness of PF in improving the quality of products and in improving the time required for the operations.
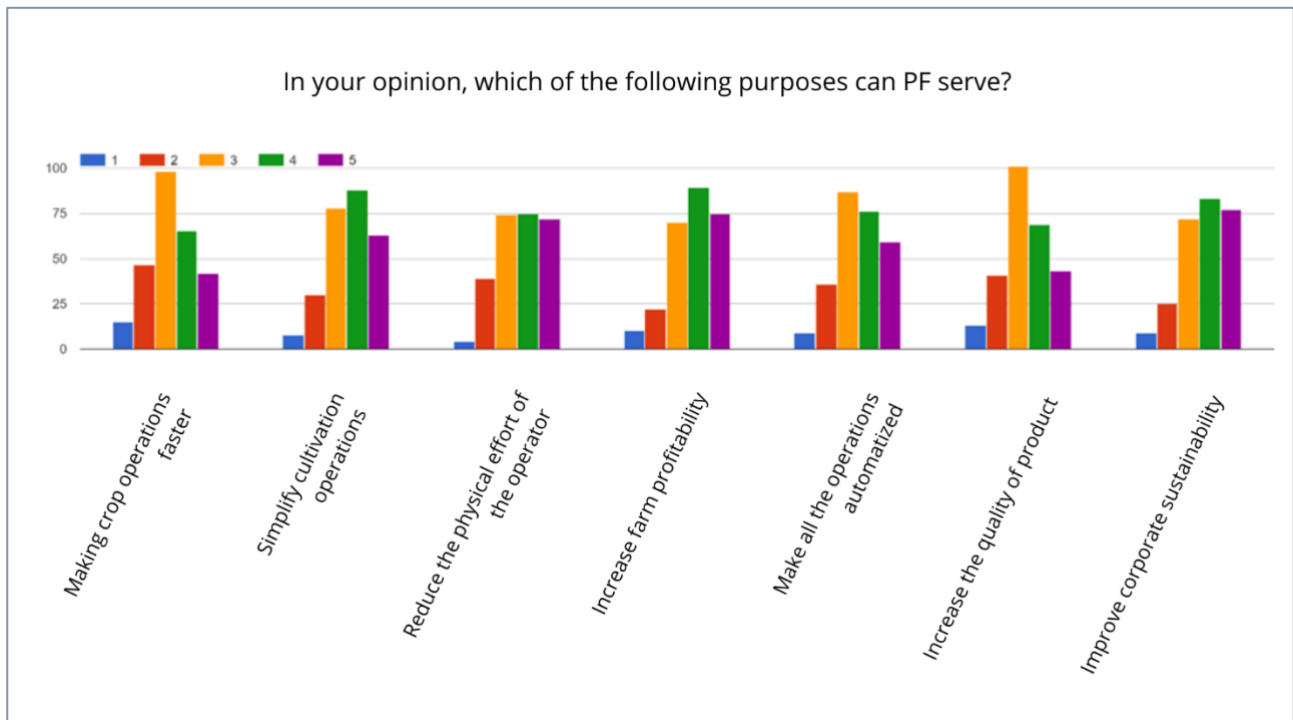

Fig.6 In your opinion, which of the following purposes can PF serve? (from 1 not at all useful to 5 very useful)

Other interesting information can be deduced from the statistics shown in the graph below (fig. 7).

The students highlight how, according to them, PF is not particularly widespread in Italy and the EU. They also argue that the PF is not meant exclusive for large companies but also that it is not necessarily an opportunity to create new jobs in agriculture.

On the other side, majority of students recognise that PF is an opportunity for companies that produce plants and machinery and a chance for professionals with greater technical skills to innovate agricultural products and services. Another interesting output resulting from the question is the awareness of the students on the need of specific skillset to adopt and develop PF techniques.

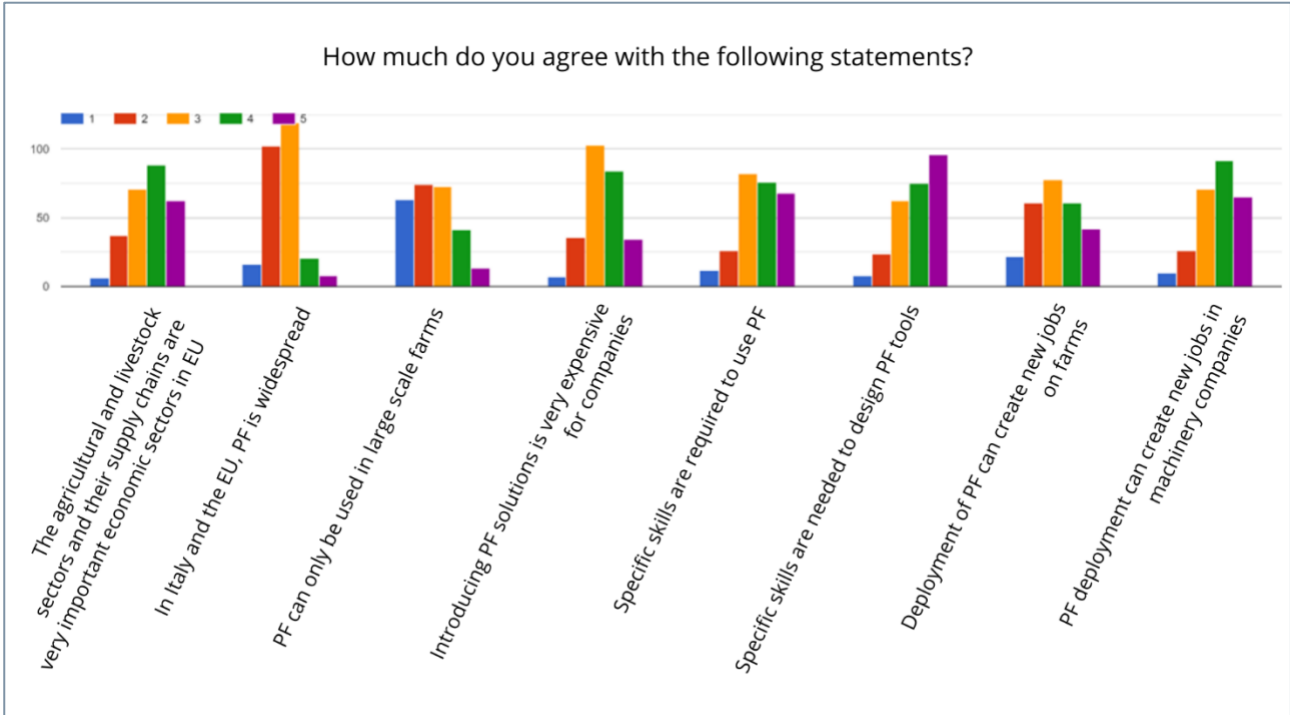How much do you agree with the following statements?

Fig.7 How much do you agree with the following statements? (From 1 totally false to 5 totally true)

1.3 Attitude and propensity for Precision Farming

The propensity of students to the precision agriculture sector is well evidenced by the statistics of the responses relating to the workplace and to school education.

The majority of students (over 60%) show their interest in the sector in the workplace, around 20% showed interest for careers that does not involve PF and only 12% of students would prefer to work in the agricultural sector but without a direct connection with PF (fig. 8).
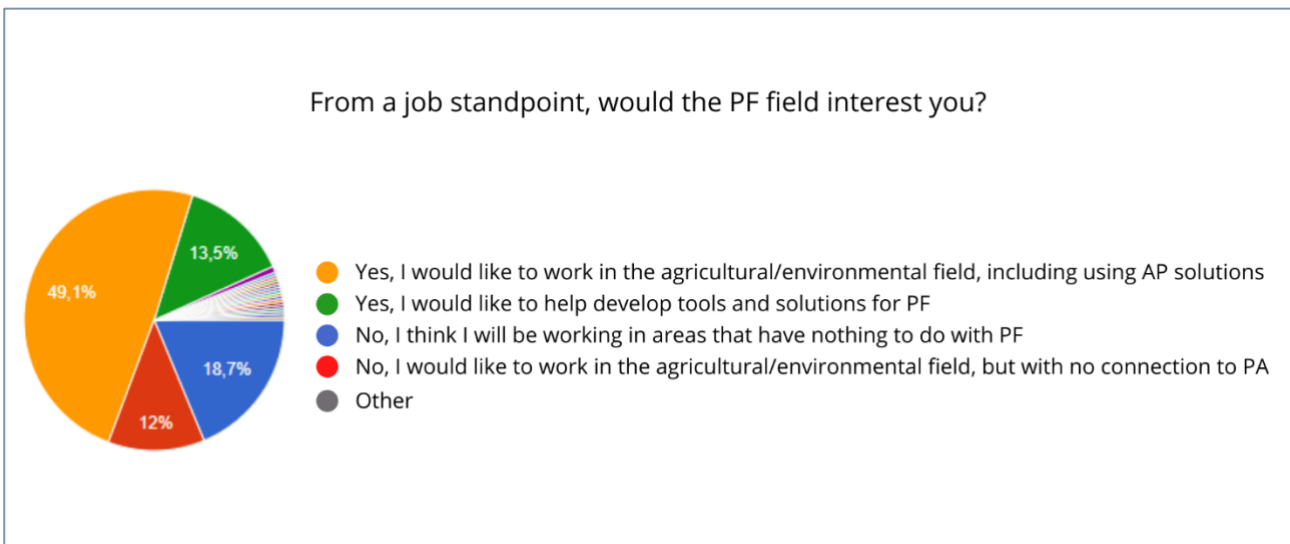

From a job standpoint, would the PF field interest you?

- 49,1% ● Yes, I would like to work in the agricultural/environmental field, including using AP solutions
- 13,5% ● Yes, I would like to help develop tools and solutions for PF
- 18,7% ● No, I think I will be working in areas that have nothing to do with PF
- 12% ● No, I would like to work in the agricultural/environmental field, but with no connection to PA
- ● Other

Fig.8 – Statistics Graph: "From a job standpoint, would the PF field interest you??"

Nevertheless, according to the students involved in this survey, school programs do not dedicate enough space and time to PF. Almost 90% of the interviewees (Fig. 9) considers that it would be necessary to adapt the study plan with a greater integration of the PF theme.
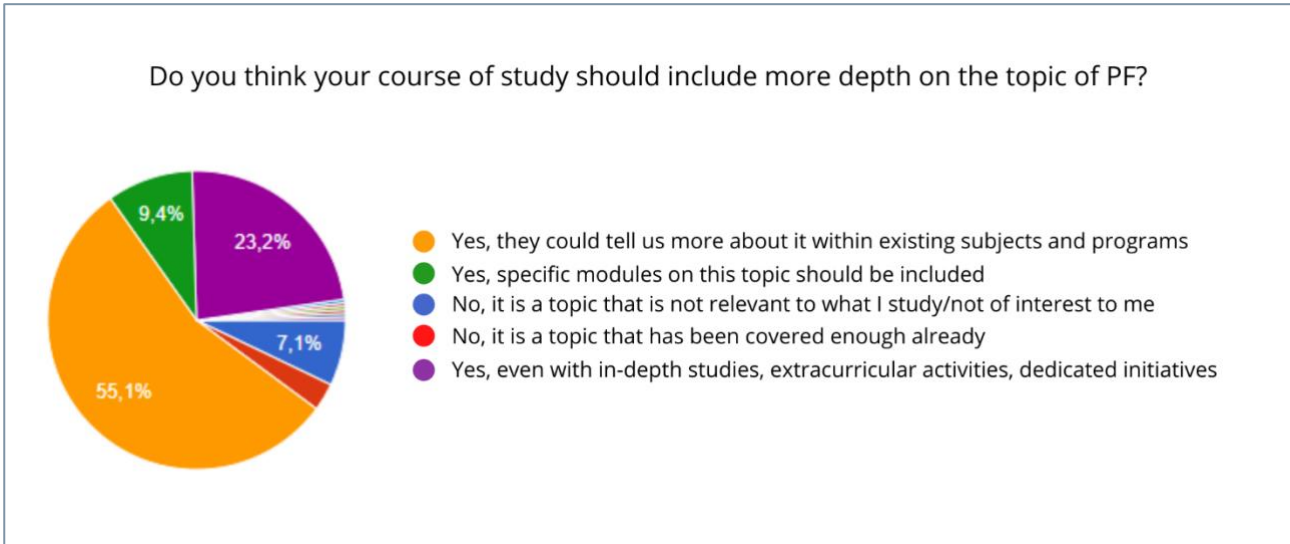

Fig.9 – Statistics: "Do you think your course of study should include more depth on the topic of PF"

The statistics of the answers shown in the graph below (fig. 10) underline students are aware that, in order to develop PF solutions and systems, it is necessary to involve typical school subjects of Technical Institutes especially those oriented toward electronics, engineering, computer science and automation.

However, as told, this answer was provided from students of Agriculture-oriented schools, since technical institutes didn't participated in the survey even if invited to do so.
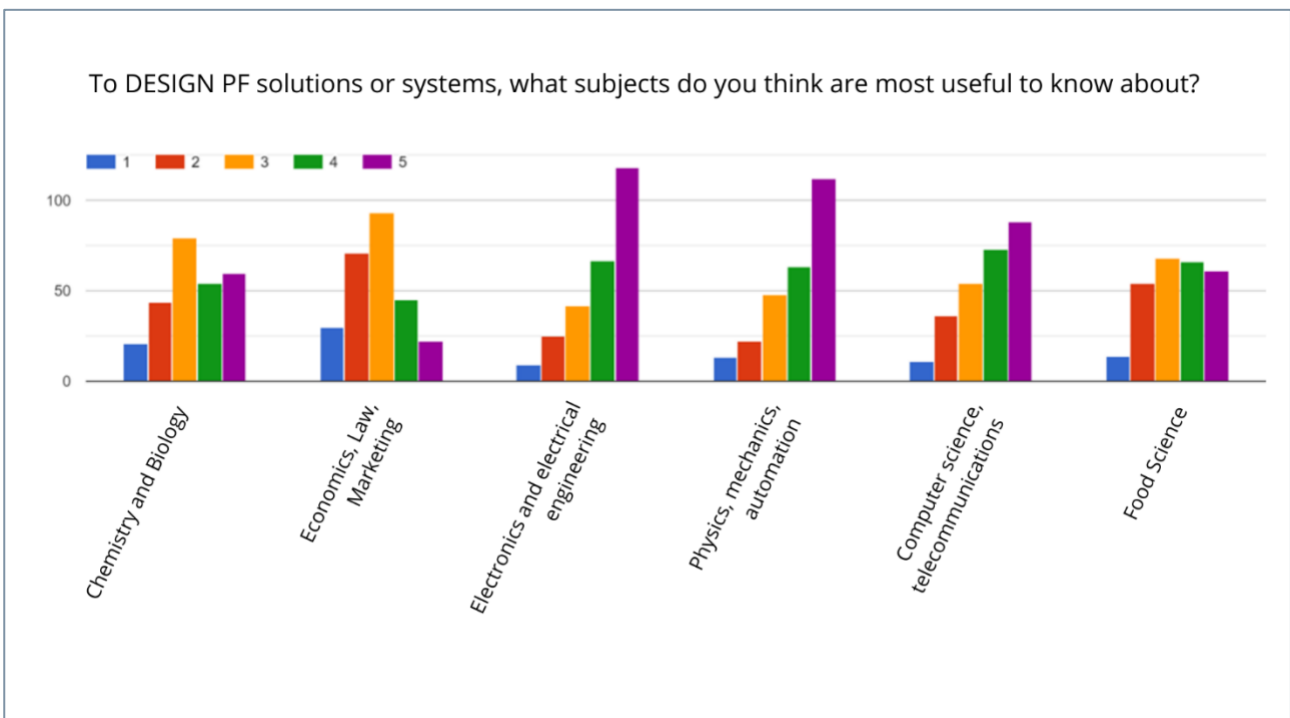

Fig.10 – To design PF solutions what subjects do you think are useful to know about? (From 1 totally useless to 5 most useful)

As regards the use of PF solutions or systems (fig. 11), students tend to give importance to all the subjects available in the application, with the exception of the ones related to Social Sciences. Also, in this case the importance assigned to technical subjects is denoted.
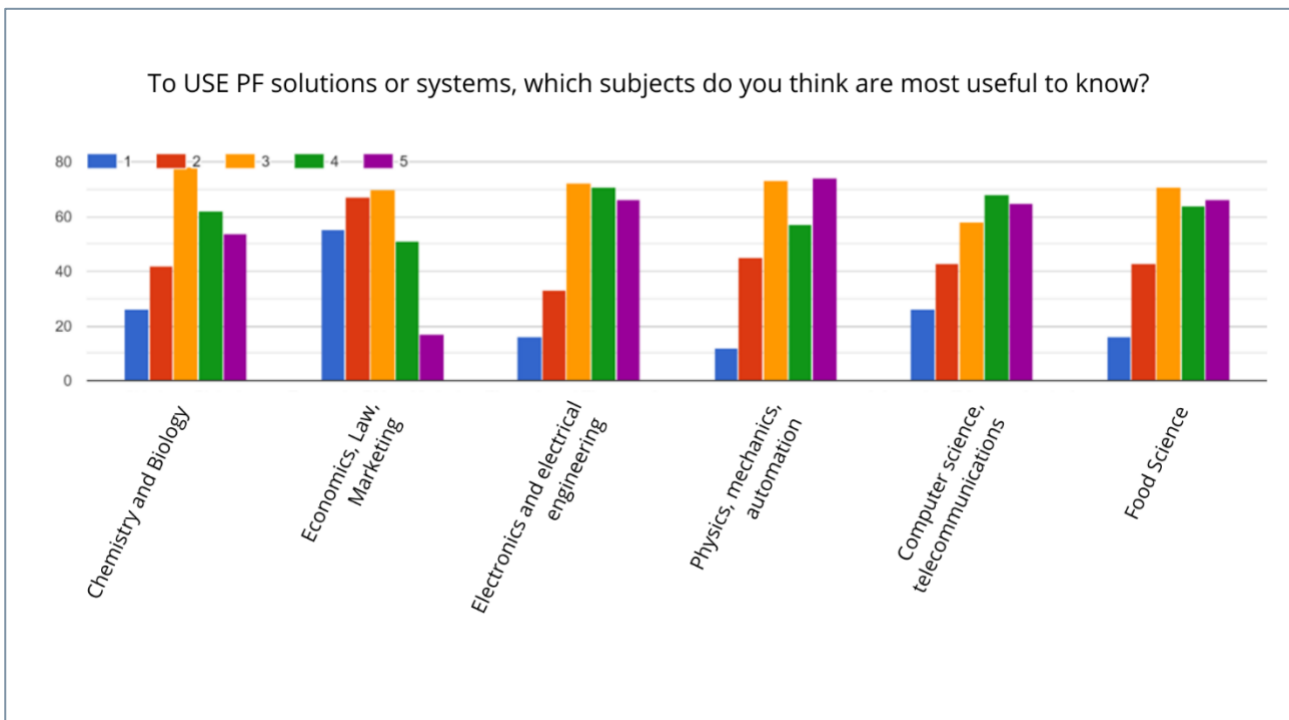

Fig.11 – To USE PF solutions, which subjects do you think are most useful to know? (From 1 totally useless to 5 most useful)

2 Questionnaire results in Slovenia

In Slovenia the questionnaire has engaged the 4th (3th in Slovenia) and 5th (4th in Slovenia) grades of some high schools of the Eastern Region which include in their study plan characterizing subjects and activities relevant for research purposes: agriculture, precision agriculture, mechanics, mechatronics, electronics and electrical engineering.

To select the classes, a screening was conducted by listing all the high schools in Slovenia, sifting the elements based on compatibility with the topics covered in Transfarm 4.0.

A second filter applied to the selection was to distinguish and prefer the institutions that offer their students a technical-scientific preparation.

The following were therefore identified:

- Agricultural technical institutes and some professional institutes for agriculture and the environment which aim to prepare students for the topics of food production and processing.

- A sample of industrial technical institutes, and in particular those divided into the following sectors:

    1. Specialized in mechanics and mechatronics, whose purpose is to train professionals capable of designing and building mechanical and electromechanical systems.

    2. Specialized in electronics and electrical engineering, intended to train professionals in the field of electronics, robotics and industrial automation.

2.1 Participation level

The activity was proposed to a total of 6 schools, of which:

- High school for Agriculture

- Technical school for Agriculture, Mechatronics, Environment

The institutes were contacted, on November 22, 2021, with a formal letter from University of Maribor in which the initiative was presented and the actors was invited to participate by distributing the questionnaire among the students of their complex.

This first sending was followed by a telephone contact and e-mail. The school visit was arranged with the teachers via e-mail. This was followed by a live presentation of the Transfarm 4.0 project in the schools, and at the end of the presentation, students physically completed the surveys.

After successfully contacting the teachers at the schools and agreeing on a date, we visited the schools. Each presentation lasted about 30 minutes. Before the presentation started, we asked the students if they had ever heard of precision agriculture. A short discussion followed. We presented the aim of the project, explained what it was about and how students could get involved. The focus of the presentation was on the pilot projects, where we showed a video to the students. After the successful presentation, we asked students if they could complete the project surveys. In total 47 students participated at the survey and completed the questionnaire.

2.2 Knowledge of the topic

Based on the answers to the questionnaire, about two thirds of the respondents had already heard of Precision Farming (Fig. 1). However, more than half of the students have heard of it on internet or at school, the other 50% had heard about PF in specialized magazines, from peers and in their own farm (Fig. 2).
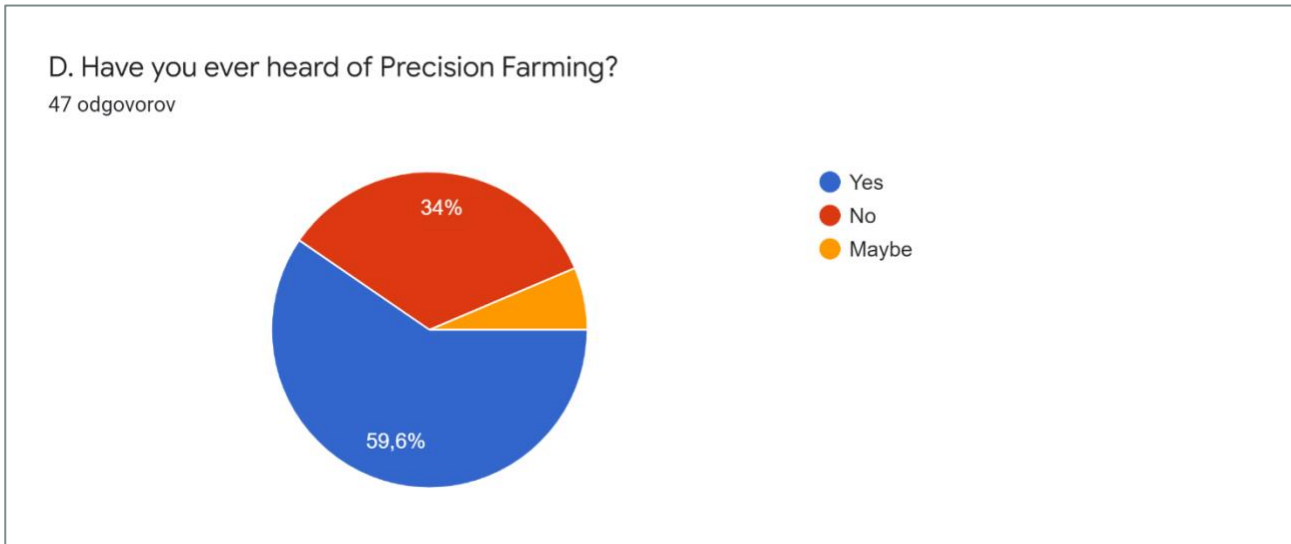

D. Have you ever heard of Precision Farming?
47 odgovorov

Yes — 59,6%
No — 34%
Maybe

Fig.1 Answers to the question "Have you ever heard of PF?"

H. Where did you learn about Precision farming?
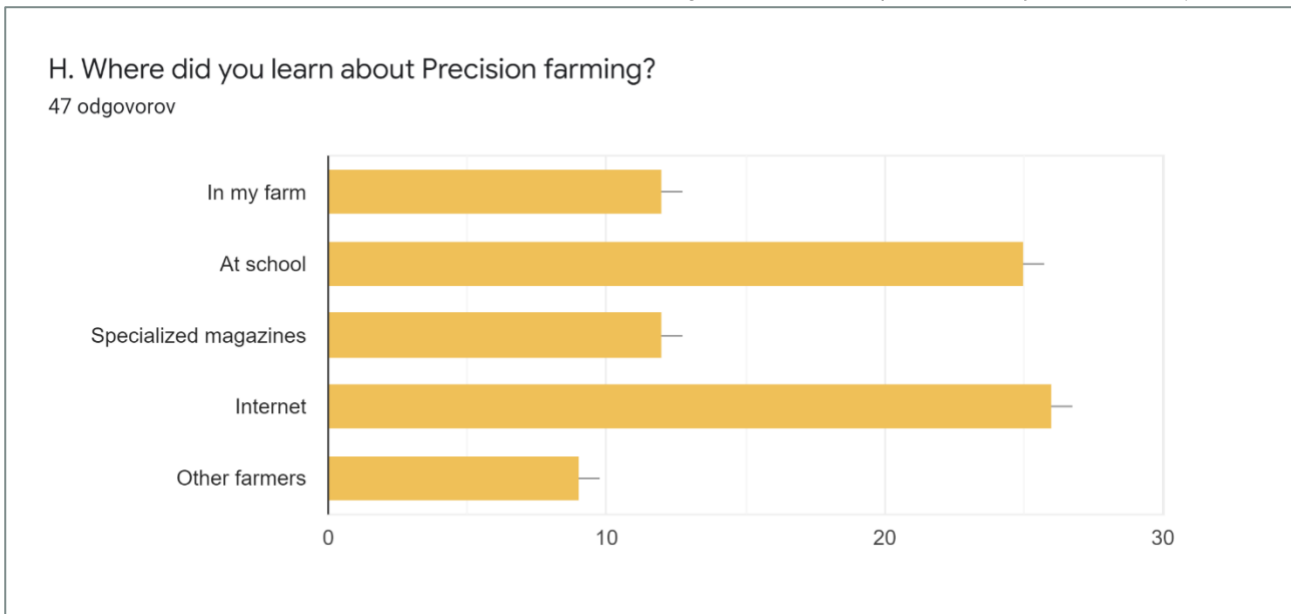47 odgovorov

Fig 2 Answers to the question "Where did you learn about PF?"

The graph shows how a clear majority of students distinguish Precision Farming from Digital Farming (Fig 3), even though on the next figure (Fig.4) student mixed the two practices.
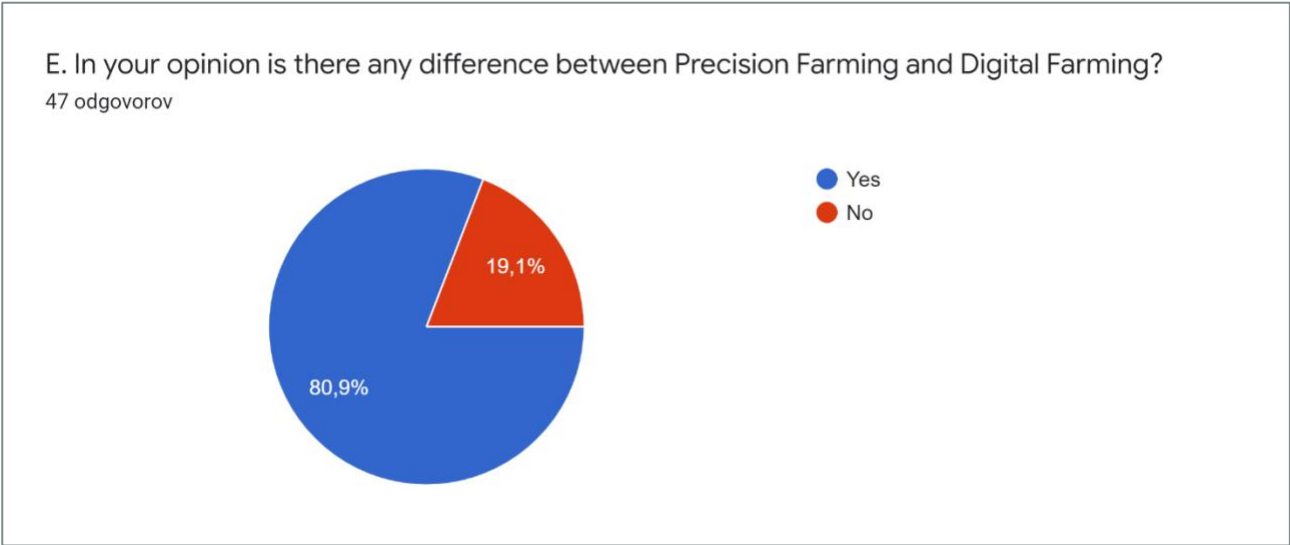
E. In your opinion is there any difference between Precision Farming and Digital Farming?
47 odgovorov

- Yes
- No

19,1%

80,9%

Fig.3 Answers to the question "In your opinion, is there a difference between PF and DF?" in percentage

G. When Precision Farming is mentioned, which of the following techniques do you think it refers to?

- Yes
- No

IoT | Big Data | Remote sensing | NDVI | Forecast-based plant protection | Variable rate of fertilization | Lidar | GPS
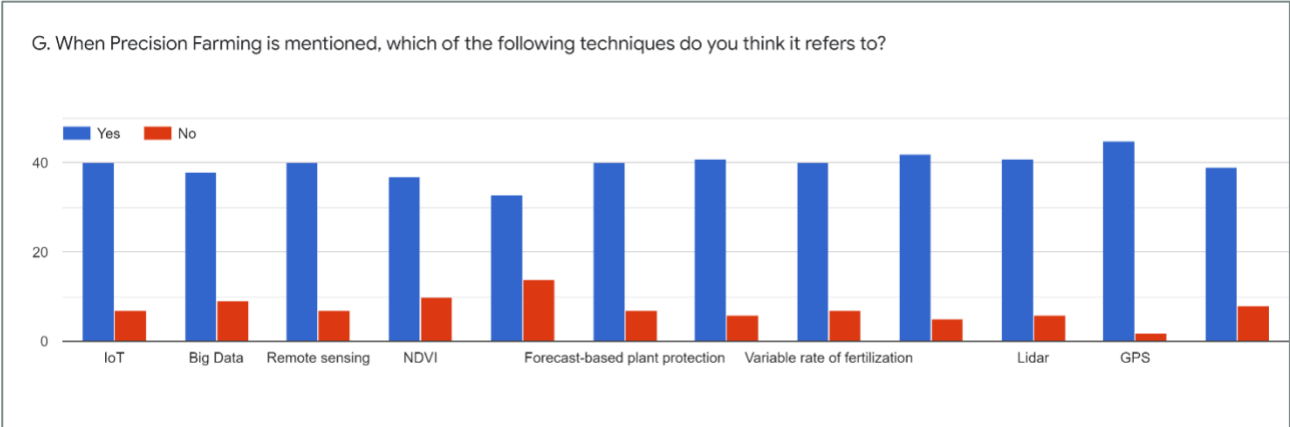
Fig.4 "When we talk about PF, in your opinion, which of the following techniques are we referring to?"

As regards the concrete application of Precision Agriculture techniques (fig. 5), just over half of the interviewees believe that all the sectors taken into consideration are interested in PF techniques, while only a few are those who do not consider the development of the PF to be applicable in any field.

F. In which sector Precision farming is appliable
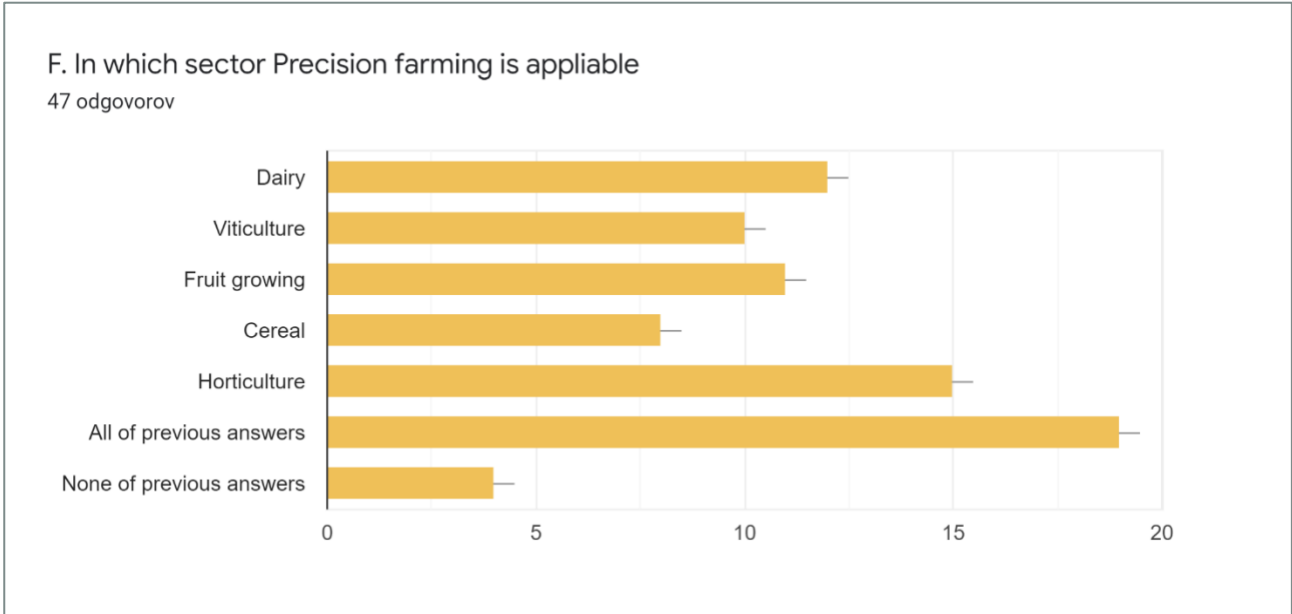
47 odgovorov

Fig.5 Statistics Graph: "In which sector do you think the PF is applicable"

The usefulness of applying PA techniques is a substantially well supported topic by the majority of students (Fig. 6). It is interesting to note that between the two answers that found the most perplexity about the purpose of the PA there is the one relating to the quality of the product and the corporate sustainability of PF. An aspect that deserves further study.
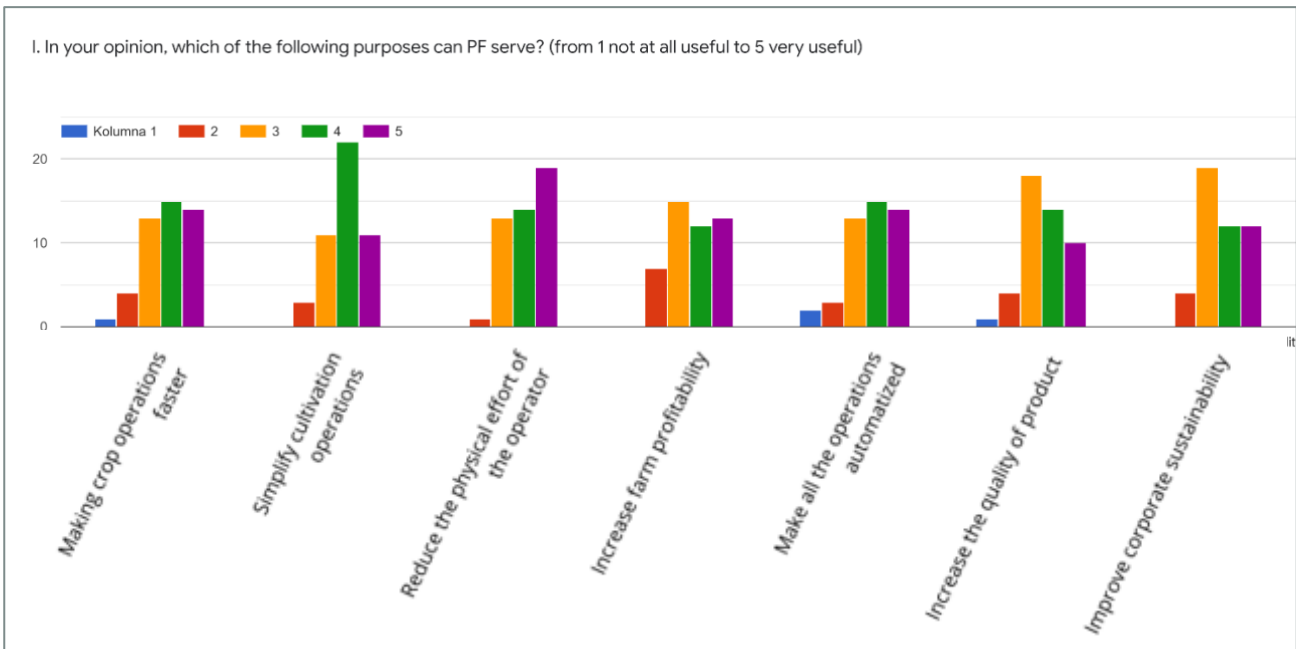

I. In your opinion, which of the following purposes can PF serve? (from 1 not at all useful to 5 very useful)

Fig.6 In your opinion, which of the following purposes can PF serve? (from 1 not at all useful to 5 very useful)

Other interesting information can be deduced from the statistics shown in the graph below (fig. 7). The students highlight how, according to them, PF is not particularly widespread in Slovenia and the EU. They also argue that the PF is not exclusive to large companies but also that it is not necessarily an opportunity to create new jobs in agriculture. But that PF is mostly an opportunity for companies that

Interreg
CENTRAL EUROPE
European Union
European Regional
Development Fund

Transfarm4.0

produce plants and machinery and a chance for professionals with greater technical skills.
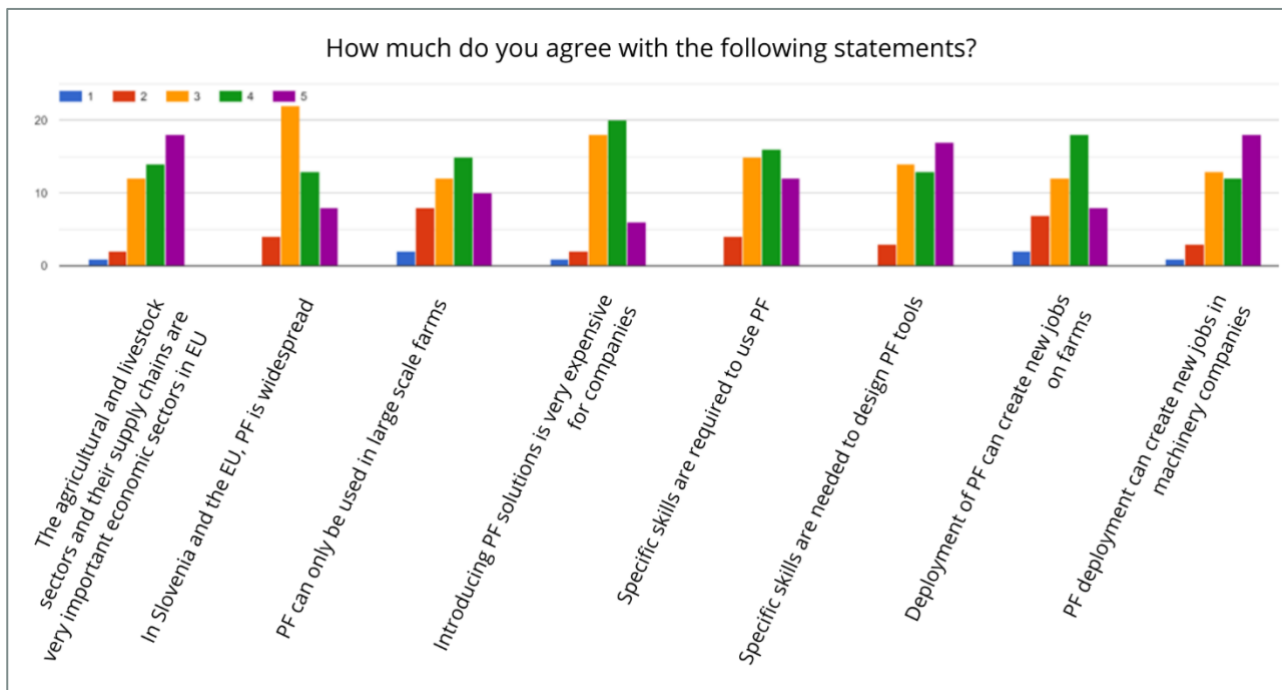

Fig.7 How much do you agree with the following statements? (from 1 totally false to 5 totally true)

2.3 Attitude and propensity for Precision Agriculture

The propensity of students to the precision agriculture sector is well evidenced by the statistics of the responses relating to the workplace and to school education. The majority of students (over 84%) showed their interest in the sector of PF in the workplace (fig. 8).
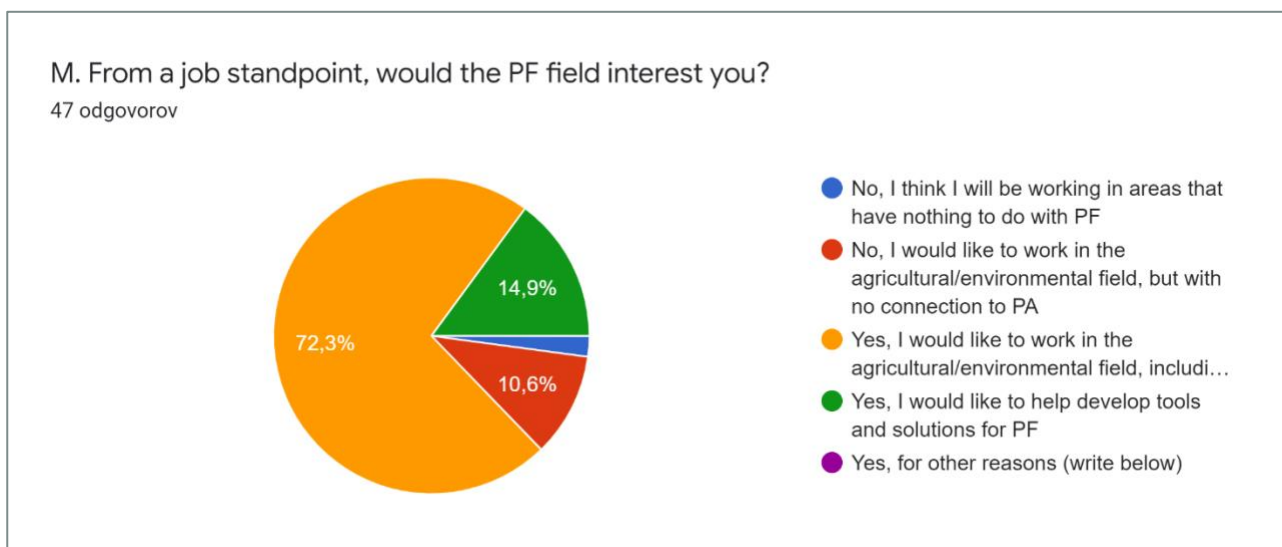

Fig.8 – Statistics Graph: "From a job standpoint, would the PF field interest you?"

An interesting point of view is highlighted in the Fig. 9 that almost 90% of the interviewees perceive necessary to adapt the study plan with a greater integration of the PF theme.
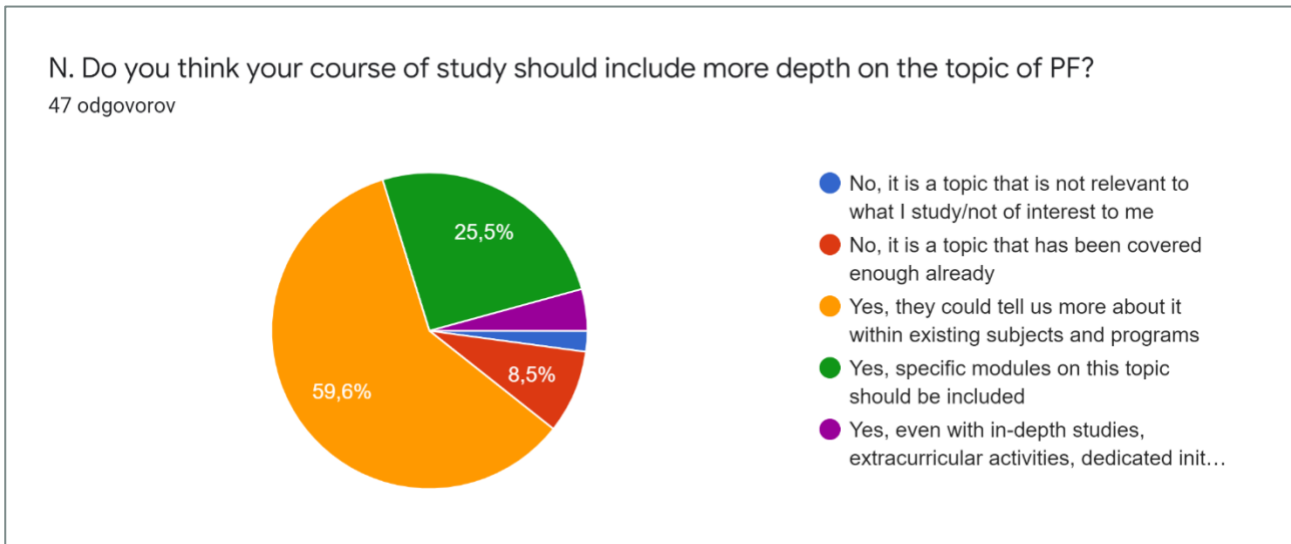

Fig.9 – Statistics: "Do you think your course of study should include more depth on the topic of PF"

The statistics of the answers shown in the graph below (fig. 10) underline that student are aware that, in order to develop PF solutions and systems, it is necessary to involve typical school subjects of Technical Institutes and integrate them with the normal agricultural curricula.
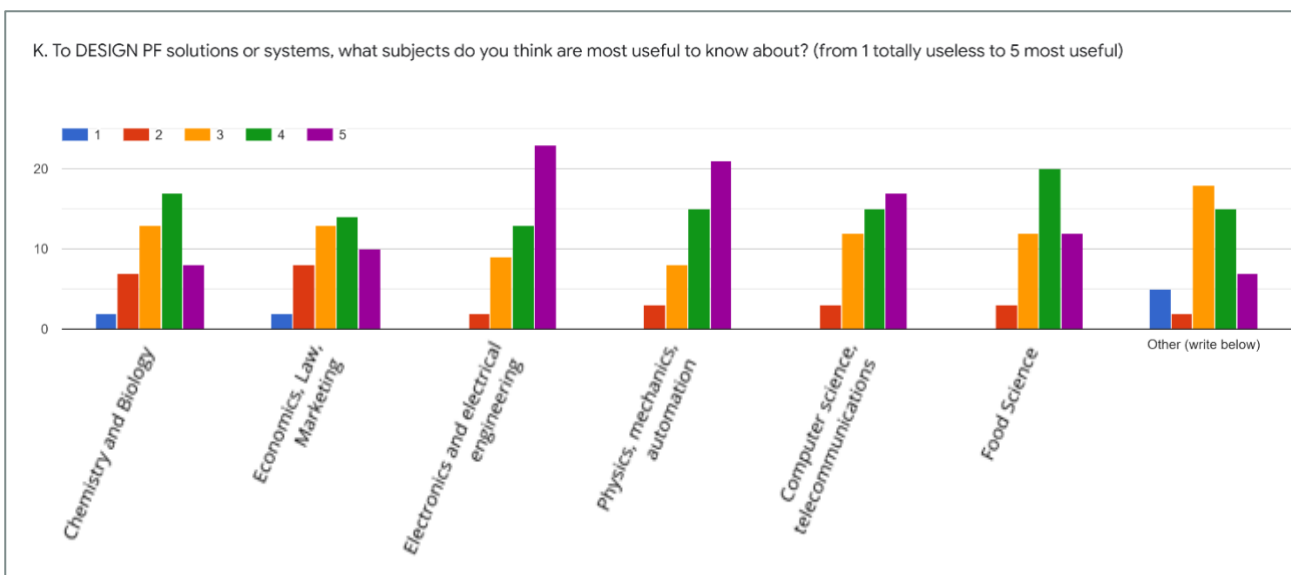

Fig.10 – To DESIGN PF solutions what subjects do you think are useful to know about? (from 1 totally useless to 5 most useful)

As regards the use of PF solutions or systems (fig. 11), students tend to give importance to all the subjects available in the application, with the exception of the ones related to Social Sciences. Also in this case the importance assigned to technical subjects is denoted.
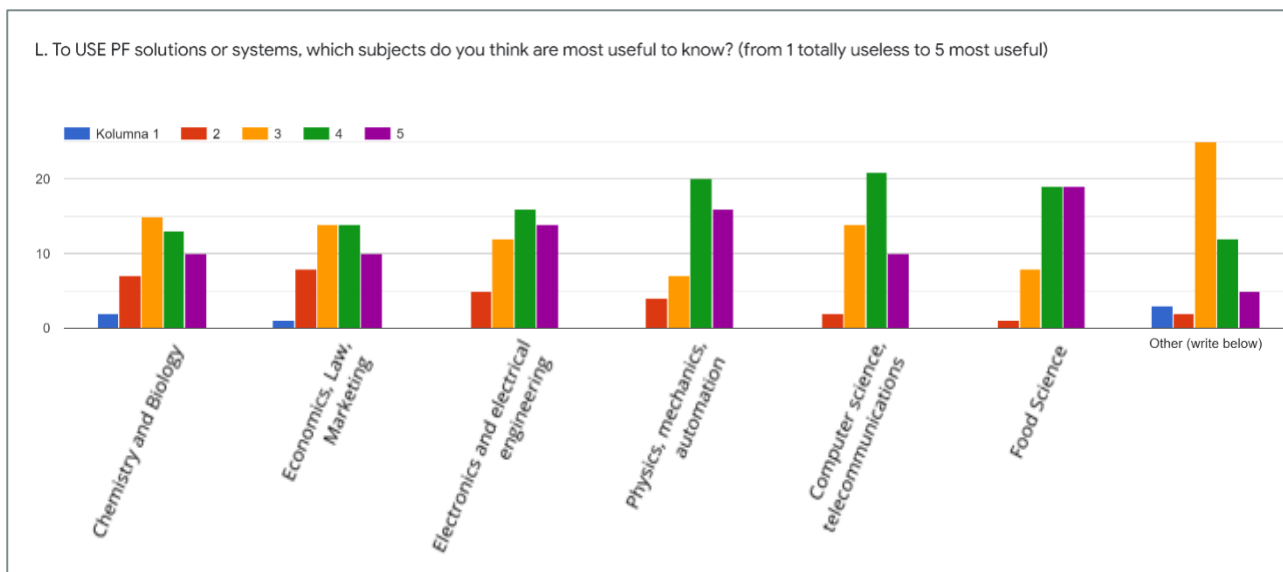
Fig.11 To USE PF solutions, which subjects do you think are most useful to know? (from 1 totally useless to 5 most useful)

3 Questionnaire results in Hungary

In Hungary the specific agricultural education starts in the high school, however students learn about environment, cultivated and wild plants in the elementary school. This questionnaire was shared with technical training schools, vocational schools, and technical schools, high schools in the field of agriculture, horticulture, viticulture, food science, and mechatronics. The preliminary screening has been conducted according to the database of the Educational Authority.

There are five Centers of Agricultural Vocational Training in Hungary:

- Alföldi Center of Agricultural Vocational Training,

- Southern Center of Agricultural Vocational Training,

- Northern Center of Agricultural Vocational Training,

- Kisalföld Center of Agricultural Vocational Training, and

- Central-Hungarian Center of Agricultural Vocational Training.

These Centres offer studies among others in the fields of Agriculture and Forestry, Food industry, Environmental protection and Water management. Selection of the institutes were carried out based on the following keywords: "horticulture", "viticulture", "enology" and "mechatronics".

The questionnaire was translated to Hungarian and uploaded into the on-line survey platform of the Hungarian University of Agriculture and Life Sciences. The survey opened in the beginning of January 2022 and closed on the 15th of February 2022. In December 2021 and January 2022 we were contacting with directors one by one representing schools from all the five Centres of Agricultural Vocational Training. During the phone interviews, we introduced the Transfarm4.0 project and main purposes of the questionnaire. To achieve higher visibility of the project we contacted with the Chancellor of the Central-Hungarian Center of Agricultural Vocational Training. The directors of the schools were open for the contribution; in the same time they underlined that, they do not guarantee that all students will fill the survey. We offered that Hungarian report of the questionnaire would be shared with the schools to use the results if those are useful.

3.1 Participation level

According to the on-line survey platform we reached 298 students with the questionnaire and finally 72 students filled the survey. It means that 24% of the participants answered to all questions. Forty-four percent of the participants attend in vocational secondary schools, while 31% of the participants attend in technical school, and 22% in vocational training school. Thirty percent of the participants were attending in the last year of studies, while 28% in the penultimate year, 3 % percent were not answering this question and the rest of the participants (39%) choose the "other" option as answer. In Hungary, the age of the students in the Agricultural Vocational Training system is not specified. Meaning that both young generation (16-18 years old students) and older generation could attend on the courses depending on the course type. Most frequently older generation enrol in correspondence training (part time training). To reach as many students as possible we opened the questionnaire to all type of trainings and we did not limited restricted the participation according to the age of the respondents.

The major specialization of the responders was management (49%), while 11% were choose cultivation technology and 5% technical. Thirty-one percent marked the "other" option (within this the students studying: viticulture and oenology, wine and champagne technology, agriculture, agricultural mechanical engineering, equestrian) while 4% was not answering to the question.

3.2 Knowledge of the topic

According to the answers, 65% of the students heard about precision farming (Figure 1), while 32% did not know about the technology and 3% were not answering to this question. Among those participants who know about PF, 60% learned about it at the school, while 19% has the knowledge from the Internet, and 10% from other farmers while 5% in their own farm (Figure 2). This result is in accordance with the Hungarian strategy that precision technologies should be included in the education in both the high school and university level.
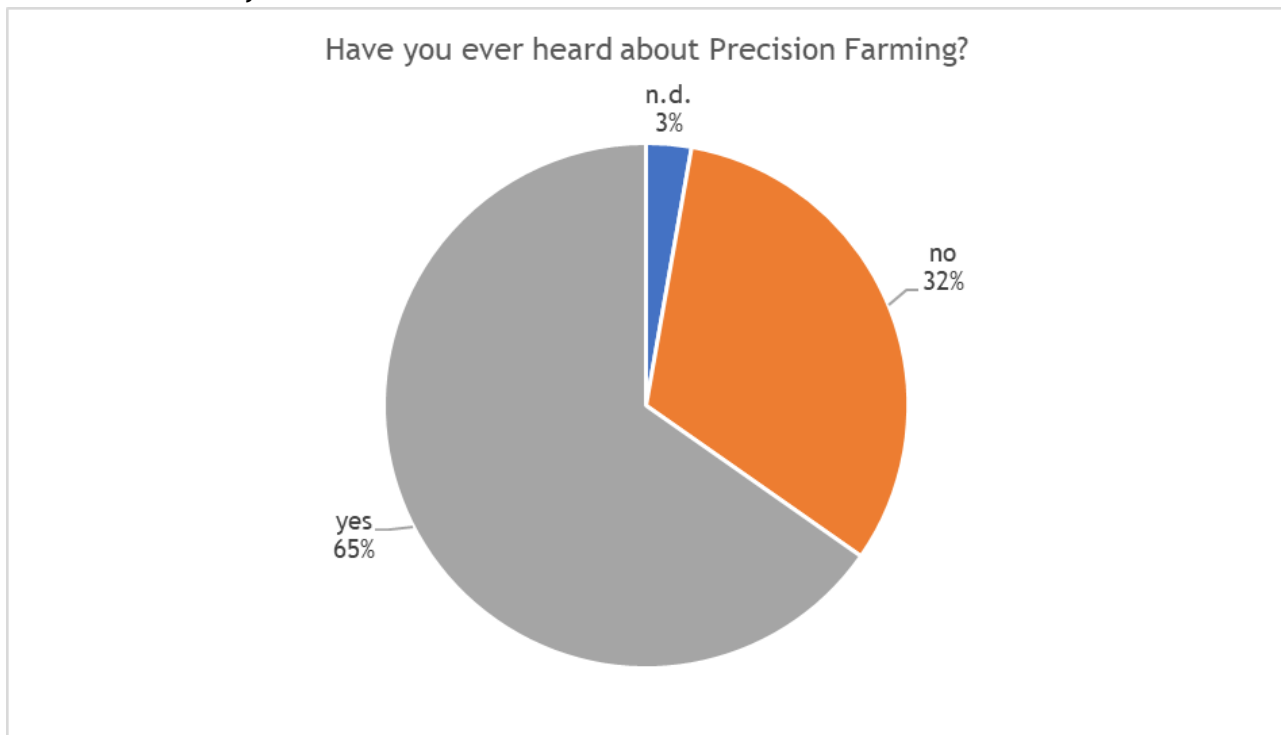

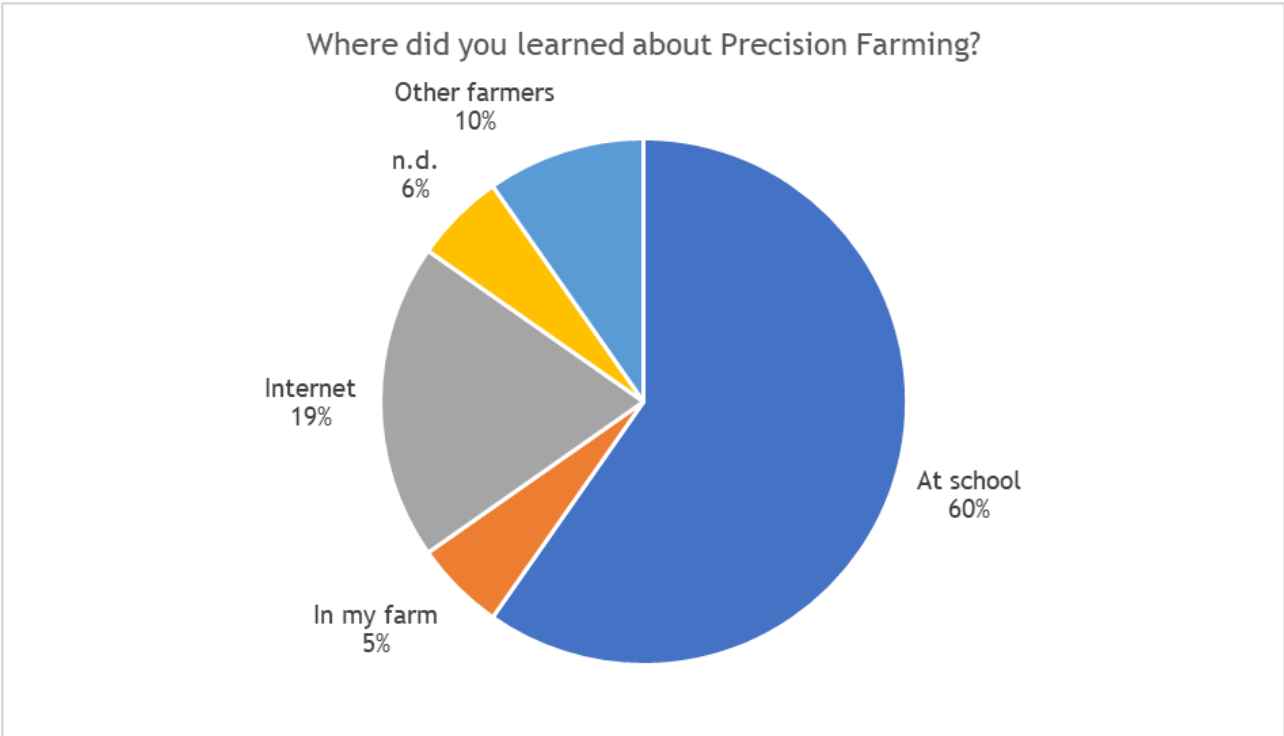*Fig.1 – Hungarian respondent's knowledge about the PF technologies*

Fig.2. Hungarian respondent answers to the question: "Where did you learned about Precision Farming?"

Eighty-one percent of the respondents considered that there is a difference between Precision farming and Digital farming (Figure 3).
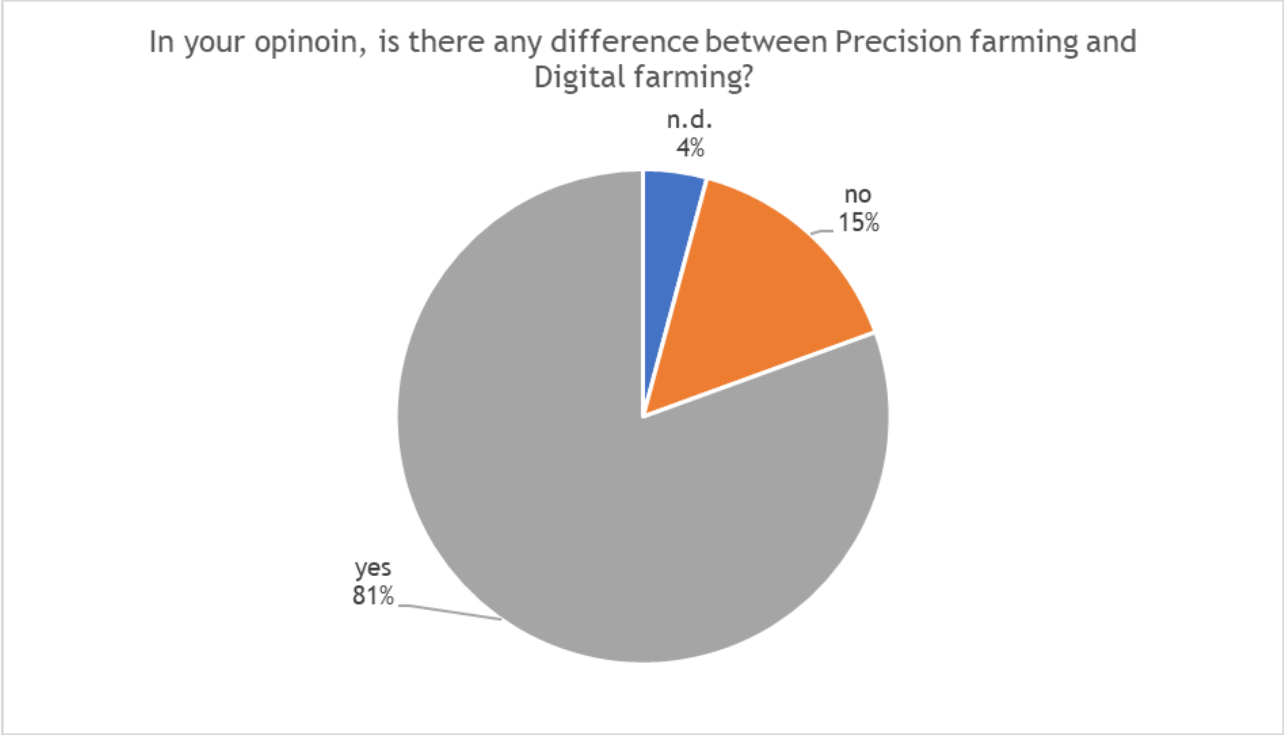

Fig.3 –Answers to the question "In your opinion, is there a difference between Precision farming and Digital farming?"

Concerning the techniques linked to Precision farming, most respondents consider that IoT and Cloud-based data management refers the least to PF (Figure 4). In addition, near-surface remote sensing and

forecast-based plant protection; field soil and chemical sensor were not strongly linked to the PF. Drone technology and variable rate fertilization/plant protection were more linked to the PF technologies. Other surprising result is that 50% of the respondents link automatic steering to the PF technologies, meaning that this technique is considered as the most relevant in precision agriculture. No respondents answered, "I don't know", meaning that all participants have the knowledge about these technologies and have a strong opinion.
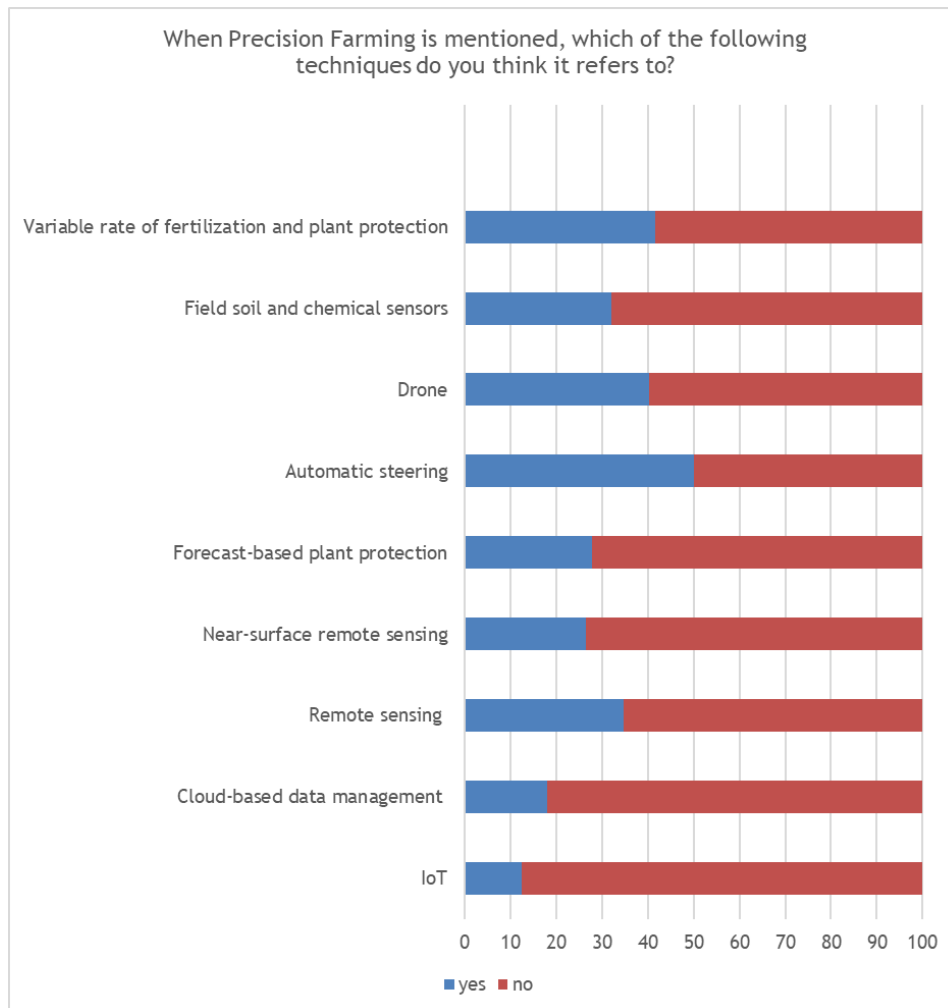

Fig.4- Answers to the question "When precision farming is mentioned, which of the following techniques do you think refers to?"

Targets of this questionnaire were students studying in technical training schools, vocational schools, and technical schools, high schools in the field of agriculture, horticulture, viticulture, food science, and mechatronics. Among the respondents, 26% considered PF as applicable technology in cereal production (Figure 5). This is in agreement with the present state of the PF technologies in Hungary, i.e. PF is more linked to the agricultural production than to any other sectors (horticulture, viticulture). Fifteen to sixteen percent of the respondents considered that PF is applicable in horticulture, fruit growing and viticulture, while 8% think that PF is relevant in dairy. Interestingly 16% of the participants believe that PF is useful in all sectors: cereal, horticulture, fruit growing, viticulture, dairy, while only 1% think that none of the listed sectors would apply PF.

In the next question, respondents were asked to evaluate the importance of certain purposes (Simplify cultivation operations, making crop operations faster, Reduce the physical effort of the operator,

increase farm profitability, make all the operations automatized, Increase the quality of product, Improve corporate sustainability) in PF. Each purpose could be rated from 1 to 5, where 1 means that the purpose is not important, while 5 means very important. Figure 6 showed that most respondents agree with that increasing farm profitability is the most important aspect (sum of points=282, median=4), while simplifying cultivation operations have less importance (sum of points=240, median=3)
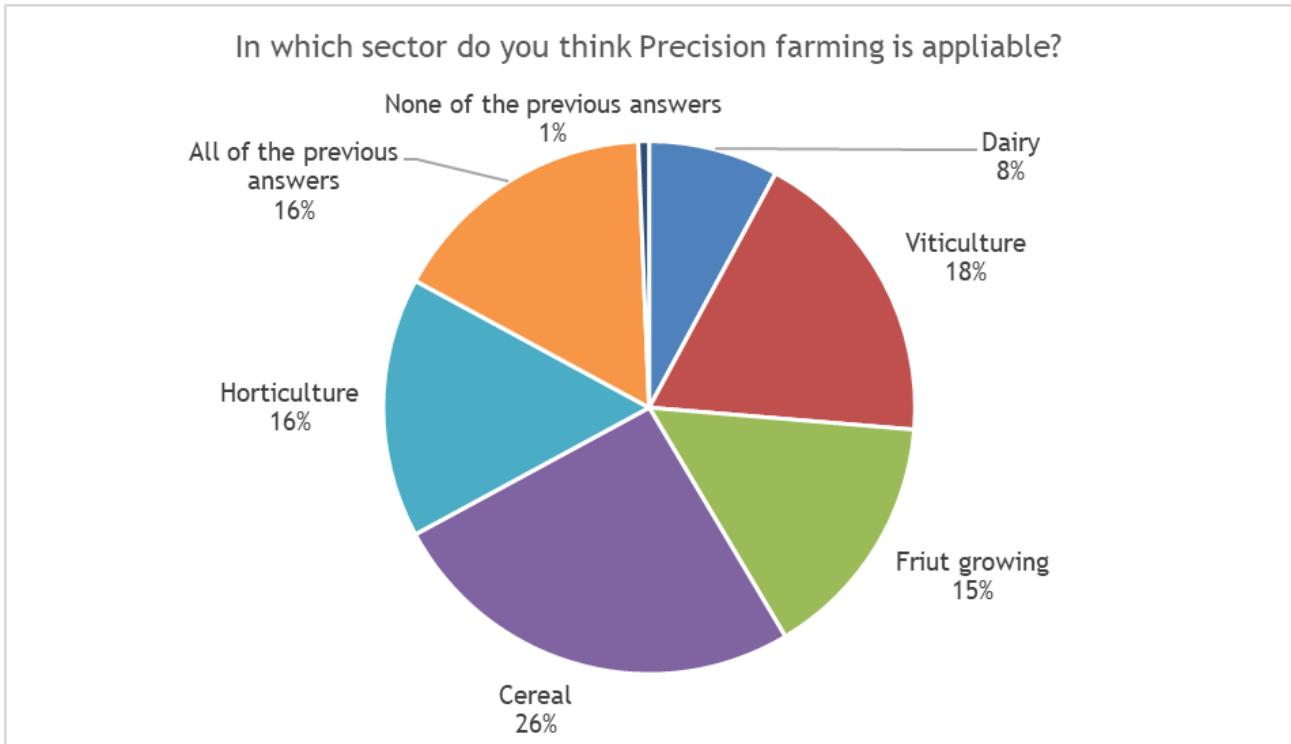

Fig.5 – Answers to the question: "In which sector do you think PF is applicable?"
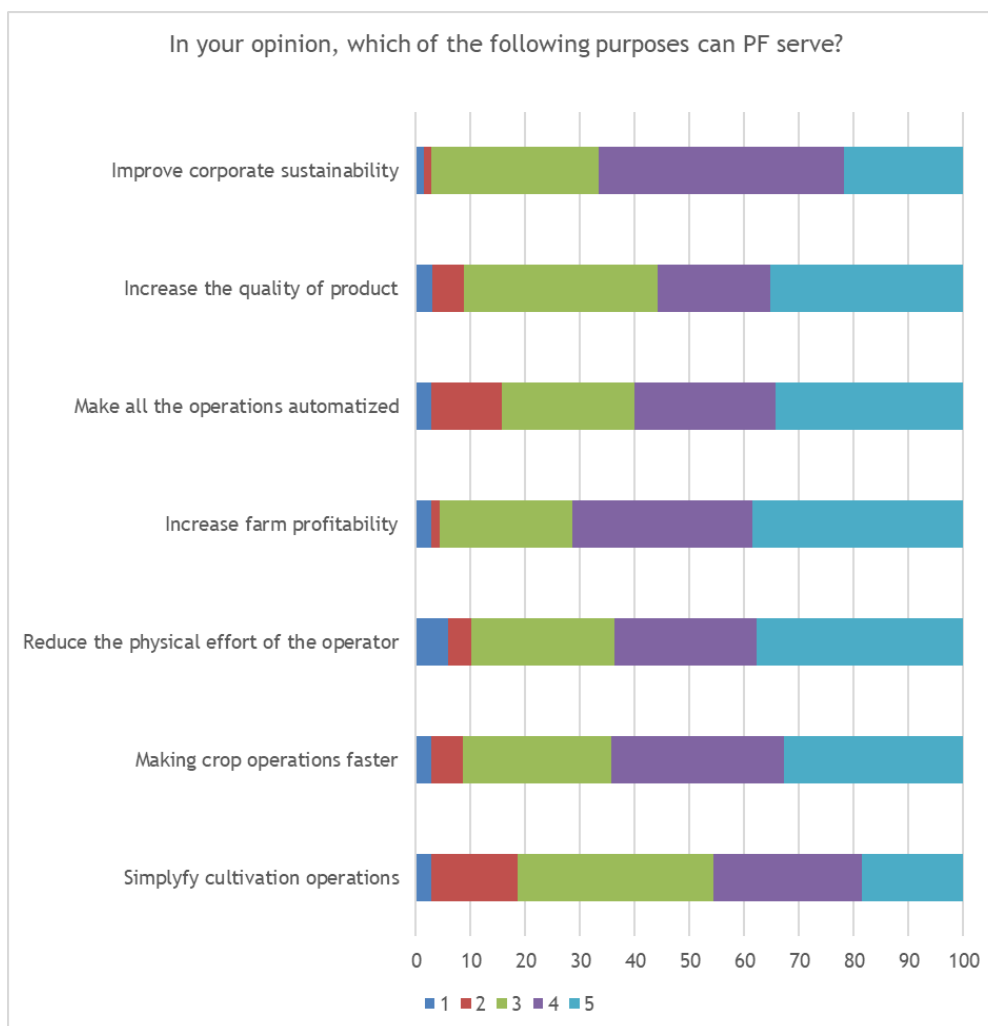
Fig.6 – Answers to the question: *"In your opinion which of the following purposes can PF serve?" (numbers of responds from 1 totally useless to 5 most useful)*

Respondents were asked to rank from 1 to 5 how much they agree with the statements (Figure 7):

- "The agricultural and livestock sectors and their supply chains are very important economic sectors in EU"

    Respondents rate this statement with the highest points, sum of points was 280, median=4). Thirty-seven percent of the respondents totally agree with the statement and 34% agree with it, while only 2.8% do strongly disagree with the statement.

- "In Hungary and the EU, Precision Farming is widespread"

    Forty-one percent of the responders neither agree nor disagree with this question, while 32% and 12% agreed and strongly agreed with the statement respectively. This result is in agreement with our previous findings, that many growers considered PF as present but not widespread in Hungary. Sum of points was 239 (median=3).

- "Precision farming can only be used in large scale farms"

    Most respondents (41%) neither agree nor disagree with the statement, while 21% and 11% agreed and strongly agreed with it. We consider that the students have little knowledge about the economic side of PF and those critical farm size aspects which influencing the spreading of the PF technologies. This would be the reason why most students neither agree nor disagree with it. Sum of points was 211 (median=3).

- "Introducing Precision Farming solutions is very expensive for companies"
  - The answers to this question is in parallel with the former one as, 35% of the respondents neither agree nor disagree with the statement, while 32% strongly agreed with it and 22% agreed. In general we can conclude that high sum of points was given: 263 (median=4), showing that most students consider that PF is an expensive way of growing.
- "Specific skills are required to use Precision Farming"
  - Responders mainly agreed (38%) and neither agree nor disagreed (32%) with the statement, while 22% strongly agreed. Sum of points was 264 (median=4).
- "Specific skills are needed to design Precision farming tools"
  - Same pattern obtained for this question, responders neither agree nor disagreed (34%) and agreed (32%) with the statement. Sum of points was 254 (median=4).
- "Deployment of Precision farming can create new jobs on farms"
  - This question was very important to find out if students consider PF as a possibility to create new positions in agriculture. We found that 37% agreed with the statement while 25% and 21% neither agree nor disagreed and strongly agreed respectively. Sum of points was 251 (median=4).
- "Precision farming deployment can create new jobs in machinery companies"
  - Respondents consider that PF could create jobs more intense in machinery companies than in agriculture. Twenty-one responders neither agree nor disagreed with the statement, while 20 participants agreed and strongly agreed with it. Sum of points was 256 (median=4).
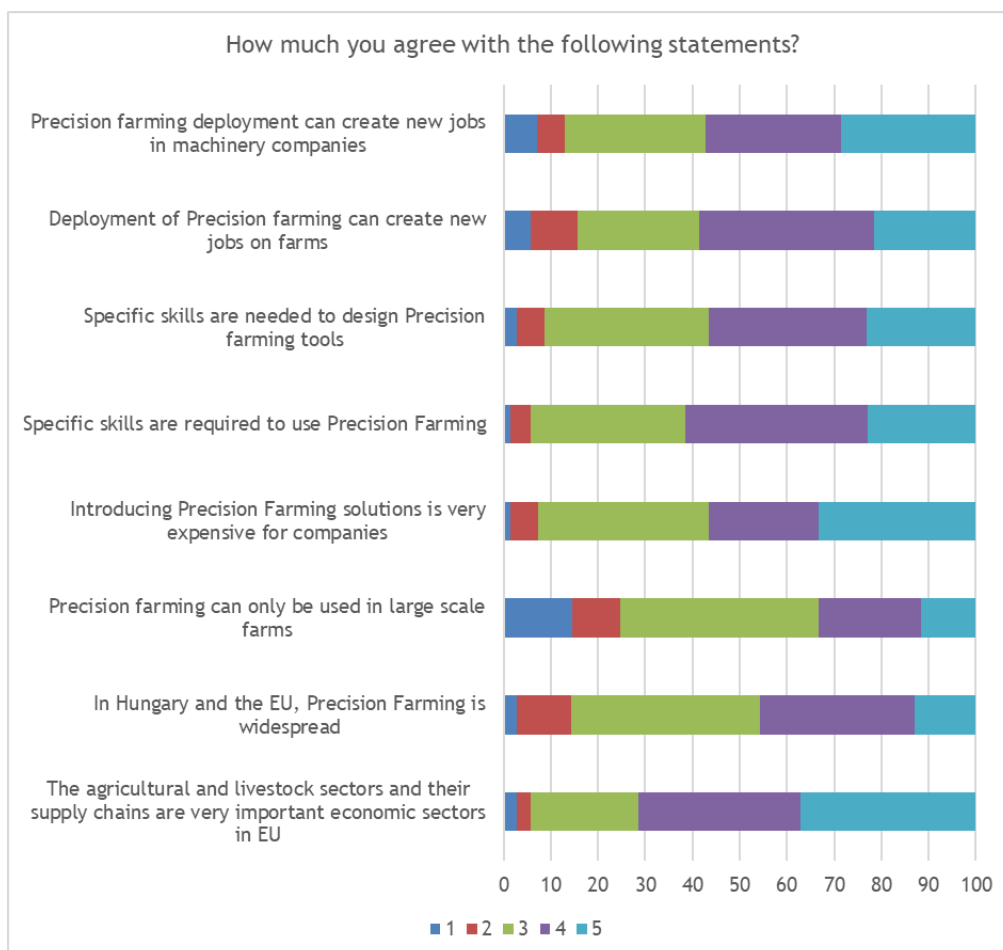

Fig.7 – Responds to certain statements linked to PF (numbers of responds from 1 strongly disagree to 5 strongly agree)

3.3 Attitude and propensity for Precision Agriculture

Most of the respondents (54%) answered that they could work in agricultural or environmental sector and use PF solutions, while 11% could develop tools and solutions for PF. Altogether 31% of the responders will possibly not work with PF technologies for two reasons. Eighteen percent would work in completely different sectors, while 13% considered that he or she will work in the field of agriculture or environment but without the connection to PF technologies (Figure 8).
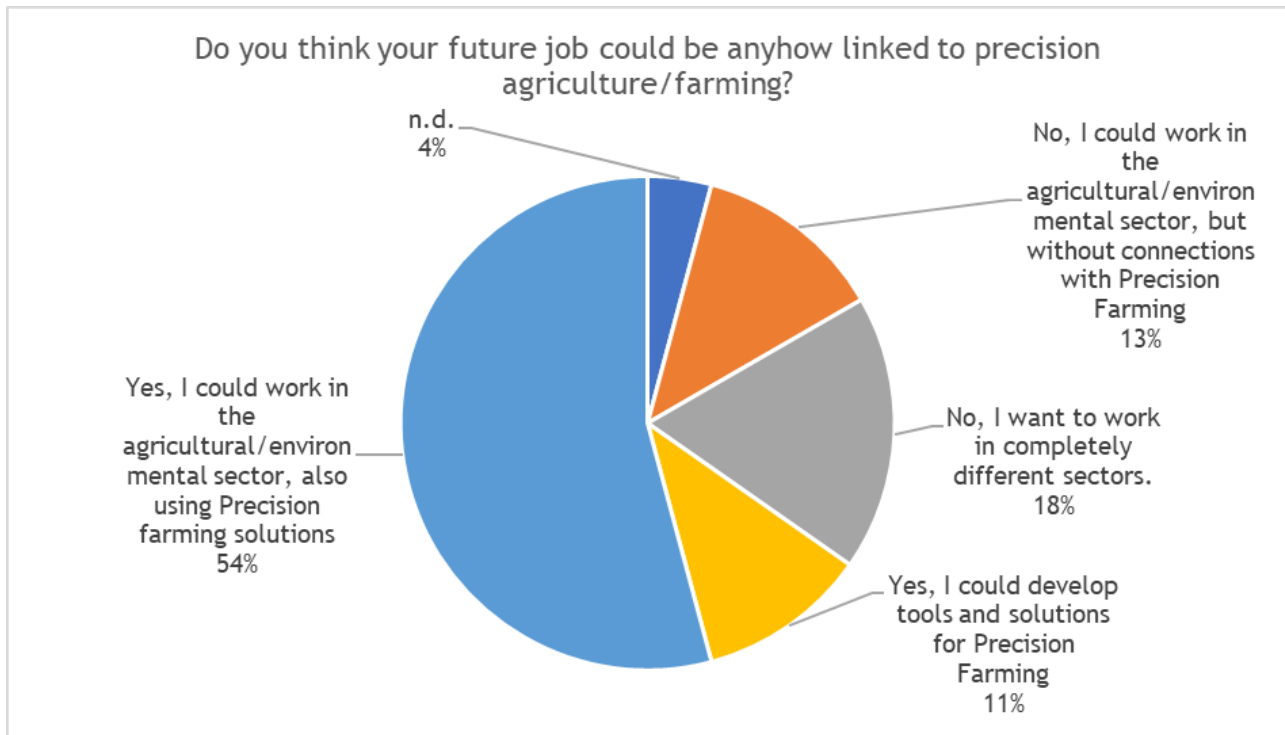

Fig.8 – Responds to the question: "Do you think your future job could be anyhow linked to precision farming/agriculture?"

Concerning the education (Figure 9), 39% of the participants considered that precision farming topics should be better explained as part of the existing subject, while 10% suggest that specific lessons/modules would be beneficial to be included. Fifteen percent of the participants considered that even with supplementary studies or within extra-curricular activities the topic (PF) would be deeper learned. Altogether 31% of the participant things that the PF does not needed to be deeply involved in the education as it is. In more particular 17% considered that it is not relevant to their studies, while 14% things that the topic covered enough. Concerning the courses, the pattern in Figure 10 is almost the same as above, except for that 35% of the participants considered that courses could tell more about PF within existing subjects and programs, while 19% things that specific modules in the topic would be beneficial.
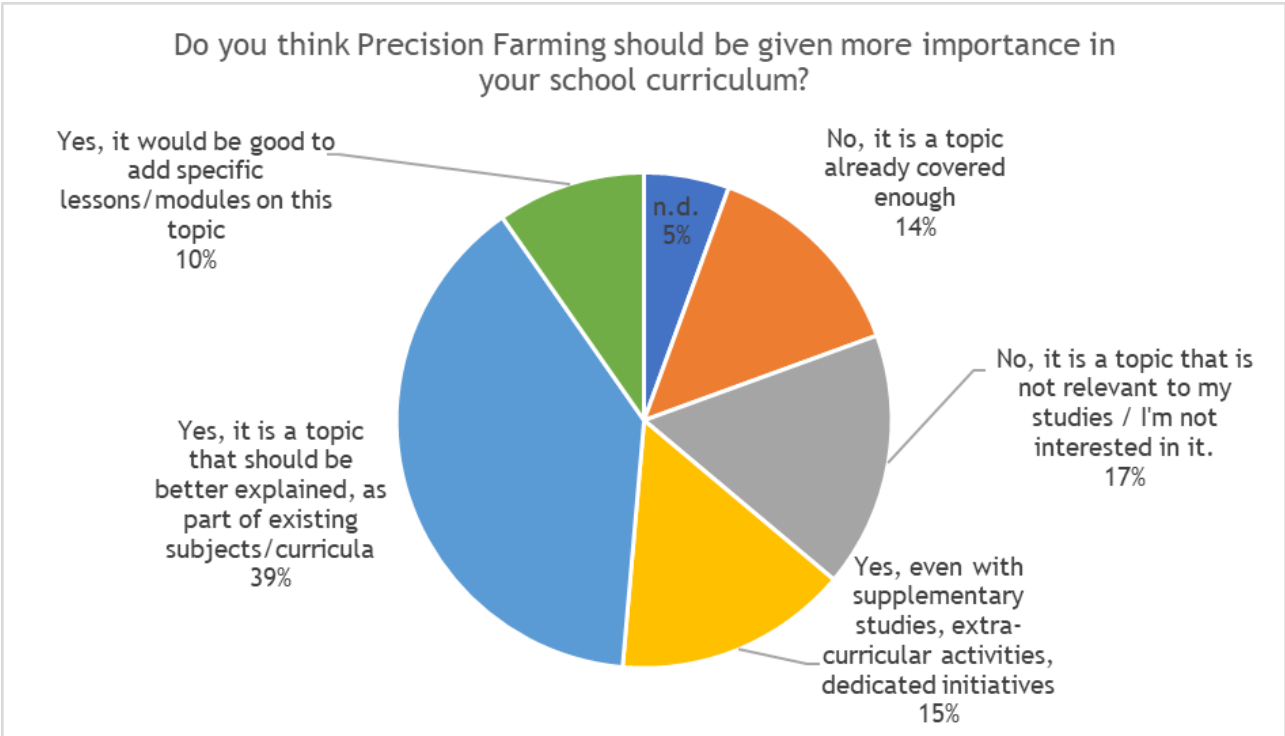
Fig.9 – Responds to the question: "Do you think PF should be given more importance in your school curriculum?"
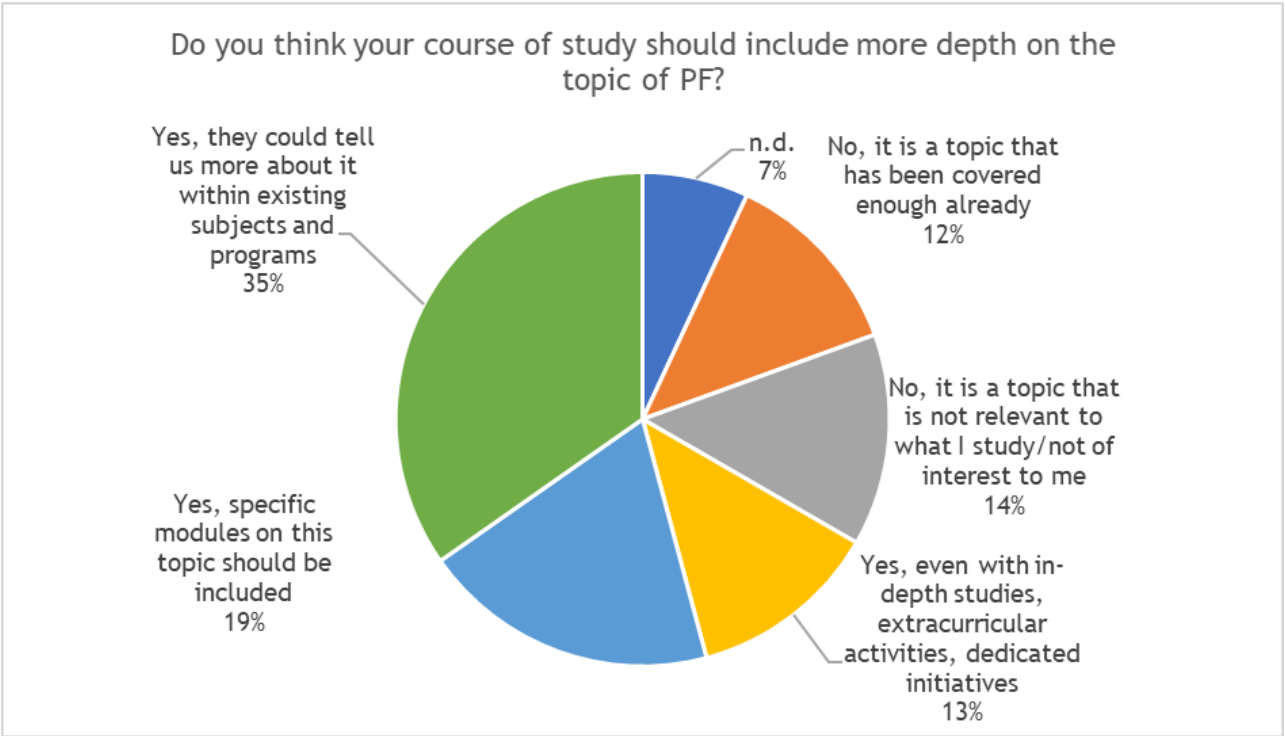

Fig.10 – Responds to the question: "Do you think PF should include more depth on the topic PF?"

Participants were requested to evaluate the usefulness of the following subjects in the Design of PF solution (Figure 11):

- Chemistry and Biology
- Economics, Law, Marketing
- Electronics and electrical engineering
- Physics, mechanics, automation
- Computer science, telecommunications
- Food science
- Other (please, specify)

According to the sum of point given to each of the subjects Computer science and telecommunication, and Physics, mechanics, automation (sum of points 270 and 263 respectively, median=4) are considered as the most important subjects while Economics, law and marketing were considered as the least useful (sum of points 231, median=3) (Figure 11). The same pattern was observed when the same subjects were evaluated according to those usefulness to use PF solutions (Figure 12). One of the participants specified which topic would be useful to be involved in the education, this topic was "cryptography". In the context of data management, data security and protection of the digital information this topic a relevant subject to be involved in the education.

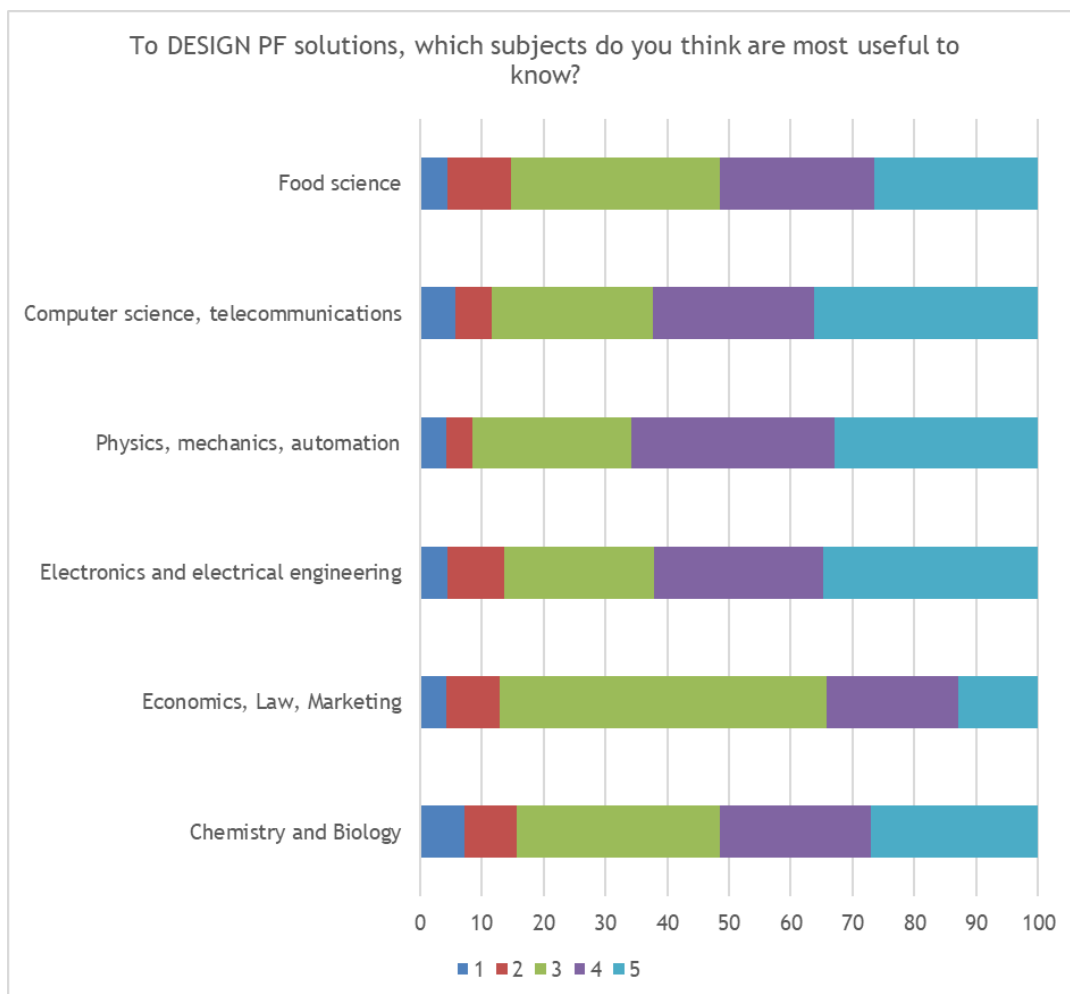Fig.11 – To DESIGN PF solutions, which subjects do you think are most useful to know? (from 1 totally useless to 5 most useful)
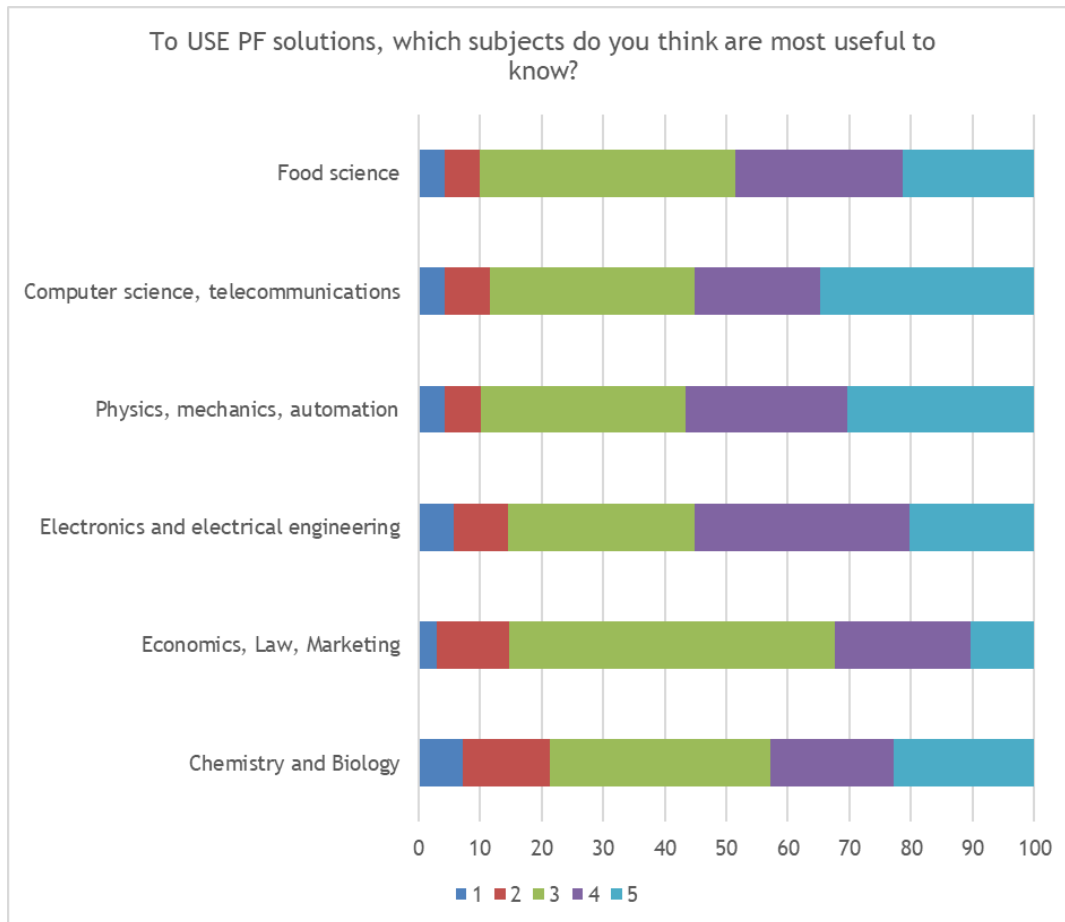
Fig.12 – To USE PF solutions, which subjects do you think are most useful to know? (from 1 totally useless to 5 most useful)

4 Questionnaire results in Austria

In Austria the questionnaire has engaged the 4th and 5th grades of secondary schools of the Regions of Upper Austria and Lower Austria which include in their study plan characterizing subjects and activities relevant for research purposes: agriculture, precision agriculture, mechanics, mechatronics, electronics, and electrical engineering.

4.1 Participation level

The activity was proposed to a total of 17 higher technical schools in the Regions of Upper Austria and Lower Austria.

The institutes were contacted in December 2022 by e-mail from Francisco Josephinum for Lower Austria and from LCM for Upper Austria, in which the initiative was presented, and the actors were invited to participate by distributing the questionnaire among the students of their complex.

In total, 49 replies from Upper Austria and Lower Austria were received. It is not possible to assign the answers to the institutes due to the anonymous nature of the question.

4.2 Knowledge of the topic

Based on the answers to the questionnaire, about 80% of the respondents had already heard of Precision Farming (Fig. 1). Most of the students (about 80%) have heard of it at school. Another important source is the internet (Fig. 2). The topic of PF is not commonly learned from farmers and from magazines.
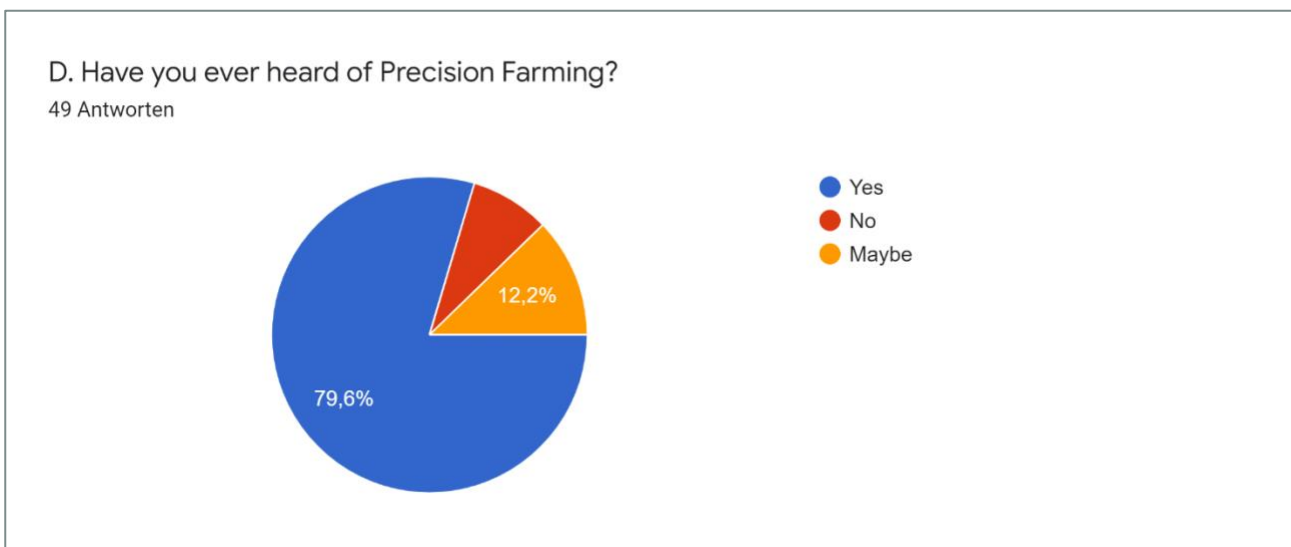

Fig.1 Answers to the question "Have you ever heard of PF?"

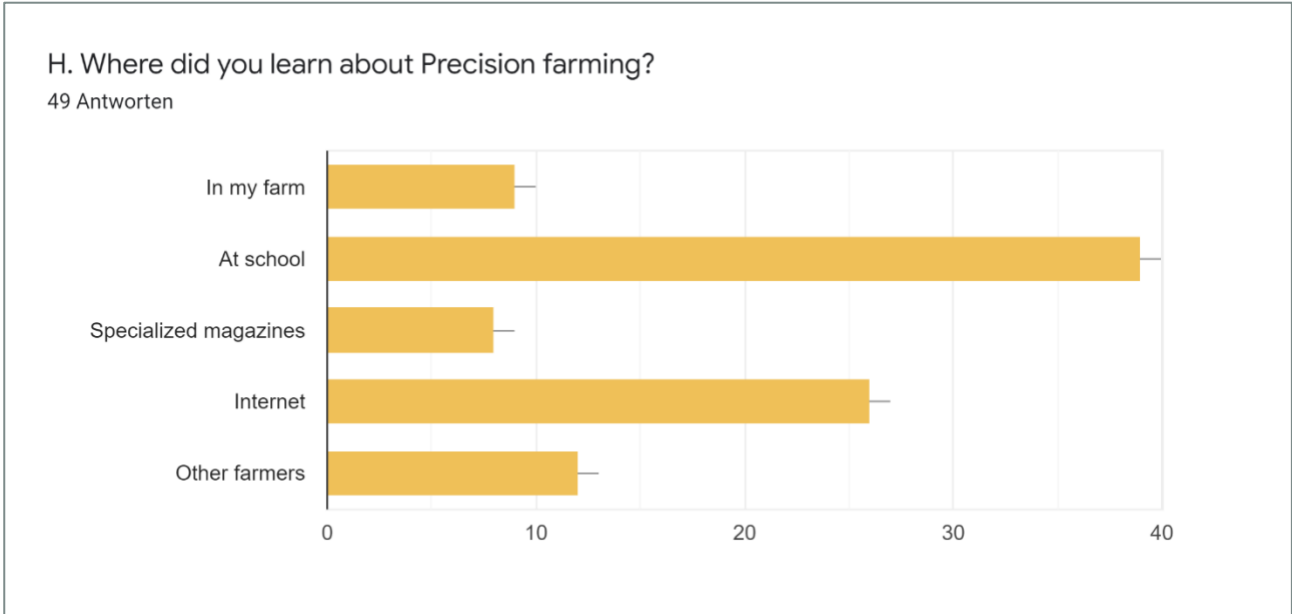## H. Where did you learn about Precision farming?
49 Antworten

Fig.2 – Answers to the question "Where did you learn about PF?"

The next graph shows how a clear majority of students distinguish Precision Farming from Digital Farming (Fig 3).

E. In your opinion is there any difference between Precision Farming and Digital Farming?
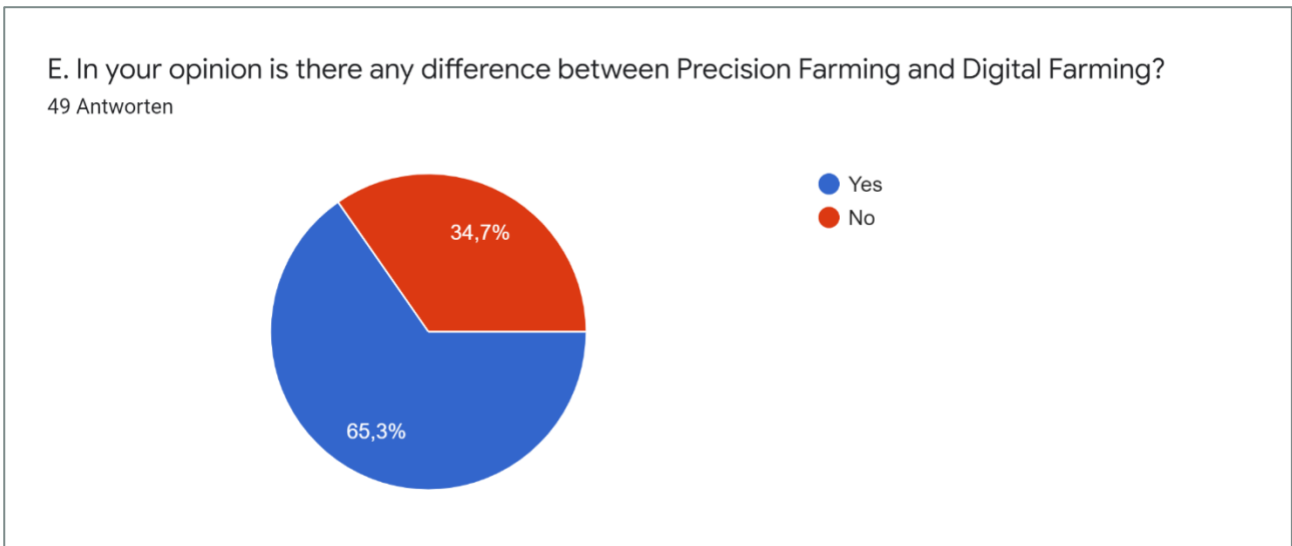49 Antworten

● Yes
● No

34,7%

65,3%

Fig.3 Answers to the question "In your opinion, is there a difference between PF and DF?" in percentage

This trend is not confirmed by the questionnaire question where students are asked to identify the techniques of Precision Farming. Most of the technologies are connected at the precision farming, even dough they belong to digital farming.
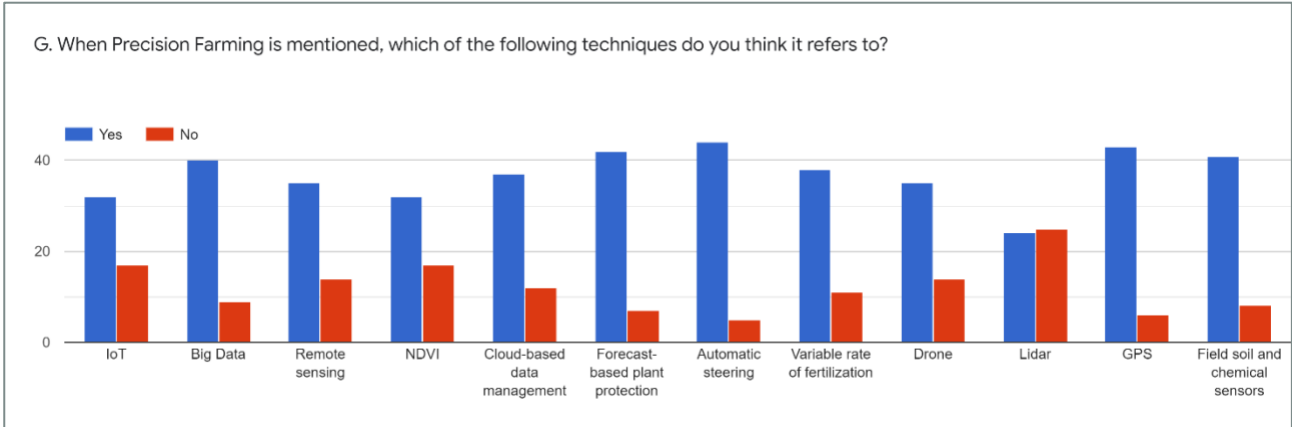
Fig.4 "When we talk about PF, in your opinion, which of the following techniques are we referring to?"

As regards the concrete application of Precision Agriculture techniques (Fig. 5), over half of the interviewees believe that PF is applicable in the sector of cereals. Also in the other sectors, PF is assumed to be applicable by more than 30% of the attendees, while only one attendee considers that PF is not applicable in any field.
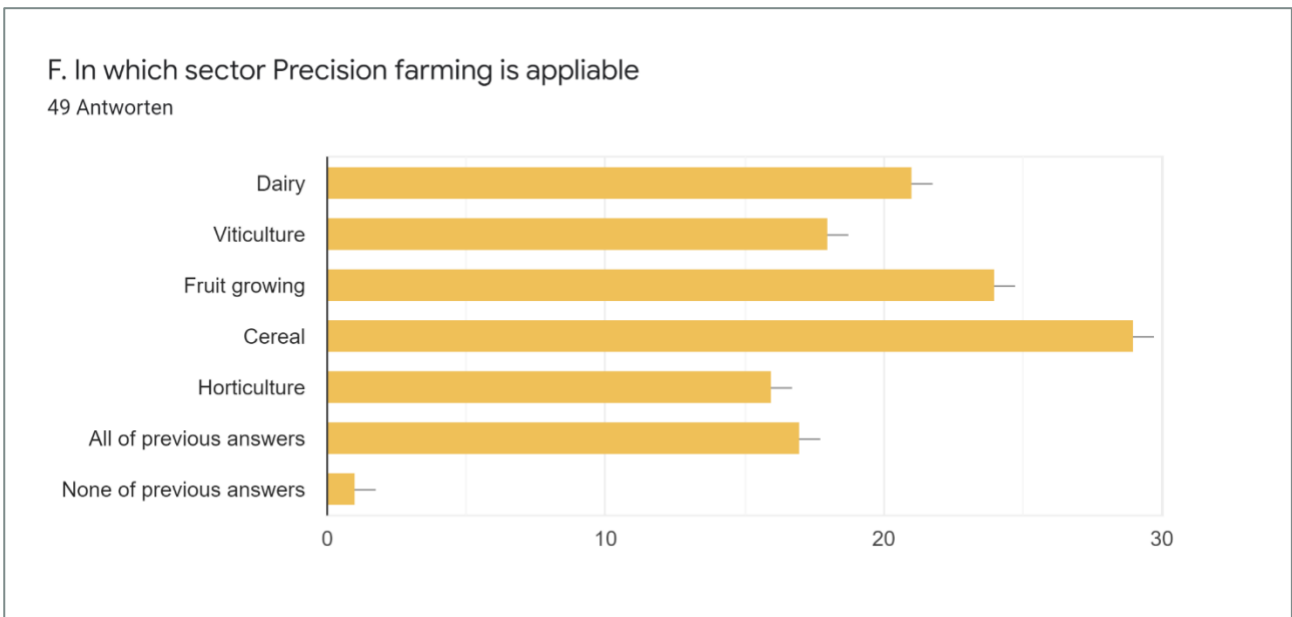

Fig 5 Statistics Graph: "In which sector do you think the PF is applicable"

The usefulness of applying PA techniques is a substantially well supported topic by the majority of students most of them agree in it usefulness in its different possible applications (Fig. 6). Only few students assume that PF is not useful for the queried topic.
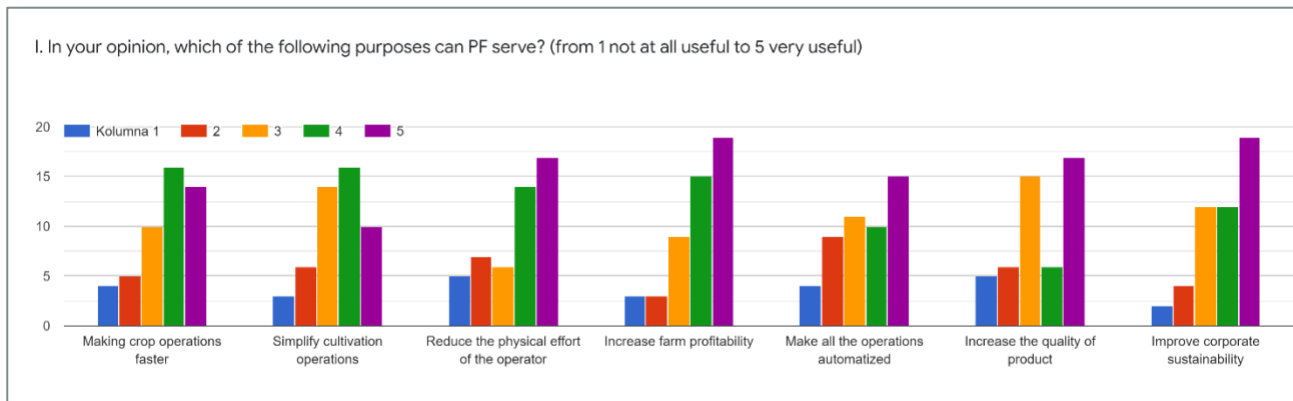
Fig.6 In your opinion, which of the following purposes can PF serve? (from 1 not at all useful to 5 very useful)

Other interesting information can be deduced from the statistics shown in the graph below (Fig. 7). The students do not fully agree with the following 8 statements (listed here, since the questions cannot be seen in the graph):

- Statement 1: The agricultural and livestock sectors and their supply chains are very important economic sectors in EU

- Statement 2: In Austria and the EU, PF is widespread

- Statement 3: PF can only be used in large scale farms

- Statement 4: Introducing PF solutions is very expensive for companies

- Statement 5: Specific skills are required to use PF

- Statement 6: Specific skills are needed to design PF tools

- Statement 7: Deployment of PF can create new jobs on farms

- Statement 8: PF deployment can create new jobs in machinery companies

Student think primary sector is a key sector in EU, PF is developed but can be improved and it can be adopted in all the farms, on the other side its introduction is not cheap and requires specific know-how.

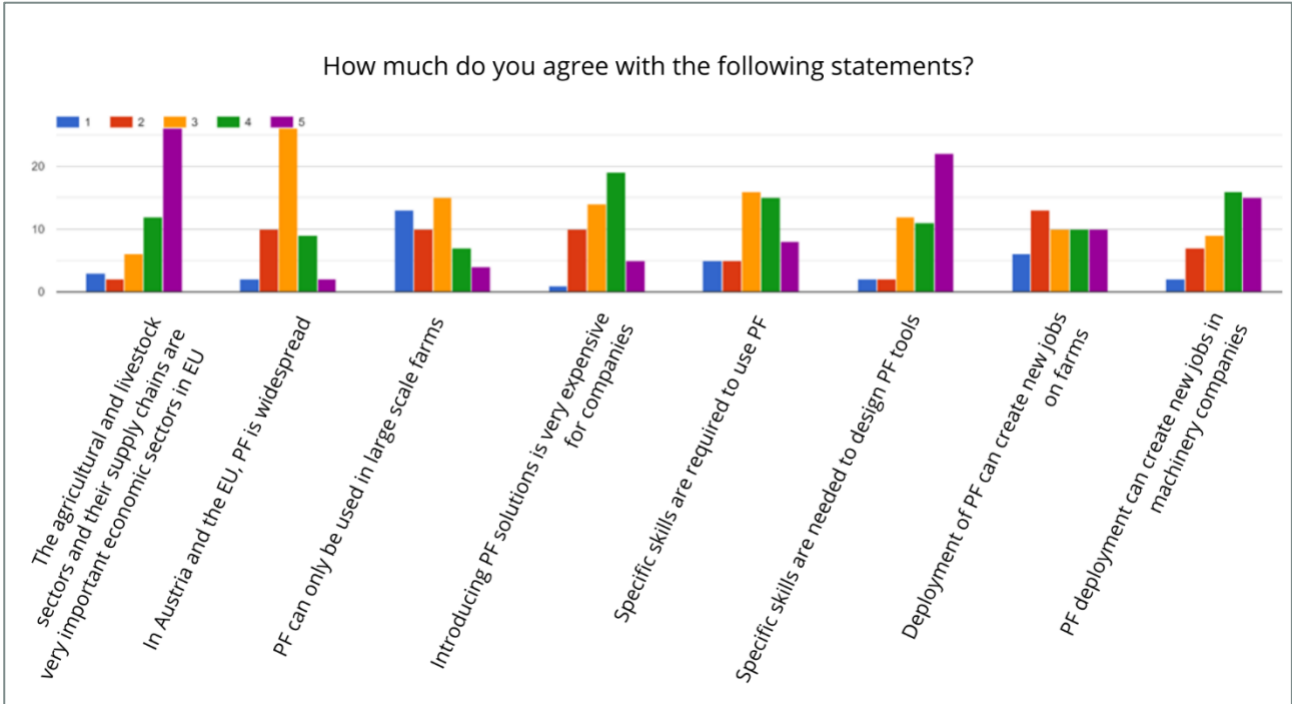How much do you agree with the following statements?

Fig.7 How much do you agree with the following statements? (from 1 totally false to 5 totally true)

4.3 Attitude and propensity for Precision Farming

The propensity of students to the precision agriculture sector is well evidenced by the statistics of the responses relating to the workplace and to school education. The majority of students (over 50%) show their interest in the sector in adopting PF techniques in their future careers (Fig. 8). Around 25% of the interviewees did not showed an interst toward PF in their future career.

M. From a job standpoint, would the PF field interest you?
49 Antworten

- No, I think I will be working in areas that have nothing to do with PF
- No, I would like to work in the agricultural/environmental field, but with no connection to PA
- Yes, I would like to work in the agricultural/environmental field, includi…
- Yes, I would like to help develop tools and solutions for PF
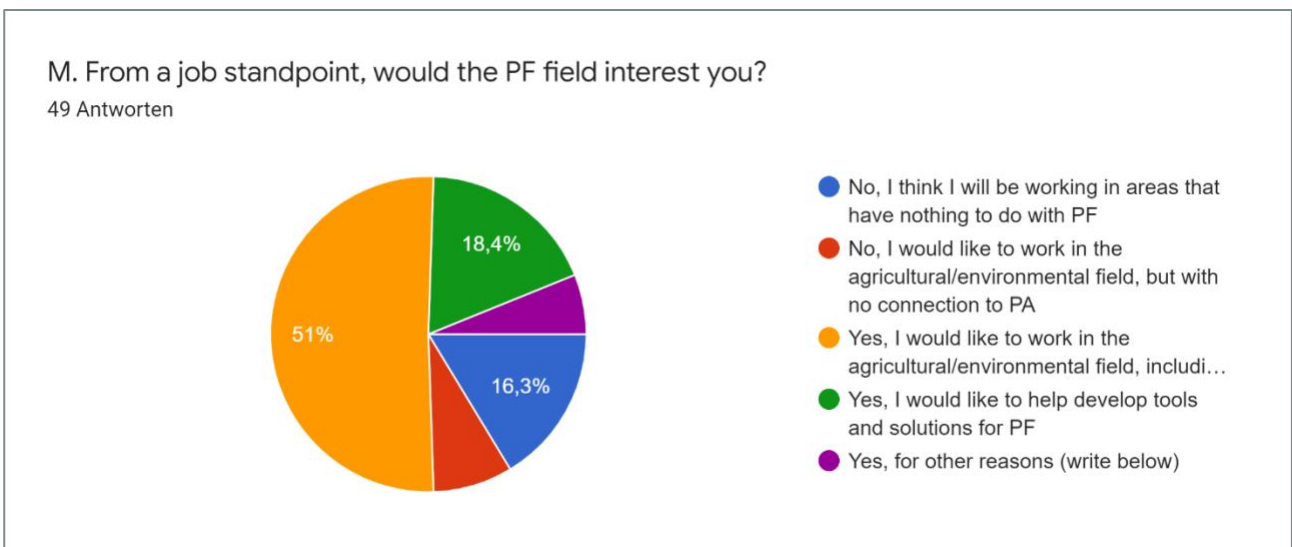- Yes, for other reasons (write below)

Fig. 8 – Statistics Graph: "From a job standpoint, would the PF field interest you??"

The most interesting data is the one in which it is highlighted that approximately 75% of the interviewees (Fig. 9) think as necessary to update the study plan with a greater space of the PF theme. Student perceive PF an important sector to be studied and deepened.
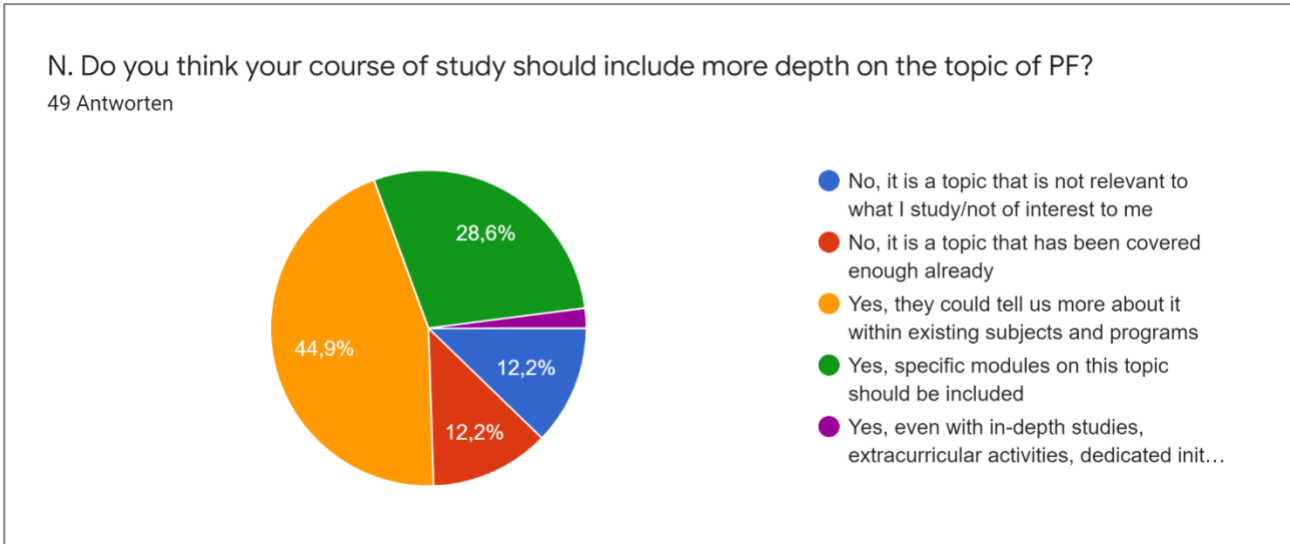

Fig.9 – Statistics: "Do you think your course of study should include more depth on the topic of PF"

The statistics of the answers shown in the graph below (Fig. 10) underline that students are aware that, in order to develop PF solutions and systems, it is necessary to increase typical school subjects present in Technical Institutes (for example: electronics and electrical engineering, physics, mechanics, automation, computer science, telecommunications), while on the other side only few students assume that subjects belonging to economics, law, marketing or food science are most useful.
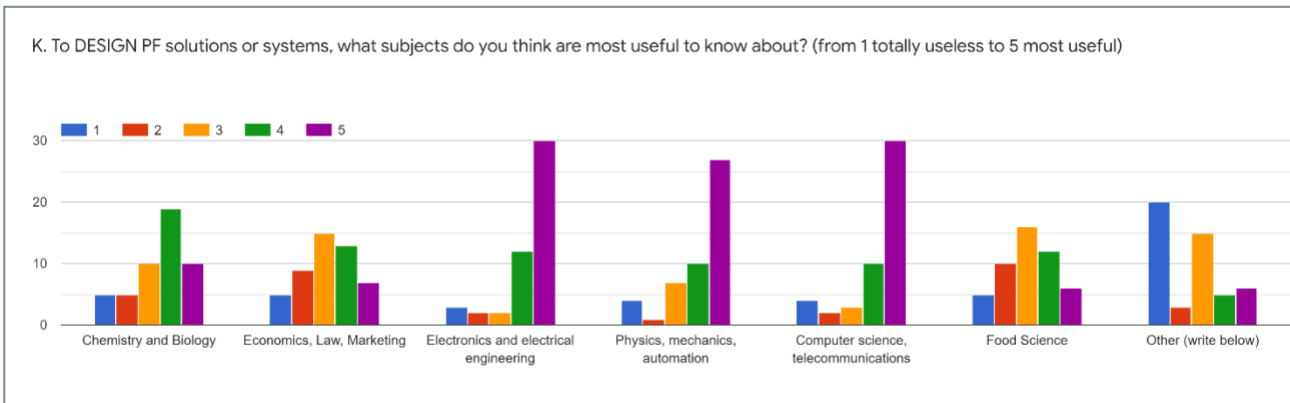
Fig.10 – To DESIGN PF solutions what subjects do you think are useful to know about? (from 1 totally useless to 5 most useful)

As regards the use of PF solutions or systems (Fig. 11), the results are similar to those of the previous question regarding the design of PF solutions, technical education is required to adopt PF practices.
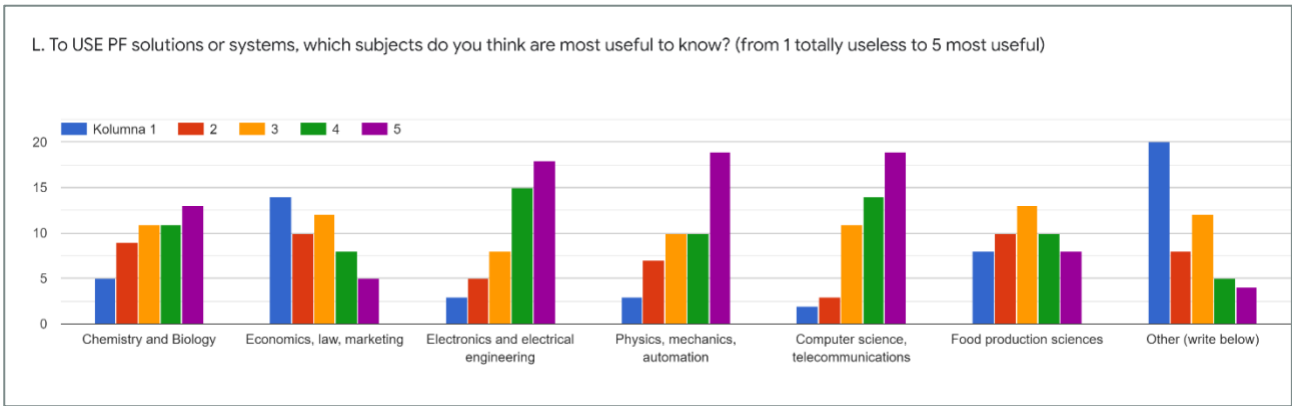
Fig.11 – To USE PF solutions, which subjects do you think are most useful to know? (from 1 totally useless to 5 most useful)

5 Questionnaire results in Poland

In Poland the questionnaire has engaged the 4th and 5th grades of secondary schools which include in their study plan characterizing subjects and activities relevant for research purposes: agriculture, precision agriculture, mechanics, mechatronics, electronics, and electrical engineering.

5.1 Participation level

In Poland, the screening has been conducted listing all the high school institutes and then it has been made a selection through the institutes according to their compatibility with the topics covered in Transfarm 4.0. The high schools thus selected were presented with the initiative and invited to participate by distributing a questionnaire to the students of their complex. As a result, 50 completed questionnaires were received. Due to the anonymous nature of the question it is not possible to allocate the answers to individual institutes.

5.2 Knowledge of the topic

Based on the answers to the questionnaire, half of the respondents had already heard of Precision Farming (Fig. 1). Most of the students (84 %) have heard of it at school. Another important source is the internet (Fig. 2).
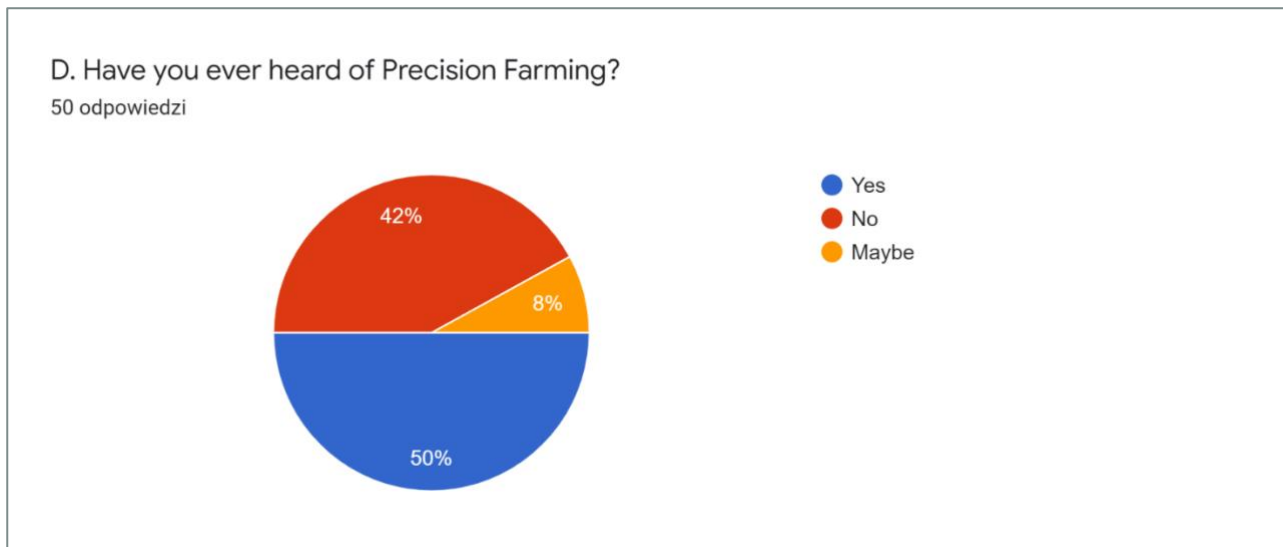

Fig.1 Answers to the question "Have you ever heard of PF?"

H. Where did you learn about Precision farming?

50 odpowiedzi

- In my farm — 4 (8%)
- At school — 42 (84%)
- Specialized magazines — 3 (6%)
- Internet — 24 (48%)
- Other farmers — 5 (10%)
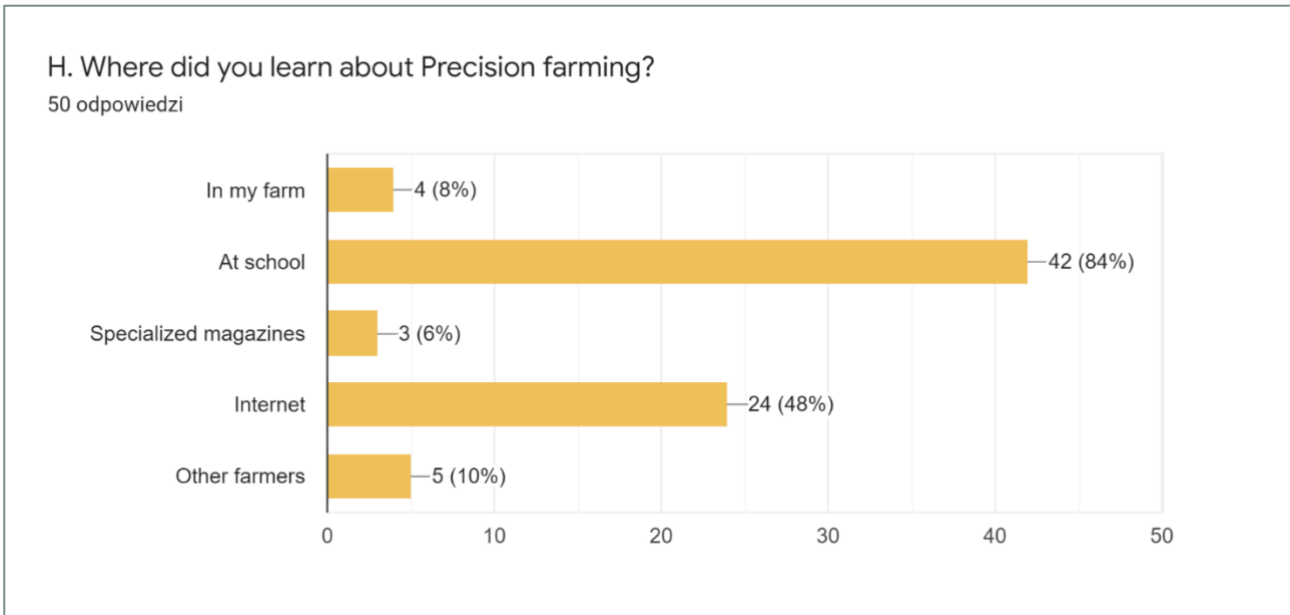
Fig 2 – Answers to the question "Where did you learn about PF?"

The second graph shows how more than half of students distinguish Precision Farming from Digital Farming (Fig 3).

E. In your opinion is there any difference between Precision Farming and Digital Farming?

50 odpowiedzi

- Yes
- No

48%

52%

Fig.3 Answers to the question "In your opinion, is there a difference between PF and DF?" in percentage

This trend is not confirmed by the questionnaire question where students are asked to identify the techniques of Precision Farming (Fig.4). The students' answers are the following:

- Field soil and chemical sensors: 96%
- Drone: 88%
- Variable rate of fertilization: 78%
- Forecast-based plant protection: 76%
- Big data: 76%

- Remote sensing: 74%

- GPS: 68%

- Automatic steering: 60%

- Cloud-based data management: 54%

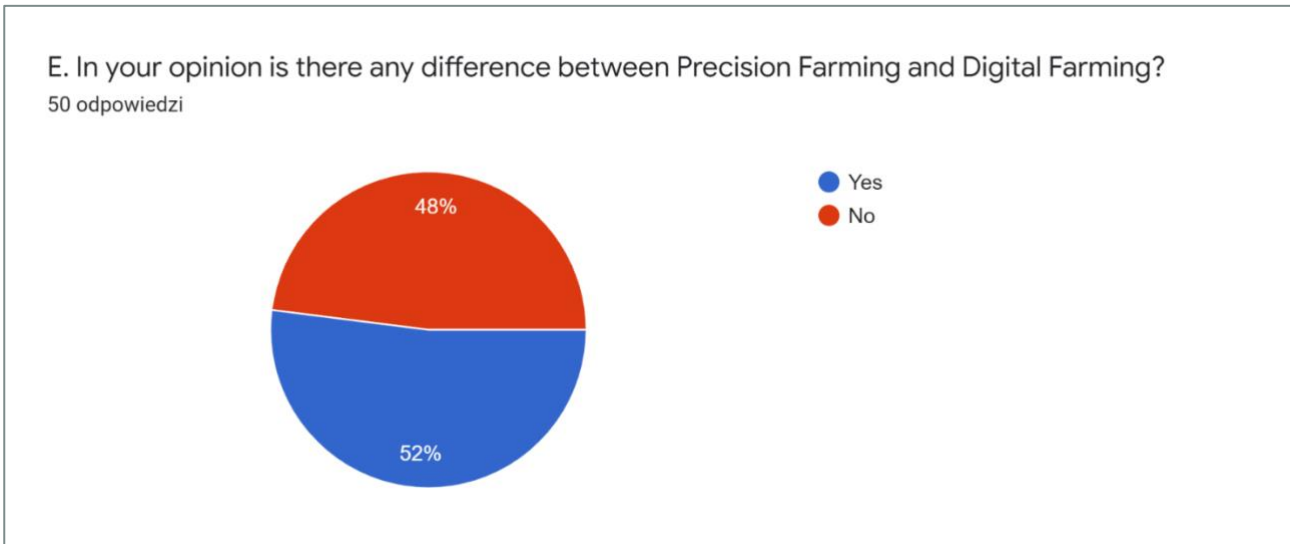- Lidar: 42%

- NDVI: 38%

- IoT: 36%
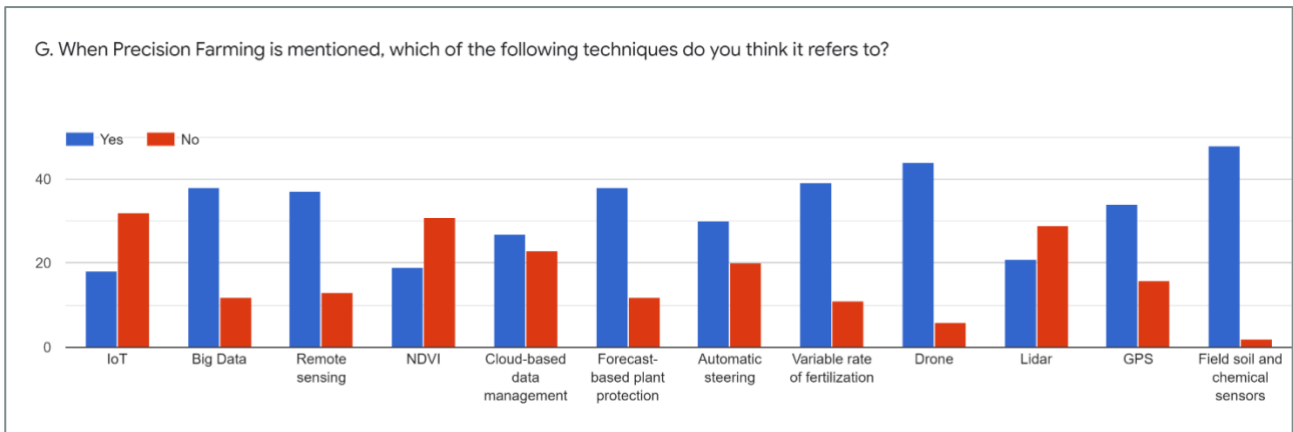
Fig.4 Answers to the question "When PF is mentioned, which of the following techniques do you think it refers to?"

As regards the concrete application of Precision Agriculture techniques (Fig. 5), above three quarters of the interviewees (76%) believe that all the sectors taken into consideration are interested in PF techniques, while only a few (8%) are those who do not consider the development of the PF to be applicable in any field.

Fig.5 Statistics Graph: "In which sector Precision farming is applicable"

The usefulness of applying PF techniques is a substantially well supported topic by the majority of students (Fig. 6). It is interesting to note that one of the questions that found the most perplexity about the purpose of the PF there is the one relating to increase farm profitability. An aspect that deserves further study.
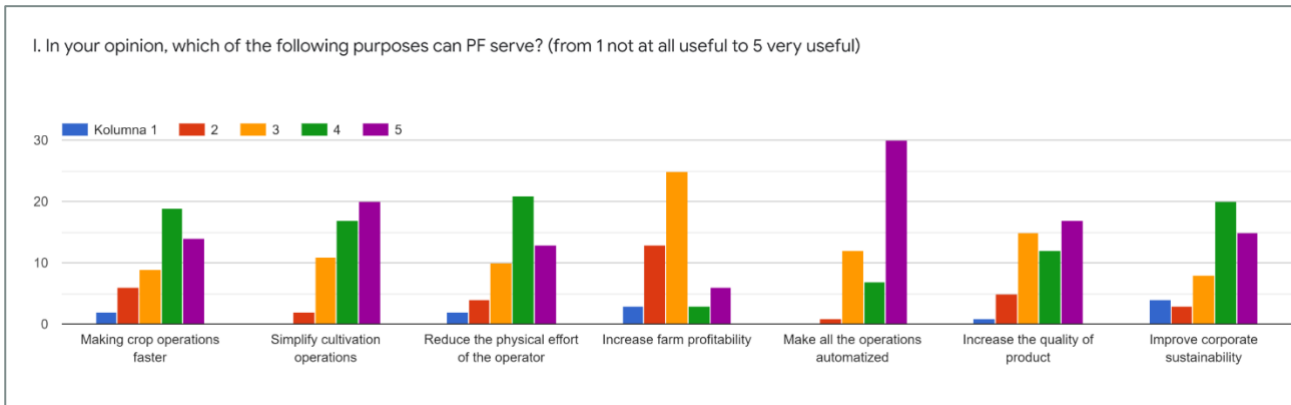
Fig.6 Answers to the question "In your opinion, which of the following purposes can PF serve?"
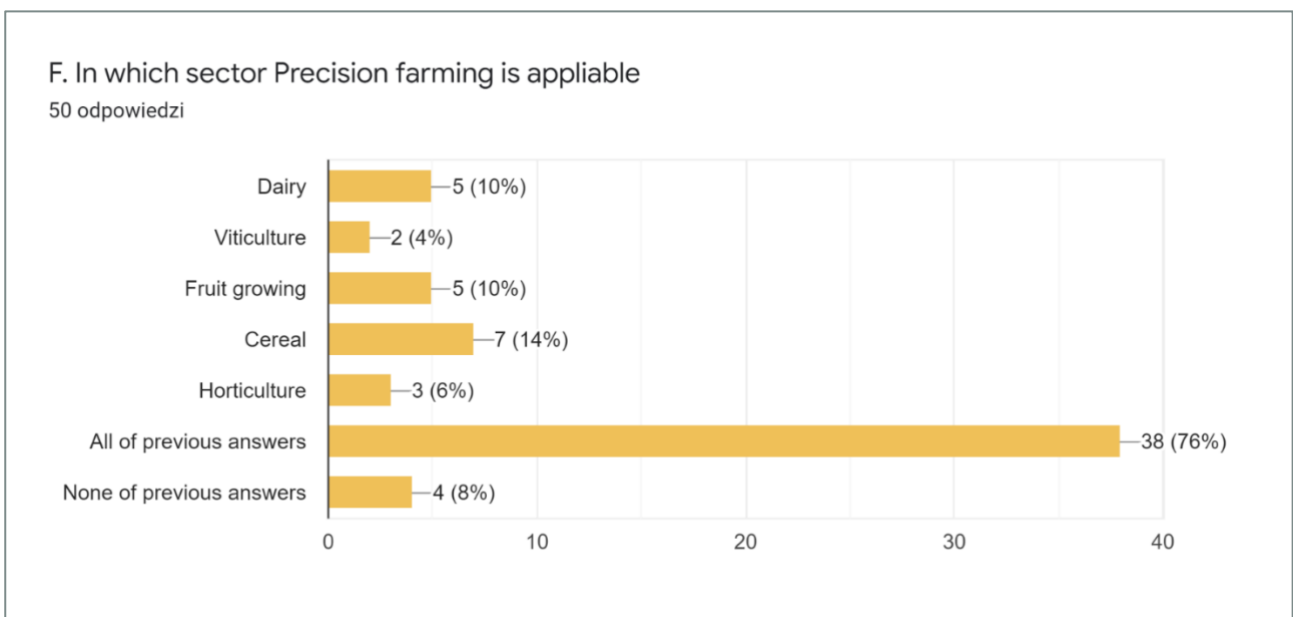
(from 1 totally useless to 5 most useful)

5.3 Attitude and propensity for Precision Agriculture

The response statistics relating to workplace and to school education were intended to show the level of the propensity of students to precision farming sector. The results showed that the majority of students (over 65%) declared that they do not plan their professional future in areas that would be related to PF. Less than 25% of the students show interest in this sector in the workplace (Fig. 7). This may be due to the strong association of PF subjects with working in agriculture, as a farmer.
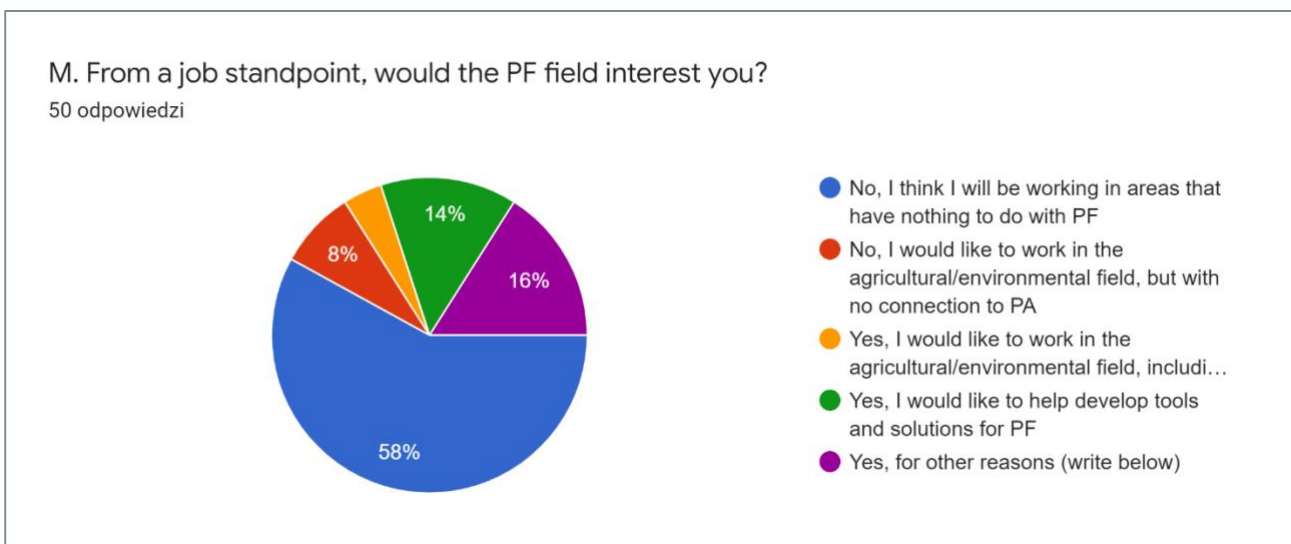
Fig.7 Statistics Graph: "From a job standpoint, would the PF field interest you??"

The most interesting data is the one in which it is highlighted that approximately 60% of the interviewees (Fig. 8) think it is necessary to adapt the study plan with a greater integration of the PF theme. PF is perceived an important topic to tackle.
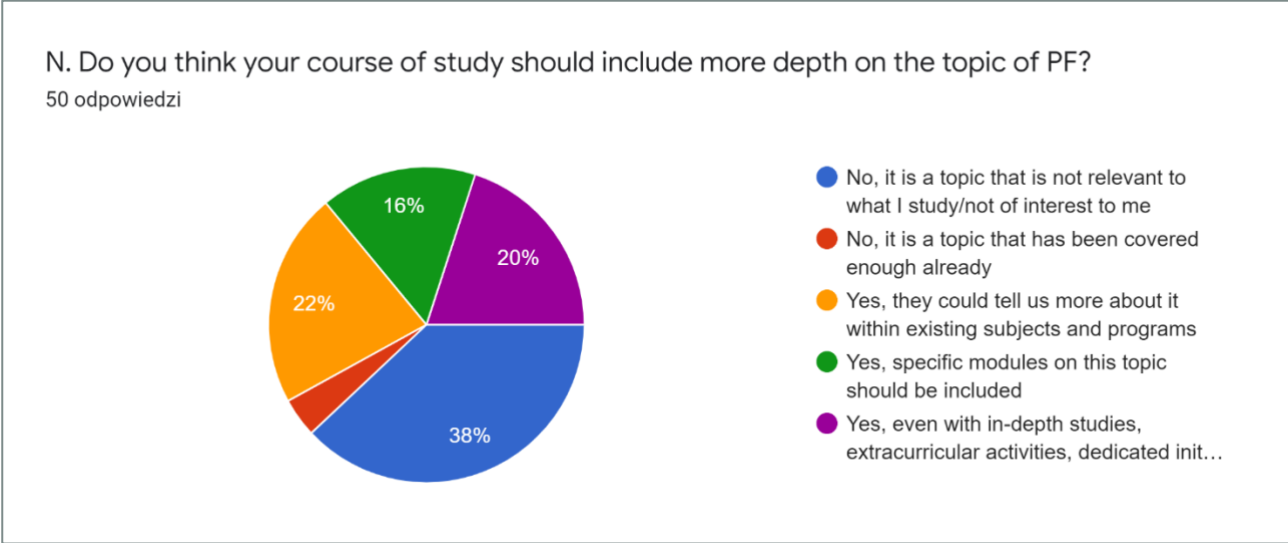
Fig.8 Statistics Graph: "Do you think your course of study should include more depth on the topic of PF"

The response statistics shown in the chart below (Fig. 9) highlights that students have awareness on the technical skills needed to develop PF solutions and systems. They basically identified all the subjects mentioned in the question to a similar extent.
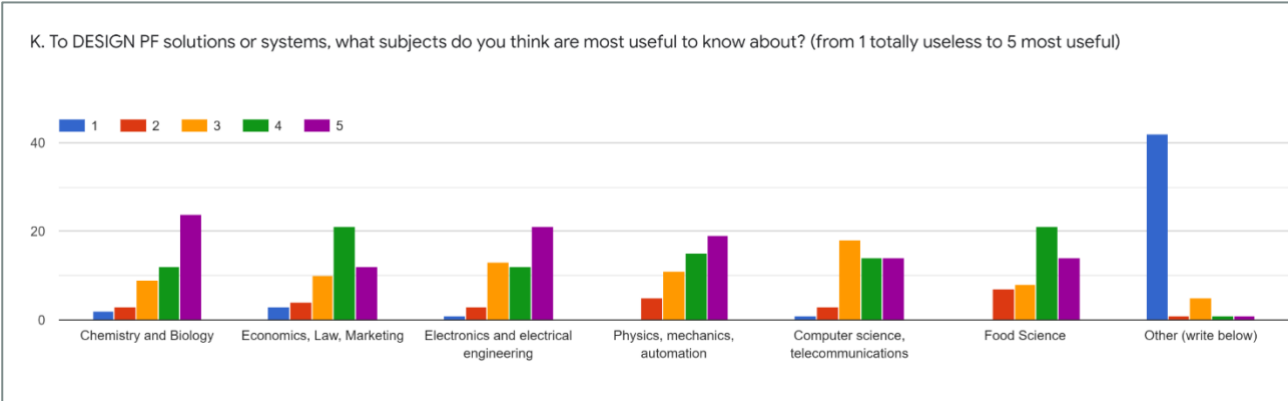
Fig.9 – Answers to the question "To DESIGN PF solutions what subjects do you think are useful to know about? "
(from 1 totally useless to 5 most useful)

As regards the use of PF solutions or systems (Fig. 10), students tend to give importance to all the subjects available in the questionnaire. In this case, however, a slight advantage attributed to technical subjects can be seen.

L. To USE PF solutions or systems, which subjects do you think are most useful to know? (from 1 totally useless to 5 most useful)

Fig.10 – Answers to the question "To USE PF solutions or system, which subjects do you think are most useful to know?" (from 1 totally useless to 5 most useful)

Conclusions

The key reason of organizing this survey was initiating a dialogue with local schools on the topic of Precision Agriculture and to bring this issue to the attention of both professors and students. Due to the composition of the sample of subjects involved, the answers have no statistical value. Data are indicative just for the attitude of the group of students actually involved.
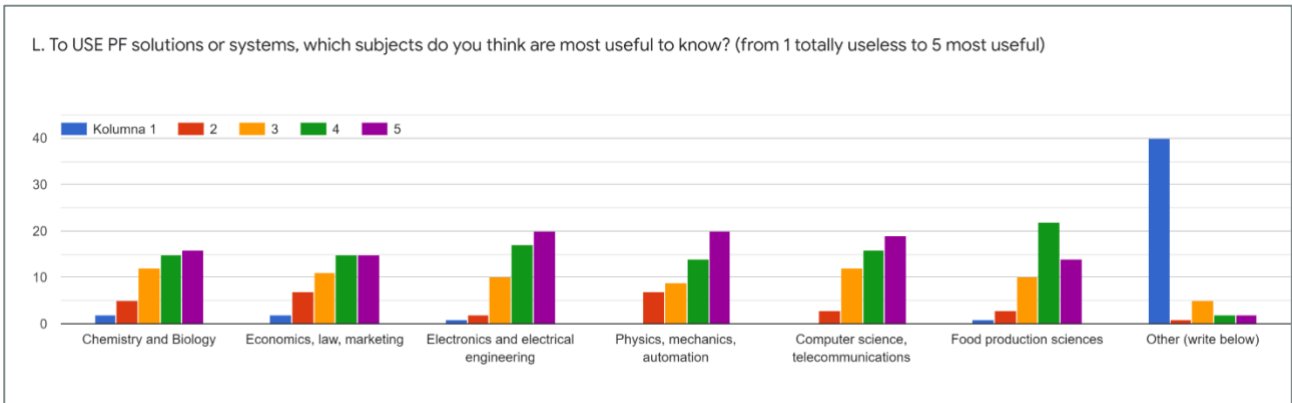
All the more reason, at the transnational level the sample of schools and students involved are not homogeneous, having impact from a statistical point of view on the responses received, making the survey results scientifically not relevant. Nonetheless, it is interesting to note some similarities and / or differences in the responses collected by the different partners.

A first positive result is that, based on the answers to the questionnaire, the majority of the respondents had already heard of Precision Farming. However, there is evident differences among the countries. While in Austria almost the 80% of the students involved in the survey heard about precision farming, in Poland just the 50% did. In Italy, Slovenia and Hungary positive answers range between 60% and 65%.
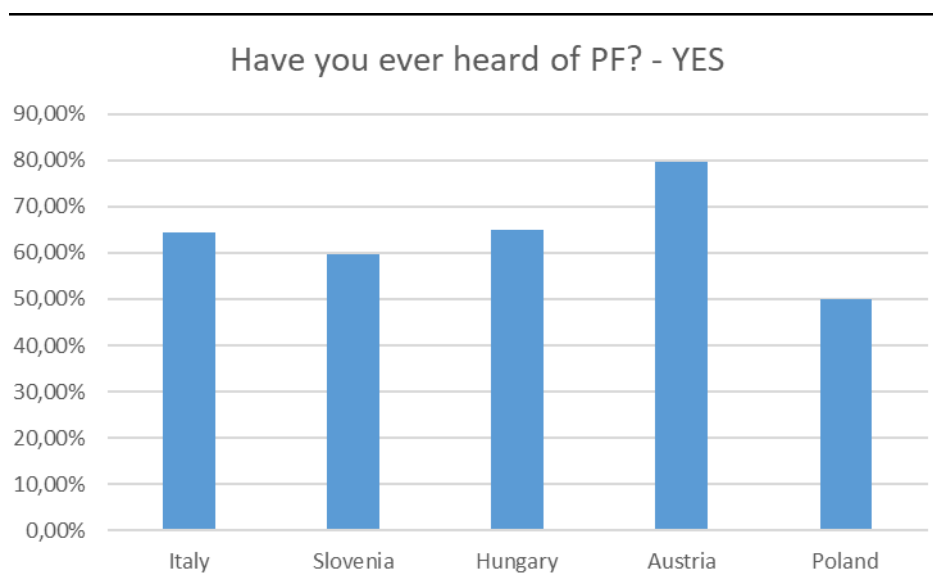
Fig.1 Answers to the question "Have you ever heard of PF? Affirmative answers"

Regarding the distinction between Precision Farming and Digital Farming, a bit of confusion on the topic can be noted. The majority of students distinguish Precision Farming, i.e. the tools that allow to complete agricultural task with high precision, from Digital Farming, i.e. digital services that support farm management and monitoring. But this trend is not confirmed when students are asked to select the tools of the PF sector. Only in Italy options as Internet of Things and Big Data Management with Cloud systems tend to be considered as PF less than others techniques such as GPS, remote sensing and the use of sensors. In Austria and in Slovenia, nearly all proposed technologies have been considered by respondents as "Precision Farming", while in Hungary, in contrast, many precision farming technologies where not recognised as such by an higher percentage of students. In Poland, where only the 52% of respondents distinguish the digital farming from the precision farming, the answers reflect the low awareness about the topic.

Concerning the sources of information, "school" and "internet" are the more prevalent answers across all the involved countries. This underlines the importance of the school processes in the formation of professional figures. It is interesting to note the low frequency of responses for specialized magazines. Further investigation is needed to define if the reason lies in the fact that in these magazines there is not enough talk about the precision agriculture, or if the new generations tend to inform more and more through digital channels also with regard to agriculture.
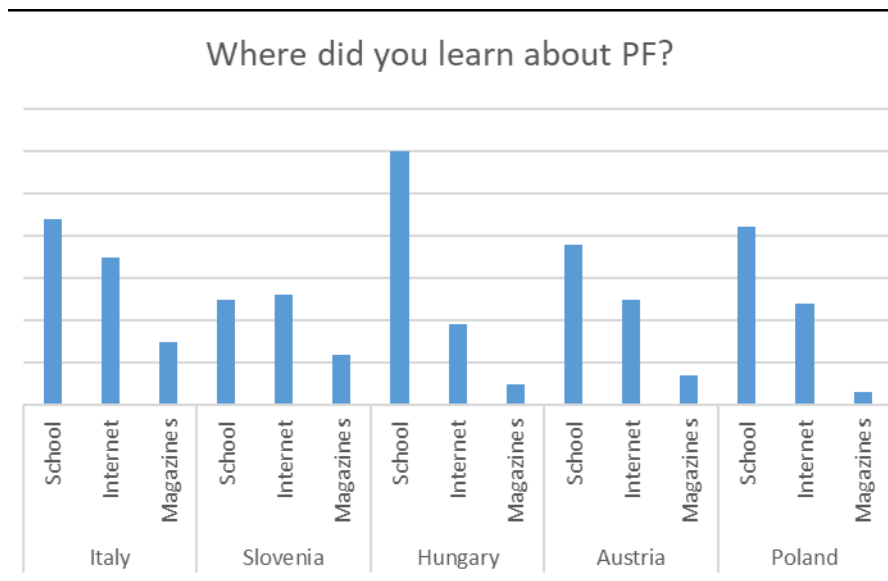

Fig.2 "Where did you learn about PF?" comparison

The possible application of PA techniques in the agricultural sectors is generally a well-supported topic. In Italy, in Slovenia and in Poland the majority of students believe that PF technologies are implementable in all the sectors mentioned. Just a few of students claim PF technologies has nothing to do with the Agricultural sector and that PF technologies are not useful in any field.

There are interesting discrepancies in the responses to questions about the purpose of PF technologies use between countries. In Austria and Hungary majority of students give relevance to the sustainability of PF solutions and consider their application leads to an improvement of products and to an increase of farm profitability, reducing the physical efforts of operators and making operations faster. Answers in other countries are more balanced. In Poland students have a quite different view and we recorded a clear majority only in the answer that argue the PF solution are useful to make all the operation automatized. The PF purpose to increase the quality of the products causes some perplexity in Italy, but also in Poland.

Interesting information can be deduced from answers related to the PF techniques application in Europe. The students, with no significant difference among the countries, argue that PF is not particularly widespread in the EU. The majority of the students also highlight that the PF is not meant exclusive for large companies but also that it is not necessarily an opportunity to create new jobs in agriculture.

On the other side PF is recognised as an opportunity for companies that produce plants and machinery and a chance for professionals with greater technical skills to innovate agricultural products and services. Overall, students in all the countries are conscious on the need of specific skillset to adopt and develop PF techniques and this is confirmed in the question about the most useful subjects to know before working with PF technologies. Technical Institute's school subjects, such Computer science and

telecommunication, Physics, mechanics and automation, are considered the most important to use and develop PF solutions.

The inputs received from the questionnaires confirm the demand for more Precision Farming integration in study plan. This trend is also confirmed in countries where is shown less interest for the sector.

However, it is interesting to note that the group pf students with less interest to the sector, both from a work and educational point of view, also match with a minor knowledge about precision farming. In fact, in the group of students where we recorded the lowest interest for possible job prospects in the PF sector (34%) and for further in-depth studies at school (58%) also correspond with the lowest percentage of students who had already heard about PF (50%).
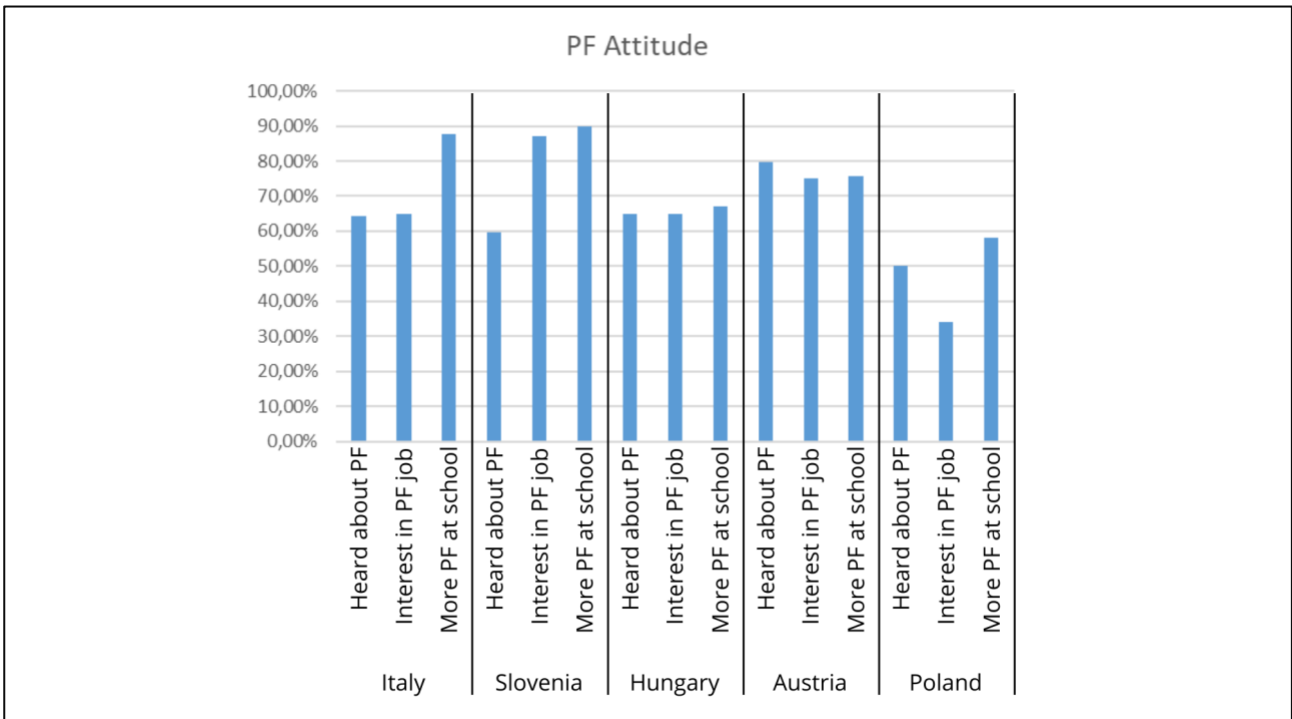
In other words, we registered a directly proportional trend that shows greater interest where there is greater knowledge of the topic. This underlines the intuition of Transfarm 4.0 proposal in the need to raise awareness and make known the issues of precision agriculture starting from the schools.

Questionnaire - Section 1

A. What school do you attend? (drop down list)

B. What is your majors specialization? (drop-down list)

C. What grade do you attend?   4 th   5th

D. Have you ever heard of Precision Farming?   *YES*   *NO*

E. In your opinion is there any difference between Precision Farming and Digital Farming?

YES   *NO*

F. In which sector Precision farming is appliable?
1. *Dairy*
2. *Viticulture*
3. *Fruit growing*
4. *Cereal*
5. *Horticulture*
6. *All of previous answers*
7. *None of previous answers*

G. When AF is mentioned, which of the following techniques do you think it refers to?

1.	*IoT*	*YES*	*NO*
2.	*Big Data*	*YES*	*NO*
3.	*Remote sensing*	*YES*	*NO*
4.	*NDVI*	*YES*	*NO*
5.	*Cloud-based data management*	*YES*	*NO*
6.	*Forecast-based plant protection*	*YES*	*NO*
7.	*Automatic steering*	*YES*	*NO*
8.	*Variable rate of fertilization*	*YES*	*NO*
9.	*Drone*	*YES*	*NO*
10.	*Lidar*	*YES*	*NO*
11.	*GPS*	*YES*	*NO*
12.	*Field soil and chemical sensors*	*YES*	*NO*

Questionnaire - Section 2

The term Precision Farming (PF)

Precision Farming seeks to use new technologies to increase crop yields and profitability while lowering the levels of traditional inputs needed to grow crops (land, water, fertilizer, herbicides and insecticides)

H. Where did you learn about Precision farming?
- *In my farm*
- *At school*
- *Specialized magazines*
- *Internet*
- *Other farmers*

I.In your opinion, which of the following purposes can PF serve? (from 1 not at all useful to 5 very useful)

1. *Making crop operations faster*   1 2 3 4 5
2. *Simplify cultivation operations*   1 2 3 4 5
3. *Reduce the physical effort of the operator*   1 2 3 4 5
4. *Increase farm profitability*   1 2 3 4 5
5. *Make all the operations automatized*   1 2 3 4 5
6. *Increase the quality of product*   1 2 3 4 5
7. *Improve corporate sustainability*   1 2 3 4 5

J. How much do you agree with the following statements? (from 1 totally false to 5 totally true)

1. *The agricultural and livestock sectors and their supply chains are very important economic sectors in EU*   1 2 3 4 5
2. *In Italy and the EU, PF is widespread*   1 2 3 4 5
3. *PF can only be used in large scale farms*   1 2 3 4 5
4. *Introducing PF solutions is very expensive for companies*   1 2 3 4 5
5. *Specific skills are required to use PF*   1 2 3 4 5
6. *Specific skills are needed to design PF tools*   1 2 3 4 5

7. *Deployment of PF can create new jobs   on farms*   *1 2 3 4*
5
8. *PF deployment can create new jobs in machinery companies*   *1 2 3 4*
5

K. To DESIGN PF solutions or systems, what subjects do you think are most useful to know about?
(from 1 totally useless to 5 most useful)

1. *Chemistry and Biology*   *1 2 3 4 5*
2. *Economics, Law, Marketing*   *1 2 3 4 5*
3. *Electronics and electrical engineering*   *1 2 3 4 5*
4. *Physics, mechanics, automation*   *1 2 3 4 5*
5. *Computer science, telecommunications*   *1 2 3 4 5*
6. *Food Science*   *1 2 3 4 5*
7. *Other_____*   *1 2 3 4 5*

L. To USE PF solutions or systems, which subjects do you think are most useful to know?

(from 1 totally useless to 5 most useful)

1. *Chemistry and Biology*   *1 2 3 4 5*
2. *Economics, law, marketing*   *1 2 3 4 5*
3. *Electronics and electrical engineering*   *1 2 3 4 5*
4. *Physics, mechanics, automation*   *1 2 3 4 5*
5. *Computer science, telecommunications*   *1 2 3 4 5*
6. *Food production sciences*   *1 2 3 4 5*
7. *Other_____*   *1 2 3 4*
5

M. From a job standpoint, would the PF field interest you?

o *No, I think I will be working in areas that have nothing to do with PF*
o *No, I would like to work in the agricultural/environmental field, but with no connection to PA*
o *Yes, I would like to work in the agricultural/environmental field, including using AP solutions*
o *Yes, I would like to help develop tools and solutions for PF*
o *Yes, for other reasons (explain)*

N. Do you think your course of study should include more depth on the topic of PF?

o *No, it is a topic that is not relevant to what I study/not of interest to me*
o *No, it is a topic that has been covered enough already*
o *Yes, they could tell us more about it within existing subjects and programs*
o *Yes, specific modules on this topic should be included*
o *Yes, even with in-depth studies, extracurricular activities, dedicated initiatives*

O. Do you think your future job could be anyhow linked to precision agriculture/farming?
- o *No, I want to work in completely different sectors*
- o *No, I could work in the agricultural / environmental sector, but without connections with Precision Farming*
- o *Yes, I could work in the agricultural / environmental sector, also using Precision Farming solutions*
- o *Yes, I could develop tools and solutions for Precision Farming*
- o *Other (explain)*

P. Do you think Precision Farming should be given more importance in your school curriculum?
- o *No, it is a topic that is not relevant to my studies / I'm not interested in it.*
- o *No, it is a topic already covered enough*
- o *Yes, it is a topic that should be better explained, as part of existing subjects/curricula*
- o *Yes, it would good to add specific lessons/modules on this topic*
- o *Yes, even with supplementary studies, extra-curricular activities, dedicated initiatives*