Erasmus+ Programme – Strategic Partnership

Project 2019-1-PL01-KA202- 065885

The international education program in the field of precision farming as an opportunity to raise the efficiency of agricultural farms manage by young agro-technicians

“PRECISION FARMING”

ANALYSE

"Which skills are the most important in the work market in the sector of agrotronics?"

Projekt finansowany w ramach programu Unii Europejskiej Erasmus+

Project financed by

Erasmus+

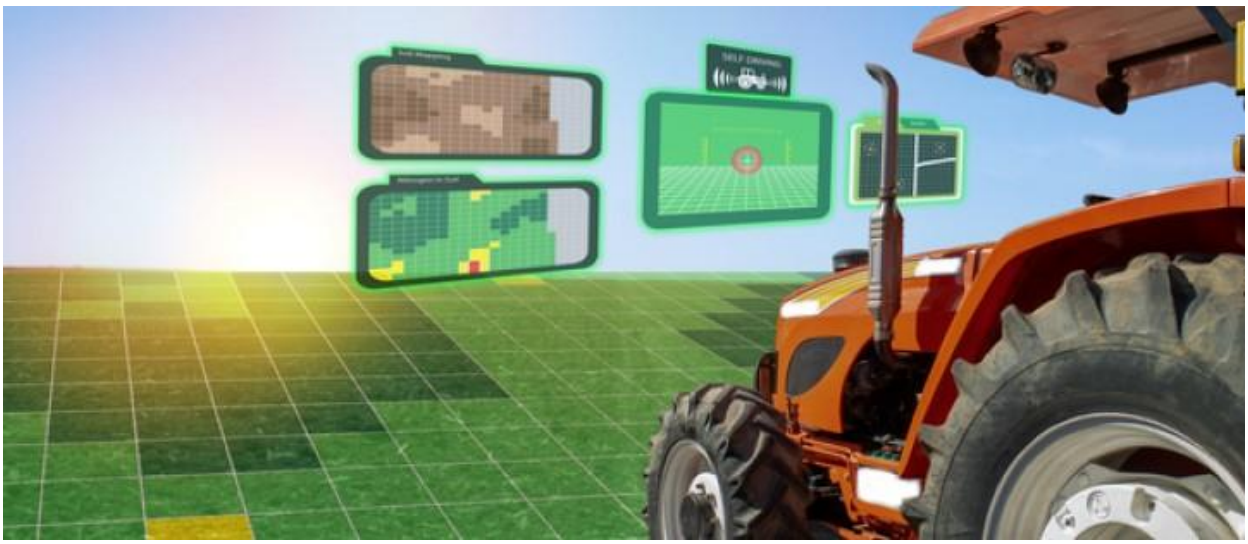
A N A L Y S E

"Which skills are the most important in the work market in the sector of agrotronics?"

- what are the job opportunities in the fields of agrotronics and precision agriculture?
- which skills are the most important for employers?
- which skills are missing for graduates of agrotronics?

Brief Introduction to Precision Agriculture (PA) to identify the labour market needs (needs of analysis)

Precision Agriculture (PA) refers the application of the *"right treatment in the right place at the right time"*



Introduction for teachers

Precision agriculture (PA) or precision farming, is a modern farming management concept using digital techniques to monitor and optimise agricultural production processes. Rather than applying the same amount of fertilisers over an entire agricultural field, or feeding a large animal population with equal amounts of feed, PA will measure variations in conditions within a field and adapt its fertilising or harvesting strategy accordingly. Likewise, it will assess the needs and conditions of individual animals in larger herds and optimise feeding on a per-animal basis.

Over the past 20 years, precision agriculture technology has changed rapidly and has become an information-intensive endeavour. Growers, retailers, farmers and others seeking to acquire new systems or upgrade existing equipment need to be fluent in terminology used in communications, hardware, software, and other areas in order to make informed decisions at the time of purchase. Also, familiarity with key terminology is part of the training that farmers need to maximize the use of the technology.

Reluctance towards implementation of precision agriculture seems to be based upon accessibility to well-trained, knowledgeable people, and the cost and availability to obtain quality education, training, and products. Given that precision agriculture is rapidly changing and the current trend for accelerated information exchange, teachers of precision agriculture face the challenge of keeping up with the pace and providing quality educational programs. The optimal value of information for precision agriculture will be best achieved by producers, agribusinesses, and teachers as they improve their:
1) agronomic knowledge and skills;
2) computer and information management skills;
3) understanding of precision agriculture as a system for increasing knowledge.

Based on the utilisation of various technologies predominantly on precise positioning through satellite technology, precision farming technology provides the site-specific management of agricultural production. The rapid development of precision agriculture in the agriculture sector has been related to the need for improved crop yield for the reduction of costs through the optimisation of inputs. With the use of precision farming, it is possible to minimise soil compaction, reduce the use of fuel, pesticide and fertilisers, and increase productivity. Other significant benefits include the reduction of negative environmental effects and increased worker safety. Major Technologies in PA are Computer Technology, Global Positioning System (GPS), Geographic Information System (GIS), Remote Sensing (RS) and Variable Rate Application. More specifically, the most widespread and well-known PA applications are related to the accurate and precise steering of tractors and other farming equipment. Methods in the PA context can be listed as machinery guidance, automatic

steering and controlled traffic farming (CTF), variable rate technology applications; harvest/yield monitoring; biomass monitoring; soil sampling; livestock tracking; precision viticulture and precision forestry.

Precision agriculture requires the learning of new skills:

- technological skills;
- environmental skills; and
- managerial skills.

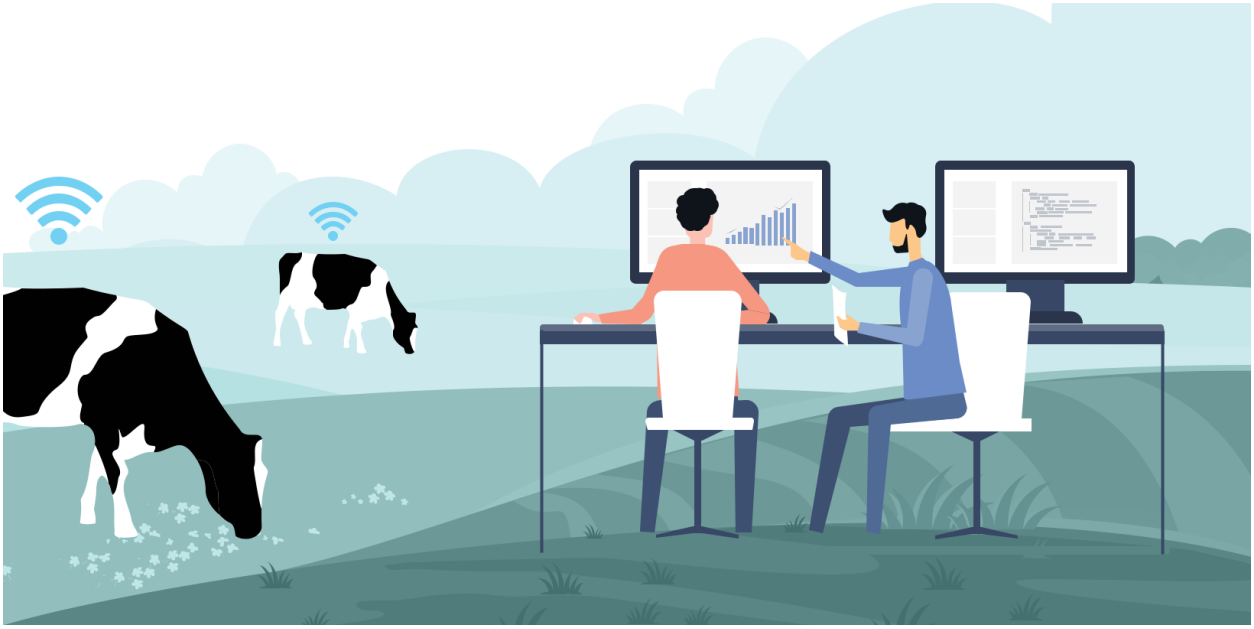
The wide diversity of agriculture throughout the EU, particularly regarding farm size, types of farming, farming practices, output and employment, new methods and technology tools, presents a particular challenge for European vocational schools and teachers. In the next chapters, we present the main needs of the agriculture sector and the perspective of develop of precision farming tools. The study may be a guide, what to pay attention to during lessons about precision farming.

Skilled workforce and precision agriculture

Workforce and skill aspects are critical for the further development of the farming sector in the EU. Farming in the EU faces many challenges: financial crises, global competition, climate change and rising costs have all put pressure on the farming community. Historically, in response to these challenges, the EU created the Common Agricultural Policy (CAP) in 1962, presented as a 'partnership between agriculture and society and between Europe and its farmers' (European Commission, The European Union Explained, 2014).

The original aim of the CAP was to improve agricultural productivity, creating a stable supply of affordable food for consumers and to ensure that EU farmers could make a reasonable living. However, in 2013 the CAP was reformed in response to the more recent challenges of food security, climate change and sustainable management of natural resources and the countryside across the EU in order to keep the rural economy alive. Furthermore, recent Eurostat figures suggest that the farming population is aging and many young people no longer see farming as an 'attractive profession' (European Commission, The European Union Explained, 2014). In 2012, the EU's Directorate-General for Internal Policies stated that 'barely 6 % of EU-27 holdings are owned by farmers under 35 (around 5 % in the EU-15 and 7 % in the EU-12). Despite the limitations of the statistical information, the number of young farmers seems to have declined steadily in all countries. Moreover, the prospects for the future may be even bleaker' (DGIP, 20122). Young people have become distanced form the way that our food is produced and, with more and more of our population living in urban centres, finding new ways to attract young must be established.

Recognising the serious nature of this problem, the reformed CAP 2014-2020 introduced new and strengthened measures to encourage young people to set up in farming, including various forms of financial support. Some measures are obligatory for Member States, such as the 'Young Farmer Scheme', where young farmers receive a 25% supplement to the direct aid allocated to their farm for a period of five years.



Precision Agriculture Technician Career

What knowledge is needed to be a Precision Agriculture Technician?

LIST OF THE SKILLS FOR PRECISION FARMING

Identified skills	Explanation
Computers and Electronics	Knowledge of computer technology, circuit boards, processors, chips, sensors, electronic equipment, and computer hardware and software, including applications and programming

Mathematics	Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
Physics	Knowledge of physical principles, physics laws, their interrelationships, and applications to fluid mechanics, material science and atmospheric dynamics, and mechanical, electrical, atomic and sub- atomic structures and processes.
Chemistry	Knowledge of the chemical composition, structure and properties of substances and of the chemical processes and transformations. Chemicals and their interactions, poisonous levels, production techniques, and disposal methods.
Engineering and Technology	Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
Mechanical	Knowledge of machines and tools, including their designs, uses, repair, and maintenance.
Telecommunications	Knowledge of transmission, broadcasting, switching, control, and operation of telecommunication systems
Communications and Media	Knowledge of media production, communication, and dissemination techniques and methods.
Economics and Accounting	Knowledge of economic and accounting principles and practices, the financial markets, banking and the analysis and reporting of financial data.
Agricultural Production/Full Food Production Cycle	Knowledge of techniques and equipment for agri/aquaculture including animal production and harvesting food products (both plant and animal) for consumption, including storage/handling techniques.
Soil Knowledge	Knowledge of soil, soil characteristics and soil sampling
Horticulture and crop production	Knowledge of plant growth, their seeds and harvesting
Animal Production	Knowledge of domestic animal production including dairy tech, aquaculture technology

Plant protection	Knowledge of plant protection techniques, equipment and materials used against pests etc.
Biology	Knowledge of plant and animal organisms, their tissues, cells, functions, interdependencies, and interactions with each other and the environment.
Geography	Knowledge of principles and methods for describing the features of land, sea, and air masses, including their physical characteristics, locations, interrelationships, and distribution of plant, animal, and human life.
What skills are required for Precision Agriculture Technicians? GENERIC SKILLS RELATED TO PRECISION AGRICULTURE	
Operations Analysis	Analysing the needs and product requirements to create a design.
Critical Thinking	Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
Active Learning	Understanding the implications of new information for both current and future problem-solving and decision-making.
System Analysis	Determining how a system should work and how changes in conditions, operations and the environment will affect the outcomes.
Monitoring	Monitoring/Assessing performance of the related individuals or organizations to make improvements or take a corrective action.
Complex Problem Solving	Identifying complex problems to develop and evaluate options and implement solutions.
Operation Monitoring	Identifying the indicators to make sure a system works properly.
Coordination	Coordinating the whole system running (including human factors) properly.
English	Communication with the World in English

PA could contribute to raising employment and education levels in rural areas

Rural areas deserve a special attention in terms of education. Studies show that school drop-out is a problem that is increasingly providing a cause for concern, and that particularly affects children and young people in rural areas. While the EU 2020 strategy for smart, sustainable and inclusive growth is aimed to reduce school drop-out rates in the EU from 14 % to 10 % or less, the drop-out rates in several rural areas remain far above 30 %. Moreover, rural areas present, in general, lower rates of tertiary education. As we understand, the situation in those areas is extremely challenging. Not only does the rural population have to bridge the educational gap with the urban population, but they also have to learn new skills, which are not necessarily addressed by the local education system.

However, PA technologies could really boost education levels in rural areas since they are all linked to the competencies identified by the EU for increasing competitiveness and growth. About 70 % of EU farmers have only practical agricultural skills. This group will have a slower adoption of precision farming technology than a group of trained farmers. Not surprisingly, adoption of precision farming is the highest in north-western European countries, where farmers are more trained than in other parts of the EU.

Conclusions on skills and education

From the skill needs identified in the different scenarios, based on research prepared by partner organizations, four main conclusions, can be drawn regarding skills and education:

1. A strong push for increased education in farming, especially in high-tech skills, would be required under all scenarios in order to achieve a significant progress with PA. A greater level of continuous and life-long learning would be necessary to keep up with the speed of expected technological developments.

Such an “education push” could also help to improve the image of jobs in farming, which is seen as critical to ensure that younger people are attracted to the profession. If farming is seen as being more knowledge-based and high-tech, it may become more attractive to new entrants.

As is clear from the list of skill needs in Table 5, the traditional role of farmers is changing in all scenarios, and may help to attract young professionals with more diverse interests such as technology, business and the environment. Roles such as “sustainability shepherd” (where the farmer is seen as the key person to ensure sustainability in the community) or “expert on local ecosystems” may carry a high status as the person is seen as having a high level of competence in the particular field, rather than as merely a farmer in the traditional sense.

2. Not only are new skills needed, but so are new forms of learning. Generally, education is undergoing a paradigm change, where new forms of learning are increasingly used. Examples are trends towards:

- virtual and blended learning (blended learning brings 'traditional' face-to-face learning and virtual learning together);
- MOOCs (Massive Open Online Courses), as offered by leading universities and independent education providers, either free or at a cost; and
- peer-to-peer learning, where anyone has the opportunity to teach a topic within their area of expertise, without having a formal teaching qualification.

A rollout of such education forms in the agricultural sector can enable and accelerate the necessary skills push. An example are new education forms that focus on the role of experienced farmers as mentors, as indicated. Other forms can be knowledge sharing mechanisms, or bite-sized virtual or blended training programs (e.g. apps for learning via a smartphone, or combined forms of technology-based distance learning and traditional face-to face learning).

Such new approaches may be particularly useful for farmers and agricultural workers on smaller farms, who often find it challenging to participate in possibly costly and time-intensive traditional training forms. Access would be encouraged by targeted incentives and support programs.

3. Overall education for agriculture and food production needs to be re-examined in order to respond to the challenges of the rapid technological progress, the need for sustainability and a decline in students attending agricultural colleges and universities.

Structural changes, including the closure of agricultural colleges and mergers with other educational institutions, have changed the layout of this educational sector. Given the magnitude of the challenges for the sector and the increasing skill needs as outlined in the

scenarios, this calls for the refreshment of the agricultural education sector to provide the skills needed in the future.

4. There is a need to improve the education of the general public on modern agriculture and food production. Although this does not relate specifically to skills for farming, the general public often struggles to understand and appreciate the complexity of new farming methods and the role of agriculture in the society and with regard to the environment. Such a lack of understanding can lead to a tendency to disagree with the uptake of new technologies, which is a risk to the future development of European agriculture.

Job opportunities for agrotronics and precision agriculture in Europe

The precision agriculture and agrotronics are at the stage of Research and Development in Turkey; thus, there is no clear job description about these occupation. The employment rate on agrotronics and precision farming is difficult to predict.

There are some critical factors in current conditions in Turkey regarding the adoption of precision agriculture and agrotronics at *the farmer level*. These factors can be summarized as :

- Farm size/the size of livestock
- High investment cost/production value (scale economics)
- Trained staff for the use of technology

- Unavailability of service sector for high-technology.

At the level of *agriculture technician and engineer* the skills and competencies for precision agriculture come out to evaluate the current employment issues.

Subjects of agrotronics or precision agriculture require multi-disciplinary education in the areas of agriculture and electronics/mechanical/computer engineers programs. Thus, in the current curricula of these programs by themselves do not meet the requirements of the employment of agrotronics or precision agriculture. However, the engineers acquainted with the necessary skills of precision farming can be easily employed in related area in Turkey as there is a well-developed agriculture industry. This point brings the necessary skills for precision agriculture into focus regarding a competitive employment environment.

Although each precision agriculture element for the agriculture activities is available on the commercial market, the use of the precision agriculture technology and agrotronics are not common in the overall agriculture activities. However, the areas identified by the related stakeholders for rapid adaptation to new technology in a short-term period are as follows:
- Depth adjustable tillage
- Mechatronic unit controller sowing
- Sensor-based variable rate spraying systems
- Smart irrigation systems

On the other hand, the precision agriculture and agrotronics are not neglected issues in Turkey. The Ministry of Agriculture in cooperation with Istanbul Technical University carried out a Project called TARBIL.

• Integrated Agricultural Monitoring and Information Systems (TARBIL) A pilot project combining Earth observations and administrative processes on a common layered structure in a modular way in real-time (2007-2011).

➢ 42.000 sensors, cameras

➢ Satellite remote sensing station

➢ Real-time data fusion system and services

➢ 1200 robot stations form an agricultural ground-based network

➢ End users: Farmers, traders, policy maker

In Romania, there are three broad areas where improvements in precision agriculture can be made:

1) agronomic knowledge and skills

2) computer and information management skills

3) the recognition and development of precision agriculture as a management system for increasing knowledge.

Within each of these dimensions, educational efforts should emphasize the specific needs of the significant players interested and/or potentially involved in precision agriculture: producers, agribusiness, and teachers.

The teachers discussion groups revealed a wide range of different precision agriculture needs. For example, curriculum and teaching methods for precision agriculture education ought to be responsive to the changing needs of producers and agribusiness.

As precision agriculture continues to mature, educational programming will need to be tailored to address the range of educational needs represented by both the beginner and advanced user.

Precision agriculture technology is new to the entire agricultural industry, including teachers. While teaching the basic concepts and principles of precision agriculture has been intuitive and relatively straight-forward, training individuals how to use the technologies of precision agriculture is complicated.

Difficulty arises, in part, from deficiencies in computer skills and understanding the geographic and spatial concepts seldom taught in agricultural programs. Precision agriculture presents a complex process of learning through collecting, integrating, and interpreting spatial and temporal information.

Therefore, the process of learning constitutes the most difficult step of precision agriculture, and consequently the most challenging to teach. Educators could do more to give a hands-on experience with precision agriculture products. Simulators, for example, can be especially instructive.

We need an increased cooperation between industry and education (including administration), so that the two sides can work together for the overall good of education.

Teachers of precision agriculture need to organize and promote education and research programs in an interdisciplinary and cooperative manner. Precision agriculture represents an opportunity to meld the agricultural disciplines about:

- modernize curricula in precision agriculture using new technologies
- Geographic Information System/GIS, big data, remote sensing - through analysing and updating existing curricula according to educational needs;
- Developing new certified curricula according to the new achievements in the area, the labour market
- Review of the current curricula in precision agriculture through analysis
- A set of new curricula and transferable modules including innovative teaching facilities
- Updated current curricula and programs in precision agriculture about:
    - Introduction to Crop Science
    - Agricultural Applications of the Computer in Precision Agriculture
    - Concepts in Precision Agriculture
    - Agricultural Business Management
    - Agri-Business Work Exploration

- Introduction to Soil Science
- Plant Pest Identification and Control
- Soil Fertility and Fertilizers
- Precision Farming Technology
- Applications of Geographic Information Systems
- Agricultural Business and Farm Management
- Advanced Geographic Information Systems
- Remote Sensing and Aerial Photo Interpretation

Precision agriculture technology is a vital component of today's agricultural industry. The training and education for consumers of the technology (identified as agricultural producers) as well as specialists who are able to install, troubleshoot, maintain, educate, and develop emerging technology are increasing in demand. By incorporating precision agriculture technology concepts into agriculture education curriculum, students will be better prepared to pursue careers in the agriculture industry.

The problem to address in order to create an agricultural educational learning environment that matches the industry, is that the use of technology in coursework must be relevant. Students enrolled in agricultural education classes are interested in learning skills that are applicable and relevant to the world around them. As the world changes, the classroom must also change. Updating curriculum, teaching in ways that are relevant and engaging, incorporating technology and making connections across topics are only a few ways vocational classrooms can reflect the world today. Students who learn outdated materials are not prepared to be active members of the present industry.

Precision agriculture concepts blend biotechnology and agronomy or mechanical content together, marrying technology with real world application. By understanding the science and application of the technology, students can grasp the capabilities of the technology itself as it relates to the course content and real world situations.

The knowledge of what kinds of agricultural technologies are used in the classrooms across the Romania is limited. In order to keep agriculture and vocational education curriculum relevant, an assessment of current teaching practices must occur.

The barriers teachers identify that prevent them from teaching precision agriculture: Funding, Equipment, Curriculum, Experience and Professional Development.

Precision agriculture is a progressive and emerging topic in agriculture. Many people within agriculture, let alone outside the field, do not have an understanding of precision agriculture or what it entails.

Precision agriculture can be seen from two points of view, the innovative technology development and the application of technology in real life. We, as agricultural educators, must do our part in educating agriculturalists on the best practices.

Continuing education for practicing agricultural education teachers should contain concepts and instruction in precision agriculture. Professional development opportunities would allow teachers to become more comfortable with the content and in the development of stand-alone modules or incorporation of precision agriculture concepts within the existing curriculum.

Practicing precision agriculture represents the future and progress of the Romanian farms. More and more farmers are using the latest technologies in the field (automated GPS systems and monitors, sensors, monitoring and control systems, etc.) to make their work easier and achieve remarkable results with controlled distribution of resources.

Jobs in precision agriculture require a unique combination of technical and agricultural expertise that is not widely available for high school students. Due to the highly technical nature of precision agriculture jobs, the curriculum in the field is often outdated and does not fully prepare students for available positions. Enhancing precision agriculture curriculum and connecting this curriculum with high schools will dramatically improve the preparedness of technicians in a number of agricultural sectors.