

Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

MINUTES OF THE 2ND STAKEHOLDER EVENT

May 25th, 2021

Due to the situation caused by Covid-19, a virtual event (videoconference) was organised by IETU using Zoom service. The agenda of the event is included in Annex 1. The slides of the presentations are attached as annex 5 collected and distributed to the attendees. The list of attendees is included in Annex 2. The meeting started at 9:30 a.m and ended at 13:00.

Warm up and introduction Janusz KRUPANEK

(Event organiser/Multi-actor strategy leader) Who is present? Short presentation

The event organizer welcomed the participants and explained:

- ❖ The aim of the event: to identify key aspects of WeLASER implementation in practice including environmental, safety, social aspects.
- ❖ The agenda of the event
- ❖ EIP-AGRI and multi-actor approach
- ❖ Some tips on how the event is going to work
- ❖ presentation of participant groups

Project and its activities - overview

WeLASER vision and project overview Pablo GONZALEZ-DE-SANTOS (Project coordinator)

The project coordinator presented a brief overview of the project highlighting the following elements:

- ❖ Project main aim
- ❖ Project-specific objective and proposed solution
- ❖ Brief description of the consortium
- ❖ Overview of project activities EIP-AGRI and Multi-actor approach and Innovation action (and consequences)
- ❖ Position of the stakeholders in the project management and communication of project activities; Newsletters and Practice Abstracts

How do we want to achieve the results ? - status of project activities

WP leaders:

Karsten SCHOLLE (FUTONICS) - WP2

Merve WOLLWEBER (LZH) - WP3

Thomas DE SAINTIGNON (AGC),
Luis EMMI (CSIC) & Guliano VITALI (UNIBO) - WP4

The leaders of technical workpackages presented project activities

- ❖ WP2 main system elements and technical characteristics of the laser scanner that is being developed
- ❖ WP3 Scanner and Perception system development: testing of system efficiency in laboratory conditions and its training using field simulation software
- ❖ WP4 Autonomous vehicle for laser weeding including development of key devices and system elements:
- ❖ Task 4.2 Adaptation of the mobile platform
- ❖ Task 4.3 Smart Central Controller
- ❖ Task 4.4 IoT and cloud computing integration and management

Expert presentations

What do we need to put WeLASER system at work?

Paul van ZOGGEL

(Van Den Borne Projecten BV)

Key factors of successful implementation of WeLASER approach were presented such as trust, software integration, support solution, flexible hardware and learning experience during implementation process

How to make autonomous agricultural machines safe? Jeroen WOLTERS (Smart Agri Technology BV)	Key considerations and practical aspects of safety and security in working in the fields with agri-robots, based on current experiences were outlined. It included planning of the work, controlling of the machine, use of sensors, safety rules for workers, connection issues, standards and good practices
WeLASER – Laser-Safety Issues Michael HUSTEDT (Laser Zentrum Hannover e.V.)	The main issues of laser technology safety including relevant legal regulations, specific conditions and safety measures (closed shielding, safety circuit and sensors) proposed in WeLASER approach were presented
How to implement WeLASER technique in practice? – opportunities and drawbacks Xavier GELLYNCK (Prof, Ghent University)	The main economic aspects related to implementation of WeLASER technique were overviewed including opportunities for its application related to precision agriculture and organic farming, market conditions (competing solutions), and potential barriers such as economic feasibility or lack of knowledge
Legal challenges for WeLASER technique implementation Pamela LATTANZI (Prof, University of Macerata)	Legal issues with regard to EU legislation concerning safety and liability of producers and users were overviewed in relation to characteristics of the WeLASER invention (autonomous vehicle, Artificial Intelligence).
Break	
Panel discussion Barriers and Bridges to implementation of WeLASER technique Farmers' voices and general discussion) Panelists: Aira SEVÓN (Organic farm&NGOs Finland) Bo JM SECHER (Nordic Sugar A/S) Marcos Garcés (farmer Spain, COAG) Troels PRIOR LARSEN (farmer Denmark) Andrzej PRZEPERSKI (farmer & agrobusiness Poland) General discussion: All attendees Beata MICHALISZYN (Facilitator) Janusz KRUPANEK (WP1 Leader)	The facilitator divided the discussion into two different parts: ❖ Panel discussion focused on two questions: 1. Do you think that use of innovative techniques such as WeLASER could increase competitiveness of your farm? Which current issues are you facing with weeding practices that you expect WeLASER can address in order to improve your business competitiveness? 2. What kind of stimulators or barriers would be important in application of inventions such as WeLASER autonomous tools in practice? Please refer to the health and safety concerns related to the use of innovative technologies. Answering the questions panelists provided valuable insight into implementation of WeLASER based on their experiences. The detailed answers for the questionnaires is provided in annex 4 ❖ General discussion related to the main topics of the meeting was held with interventions from stakeholders and consortium members. Overview of the discussion and detailed information is provided in Annex 3
Wrap up and next steps Janusz KRUPANEK Pablo GONZALEZ-DE-SANTOS	The Multi-actor strategy WP leader summarized the main conclusions and explained the next steps of stakeholders' involvement.
Closure Janusz KRUPANEK	The event organizer thanked for the fruitful event and closed the meeting. Good evaluation is received from participants (Annex 4)

Annex 1 – Agenda of the 2nd Stakeholder Event

Link to the meeting: <https://us02web.zoom.us/j/84881065558?pwd=Z0ZMemFMMjVKeGhBbExFbkIHR1hiQT09>



Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

AGENDA OF THE 2ND STAKEHOLDER EVENT

Virtual meeting

May 25th, 2021

09:30 – 9:35	Warm up and introduction	Janusz KRUPANEK (Event organiser/Multi-actor strategy leader)
9:35 – 9:45	WeLASER vision and project overview	Pablo GONZALEZ-DE-SANTOS (Project coordinator)
9:45 – 10:15	How do we want to achieve the results ? - status of project activities	WP leaders
10:15 – 10:25	What do we need to put WeLASER system at work?	Paul van ZOGGEL (Van Den Borne Projecten BV)
10:25 – 10:35	How to make autonomous agricultural machines safe?	Jeroen WOLTERS (Smart Agri Technology BV)
10:35 – 10:40	WeLASER – Laser-Safety Issues	Michael HUSTEDT (Laser Zentrum Hannover e.V.)
10:40 – 10:50	How to implement WeLASER technique in practice? – opportunities and drawbacks	Xavier GELLYNCK (Prof, Ghent University)
10:50 – 11:00	Legal challenges for WeLASER technique implementation	Pamela LATTANZI (Prof, University of Macerata)
11:00 – 11:20	Break	
11:20 – 12:50	Barriers and Bridges to implementation of WeLASER technique Farmers' voices and general discussion	Panelists, All attendees Beata MICHALISZYN (Facilitator) Janusz KRUPANEK (WP1 Leader)
12:50 – 13:00	Wrap up and next steps	Janusz KRUPANEK Pablo GONZALEZ-DE-SANTOS
13:00	Closure	

Annex 2 – List of attendees

WeLASER Consortium

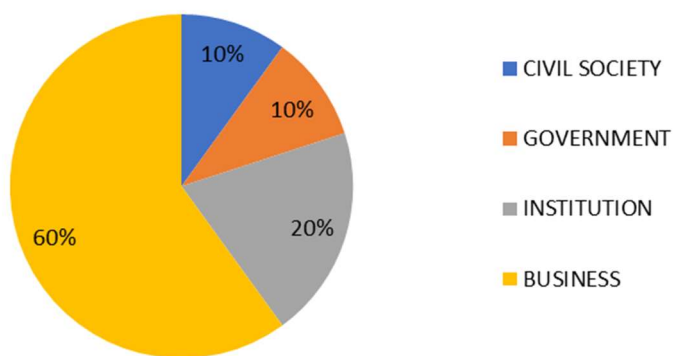
CSIC	Pablo GONZALEZ-DE-SANTOS Roemi FERNANDEZ Luis EMMI
FUT	Karsten SCHOLLE
LZH	Merve WOLLWEBER Michael HUSTEDT Lorenz A. LÜNSMANN Hendrik SANDMANN Alexander BRODEßER
UCPH	Christian ANDREASEN
COAG	Alvaro ARETA Laura GARAU
UNIBO	Giuliano VITALI Maurizio CANAVARI Matteo FRANCA Cristiano FRAGASSA
AGC	Thomas DE SAINTIGNON
IETU	Janusz KRUPANED Beata MICHALISZYN-GABRYS
UGENT	Xavier Gellynck Duc TRAN
VDBP	Paul VAN ZOGGEL

Stakeholders

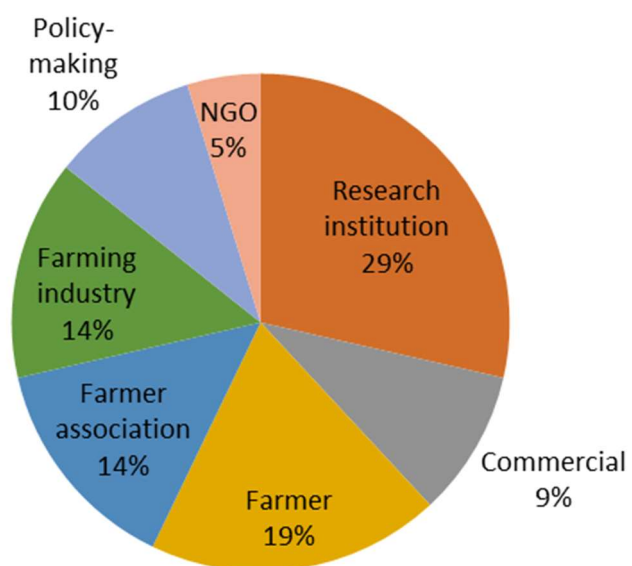
COUNTRY	Organisation name
POLAND	The Institute of Precision Agriculture
POLAND	Institute of Technology and Nature (ITP)
ITALY	Ordine Agronomi
ITALY	Professional
ITALY	UNIMC
ITALY	UNIMC
ITALY	Confagricoltura
SPAIN	Cooperativas Agroalimentarias de España
SPAIN	Spanish Ministry of Agriculture and Fisheries, Food and Environment
SPAIN	Juventudes Agrarias
BELGIUM	Inagro

<u>BELGIUM</u>	<u>ILVO</u>
THE NETHERLANDS	Smartagritechnology
THE NETHERLANDS	City Green Ecosystem
DENMARK	Nordic Beet Research
DENMARK	nordzucker
DENMARK	Danish Environmental Protection Agency
DENMARK	Farmer
EU LEVEL	VIA CAMPESINA EUROPE

STAKEHOLDER AREA OF COMPETENCE



SPECIFIC AREA OF COMPETENCE



Annex 3 – Discussion session

Panel discussion

The short panel session was held. During the session, panelists were asked for a very brief answer to the following two questions:

1. Do you think that the use of innovative technologies, such as WeLASER, can increase the competitiveness of your farm? Please explain why. What current issues are you facing regarding weed control practices that you think WeLASER technology can solve to improve your company's competitiveness?
2. What other stimuli or barriers could be important in implementing technologies such as WeLASER in practice? Please justify your answer briefly. Please also refer to the occupational health safety aspects.

Panelists:

1. Aira Sevón,
2. Bo JM Secher,
3. Troels Prior Larsen,
4. Marcos Garcés
5. Andrzej Przeperski (expressed his opinion by sending written statement)

Summary of panelists' statements.

Agricultural crops are associated with weed problems for example the cereal fields. Due to changes taking place in the countryside, agricultural practices are aimed at maximizing the good health and safety of plants, soil and the environment as a whole. We are very much depended on the activities of the Common Agricultural Policy and Green Deal Action Plan. It would be significant to receive investment money to gain new opportunities like this type of machines.

This [WeLASER] invention would be absolutely great for organic farming, especially perfect for sugar beet farming. Many companies, in order to limit the use of chemical agents for weed control, are looking for new solutions in this field. For example, Denmark is close to meeting its herbicide use limits: WeLASER technology could be a good solution for both conventional and organic farms in this country. For companies (example Danish) in the sugar industry, the implementation of the WeLASER technology would be a great support. The use of innovative technologies such as WeLASER can increase the competitiveness of farms, provided that the investment will pay off within a certain period of time. Currently, the costs calculations are not known and there is not possible to compare them with costs of other technologists.

The technology is very interesting. Safety aspects, which were underlined by other participants are important especially having the farm of about 20 hectares and having in mind that there are people around the farm where the robot is operating that could be in danger. But there are other, very important problems - controlling weeds. We are looking for and cannot find alternative solutions for weed removal without chemicals. In the future safety problems will be solved.

Farmers must manage the risk, know how to carry pioneer growing and benefit from professional revolution. The initial trainings and continuous trainings are needed for the implementation of new technologies – the WeLASER technology is an example of this.

The barriers indicated by the panelists were:

- Price of the new technology. Financial assistance will be needed, especially for small farms. Large farms or producer groups are the first to enter the highest technological level.
- Reliability.
- Trust in a new solution.
- There are concerns about the safety aspects of people who move around the field. For example, citizens (Finland) have free possibilities to go round the forest and fields. This would be dangerous.
- Human supervision is needed in order to provide safe, for the environment and people, operation of the technology.
- The issue of some technical matters is important: stability of the GPS system, equipment with sensors.

General discussion

We have to think about CAP and possibility of using of pandemic funds which will be just right for WeLASER technology implementation. Unfortunately, it will be coming into force in 2021. There is information that it might be delayed and it will be used in next two years 2022-2023. It might come too quickly for the project. We are hoping that it can be relevant for producers of sugar beets, vegetables and perhaps something else and hopefully also for cereal farmers, if the technology is efficient and the costs are low enough. The project management is urged to approach the EU Commission to make them see the arising opportunities and use the project's results as the possibility to affect the structure of the fund of next CAP.

There was a question of opportunities of WeLASER use for perennial weeds. Perennial weeds such like Thistle and Couch grass will be always the problem. They regrow as their root system can be very deep. They come again and again and we have to treat the field many times, but if we are looking at conventional farmers we can use different techniques for this. Danish farmers have the opportunity to use drones to map their fields and to spray crops for perennial weeds like thistles in the specific places. The combination of different methods could be useful but there still be a problem with organic agriculture and we really do not have a good solution. And it has still to be continued to avoid thistle and couch grass in the field and reduce it as much as possible and if you have a robot you will have to treat it several times as well.

This is also what we have to do today as we treat several times sugar beet in conventional and organic farms. We have to go out very early in the season to the field when the weed seedlings are very small. It will be exactly the same with the robot as there will be also regrowth of all common weeds species such like *Stelaria media* and all the other species

Another question is whether the rain affects the operation of the robot. In muddy fields it is not recommended to carry out the operations. It is rather light robots we are talking about and they do not make the same damage with the pressure as the tractor but if the crops or the weeds are wet, more energy is needed to get rid also of the water off the plants. Water protects the weeds as well. It would be much efficient to use the technique in dry conditions.

One comment is that when developing of such a platform - based on the experience of autonomous vehicles we have so far - one should not underestimate the software that has to be developed in order to control the system. The software must be easily accessible. There are examples where the developers get really confused in the end because of the troubles with operating of the system.

Question was asked whether it was tried to estimate the price tag by cost unit. The answer is: there is not enough data at this moment to estimate the cost. It is not a matter of decimal numbers but rather the range 1 thousand or 1 million. More time is needed to provide reliable figures.

The other comment regarded legislation. We have to lobby to get the approval to work with the autonomous vehicles in the fields because if we have to leave a man watching them, there will be no gain. There are common issues regarding legislation - there are no chemical compounds allowed in sugar beets for thistles. And if the farmers have

to do that the compounds have to get the approval. On the other hand, we do not have to control thistle in sugar beet field if we control it in another year in another crop in rotation system. It is important that we can have a field without thistle for sugar beet.

Regarding the software, in the project consortium we do not underestimate this as we have to spend many hours and spend many resources. Regarding the price, we do not have idea about the cost of the system by now. We are going to achieve technological readiness of the level 7 and the system will be tested but not in real environment. The idea is to have 1 phase in the project and we will need additional funding for 2nd phase. It would be good to start to think about more projects and try to engage investors. Then in the second phase we will try to achieve the readiness of technology at the level of 9 what means that the system will be ready for commercialization. We have a horizon of 5.5 years from now. The system at the end of the project will be very expensive but we hope that we decrease the cost in more 3 years.

There is a bit concern that it will take 5.5 years for the consortium to start testing the solution for commercialization as there are several machines already in the US just for sale: with some examples of: EcoRobotics, Carbon robotics 2021 modifications. It is a need to be quicker. It is advisable to have the opportunity to have somehow the technique connected to the tractor. There is declaration [in Finland] to test the solution in a farm up in the north.

We are not going to reach the market at the end of WeLASER project. We are going to bring the system as close as possible to the market. Reduction of the cost is not the objective of the project. The objective is to build a technology capable to kill weeds using laser. After that we will have the chance to work to reduce the cost and develop further the technology. This is normal in technological developments.

There is discussion about the price, the speed of the machine, effectiveness and whether there should be people in the field supervising the autonomous vehicles. We should not look into the limitations in the project but rather we should look into the future. Thanks to this [WeLASER] system we can control the weeds in conventional and organic farming (in smaller crops) without using almost all chemicals. We need the project to go to the field to solve the problem if we get to that point the rest of the concerns like price and the security will be solved.

Can the cost of autonomous machinery be reduced by incorporating the technology to existing solutions (tractor) without automatization?. For the laser technology there is another project in which we are working [project partner] in implementing laser technology integrated with a tractor in a project dealing in sugar beet farming. There we try to combine hoeing in interrow weeding with laser weeding in the row. The work started in April. In the laser part we are thinking in both directions. Using of the technology with a tractor might be also the first thing to do [from Finnish perspective].

There is discussion about the price, the running speed of the machine and effectiveness. Maybe it is a good idea about using of WeLASER in cities. There is more than 20-year experience of chemical free killing weeds in the cities and at the same time carbon emission free solutions. For that purpose, there are produced electric vehicles. In the cities there are different regulations than in the agriculture. There is no need for very high speed, low speed is fine. With the first [WeLASER] machines we can go into the Cities [Netherlands] within existing networks in which a lot of research is done and find out how the innovation works in agriculture and in the middle of the cities like London and Amsterdam.

What about the solar panels, is it possible to add solar panel? The experience from other projects is that it gives very low power. It is not essential issue in WeLASER to add solar panels just to get a few Watts of energy. Another question is whether it is possible to load the machine with renewable energy.

It has to be well recognized that tractors are different than industrial machines. The rules of operation are completely different for them. In this [WeLASER] case, the agri-robot is a self-moving machine and it needs a red button to stop it immediately as it works in any industrial machine. Contrary, tractors are not autonomous vehicles. Artificial intelligence is related in this case to machines not to tractors with a man aboard.

We have to consider how the legal aspects can have an impact on agri-robots. We have to consider many legal aspects. From a legal point of view, we have to think whether we are dealing with the machinery or a tractor. According to WeLASER presentations, we can assume that we are dealing with machinery because the speed of the robot is below 6 km per hour and consequently the tractor regulation does not apply to such kind of machine. Regarding the artificial intelligence in the WeLASER system two intelligence systems can be differentiated. We have artificial intelligence for moving the machine as autonomous robot and artificial intelligence pertained to the use of laser. The proposal for regulation on artificial intelligence will be very relevant and the “new” regulation on machinery. They will be important for safety requirements and liability rules.

The law in this field is quickly evolving. [EU] Machinery regulation and the artificial intelligence regulation want to tackle legal obstacles to such innovations in several sectors, also in agriculture. New legal acts will aid manufacturer, and also users including farmers using the agriculture robots in precision agriculture. Currently, there are legal barriers even if we can find legal solutions related to liability and safety. The new regulations will be agri-robot friendly. WeLASER will have a lot of possibilities in the future.

It is also the issue of insurance. Given the information, it is assumed that the insurance cost will be a minor issue. The investment costs and operation costs will be more significant. Although, insurance will be essential. It will be critical for both the producers and users to be correctly ensured. If we are looking from cost/price perspective, for the investment, especially given the fact that technology in this domain is evolving rapidly, LiDAR it will mean that the depreciation period for the farmer has to be reduced. Because in the period of 2-3 years new revolution of technology can come to the market and considering that the hardware is not flexible and cannot be easily adapted to changes there will be a low residual value. Once it is bought immediately the value will drop dramatically, and we should try to avoid such situation in designing of the machine. Then, the cost per year and per hectare can be reduced. If this is not the case, it will be tricky for the consumer to make the investment.

In drone manned system flying safety and security is a big problem. We have a possibility to learn from this sector with regard to safety. For example, it is required to apply a parallel system to shut down the drone fly if there is a problem. The parallel system operates in other frequency than the pilot system and is commanded by another person who is the observer of the fly. You can implement a system like this in cases where it is necessary to observe the agri-robot operating in the field.

The new drones have many sensors, software and other systems. They do only what is safe and man cannot override it. The drone cannot enter the airspace which is not allowed. It is under control. As a user you also cannot do what is not allowed to do. It is European wide system but we do not know whether it can be applied for machine on the wheels. It is good for predictable emergencies. The robot can be smarter in finding out possible accidents than the humans around but it should be a possibility to shut it down by human intervention.

Other questions

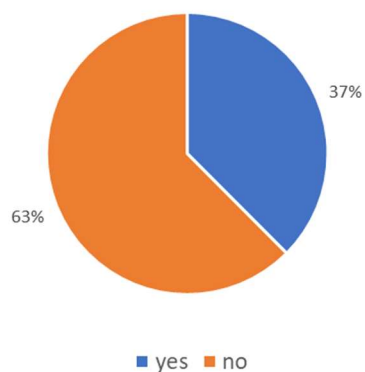
Some other questions that have been raised in the chat:

- What are the power need from the vehicle to the laser unit?
- About the cooling system have already some experience in Southern Europe regions where the temperature could be a limit?
- we have no experience with high temp environments, but there are different chillers commercially available
- Does it separate weed such as couch grass (*elymus repens*) from cereals in early stage?
- Thank you for thinking of the IT-issues, it is not farmer business to constantly "discuss and adjust" with the software. But how does it learn? Into what extent farmers have to learn and adjust it to the farm/field level information?
- I am seeing just very "clean and smooth" fields, this is not the reality e.g. in Scandinavia, also Scotland might have the same issues.
- this means these are also the areas where the human work force is very expensive.

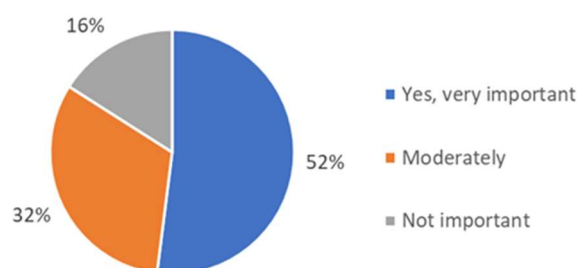
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- in Poland, there are often power poles in the fields. For what the question of the collected water line?
It often happens in the fields that a small lake forms after heavy rainfall. Will the machine enter something like this and get stuck, or will it be able to detect that something is wrong and react?
 - If understand right, we need to flag around fields to stop people to come to your field? That takes time e.g. we have 20-30 hectares field, that takes quite a bit of time if the machine should save time? How about if deers or moose come near, then the machine stops?
 - Damian, we got the same issues. Good questions!
 - What happens if the machine reaches the edge of some, for example, an irrigation ditch crossing a field?
 - Will the laser work in the air or will it detect that it is higher than it should be?
 - We are additionally using a LiDAR camera to monitor the ground and plants. So this ditch would be detected.
 - As a lawyer I can think of many safety issues... knowing the court cases increases the pain *LOL* and I know farmers would not probably consider as many hazards...
 - will the machine be able to work in the rain? will it turn off automatically when it rains? What if the machine is struck by lightning? maybe a low probability, but still.
 - Yes, surely we work the organic fields with various mechanical tools/machines throughout the year (when there is no snow ;-)), not with any chemicals though
 - 1000 euro per Ha per year was/is the threshold in application. The costs per unit depends than on how many parts will be ordered at once... We need to Think Tesla ;)
 - Bert van Loon makes a good point to also include city for bringing costs down in the future.
 - Insurance, for Drones this is maturing. We need an EASA for autonomous machines.

Annex 4 – Results from polls

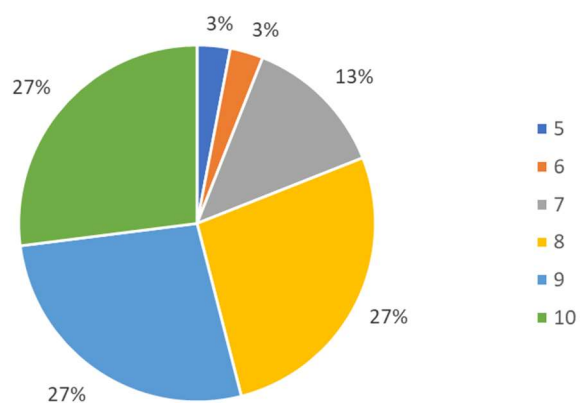
Do you have experience in working with autnnomous agricultural machines ?



Do you think that health and safety aspects copuld be an important barrier in implementation of WeLASER technology?



Evaluation of the meeting



Question: "Please evaluate the event from 1 (very poor) to 10 (excellent)"
No punctuations below 7 were given

Annex 5 – Presentations

1. Warm up and introduction (Janusz KRUPANEK)
2. WeLASER vision and project overview (Pablo GONZALEZ-DE-SANTOS)
3. WP2 (Karsten SCHOLLE)
4. WP3 (Merve WOLLWEBER)
5. WP4 (Thomas de Saintignon, Luis EMMI & Guliano Vitali)
6. What do we need to put WeLASER system at work? (Paul van ZOGGEL)
7. How to make autonomous agricultural machines safe? (Jeroen WOLTERS)
8. WeLASER – Laser-Safety Issues – (Michael HUSTEDT)
9. How to implement WeLASER technique in practice? – opportunities and drawbacks (Xavier GELLYNCK)
10. Legal challenges for WeLASER technique implementation – (Pamela LATTANZI)