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WeLASER
Eco-innovative weeding with laser

Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

MINUTES OF THE 3RD STAKEHOLDER EVENT

November 19th, 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. General information on attendees is included in Annex 2. The meeting started at 9:30 a.m and ended at 12:10. The event was a new opportunity to involve stakeholders in the project activities. It was focused on key environmental requirements in relation to farmers' and societal needs and respective EU policies. The slides of the presentations were collected and they are presented in annex 5.

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 present project developments and discuss environmental issues including environmental performance, key benefits and potential impacts related to the WeLASER application in practice ❖ The agenda of the event ❖ presentation of participant groups
Project and its activities - overview	
WeLASER project overview Pablo GONZALEZ-DE-SANTOS (Project coordinador)	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
What we have achieved so far and what is ahead – status of WeLASER invention development WP leaders: Karsten SCHOLLE (FUTONICS) - WP2 Merve WOLLWEBER (LZH) - WP3 Suzanne BARON (AGC), Luis EMMI (CSIC) & Guliano VITALI (UNIBO) - WP4 Luis EMMI (CSIC)	The leaders of technical workpackages presented recent developments and achievements of the project ❖ WP2 – Laser-based weeding system: successful trials of laser component design operations and positive laboratory testing results of weed meristem killing ❖ WP3 – Weed-meristem perception system: further training artificial intelligence based on field and laboratory data ❖ WP4 – Autonomous vehicle for laser weeding: development of key Agri robot elements: ❖ Task 4.2 Adaptation of the mobile platform to the needs of WeLASER solution ❖ Task 4.3 Smart Central Controller: integration in the system ❖ Task 4.4 IoT and cloud computing integration and management ❖ WP5 – Industrial integration and evaluation: successful completion of the design meeting the technical requirements and stakeholders needs. and plans for its testing. Successful design of the system
Expert presentations	

EU policy related to sustainable weed control in agriculture Aira Sevón IFOAM - International Federation of Organic Agriculture Movements	Environmental requirements in organic farming were presented as the most demanding in agriculture in relation to EU policy. Principles of organic farming with regard to WeLASER application were reviewed and questions related to future application in the sector posed.
Sustainable weed control: benefits and challenges – organic farming perspective Aira Sevón Organic farm, Finland	There were presented key environmental considerations and practical aspects of weeding in the fields managed according to organic farming principles. Key problems of the Finnish organic farming and the feedback from Finnish farmers related to WeLASER concept were overviewed and discussed.
How can weeding with laser beams support biodiversity? Christian Andreasen University of Copenhagen	Results of WeLASER testing were presented showing high efficiency of performance for destructing weed meristems with small impact on surrounding environment (soil life). Key environmental benefits of the technique were outlined including soil life protection, safety for pollinators and beneficial animals. Lesser impact on soil compaction. was argued in comparison with mechanical and chemical weeding based on heavy machinery.
Environmental performance of WeLASER invention – project activities Janusz Krupanek Instytut Ekologii Terenów Uprzemysłowionych (IETU)	In the presentation a brief overview of WeLASER activities related to the environment, biodiversity and sustainability were outlined along with summary of key factors determining environmental performance of WeLASER technique.
Break	
General discussion: Which factors of WeLASER technique implementation should be focused on to achieve high environmental performance? Which environmental benefits would be the biggest gain ? Are there environmental risks requiring special attention ? All attendees Beata MICHALISZYN (Facilitator) Janusz KRUPANEK (WP1 Leader**)**	❖ During the presentations and discussion, the attendees used mainly chat to express and exchange their views on the topics presented. Stakeholders comments were related not only to the environmental issues but also to general aspects of the project development. ❖ A brief discussion was held with input from stakeholders and consortium members. Stakeholders pointed at enhancing environmental and health benefits of WeLASER system application ❖ Poll related to the key topics of the meetings was carried out and the results are presented in the annex 4 ❖ 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 meeting outcomes and explained the next steps of stakeholders' involvement.
Closure Janusz KRUPANEK	The event organizer thanked for the fruitful event and closed the meeting.

Annex 1 – Agenda of the 3rd Stakeholder Event

Link to the meeting: https://zoom.us/j/93229166880?pwd=a1BVbURoUWlGYnFKVmk2THR3dXJSQT09

Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

AGENDA OF THE THIRD STAKEHOLDERS' EVENT

Virtual meeting

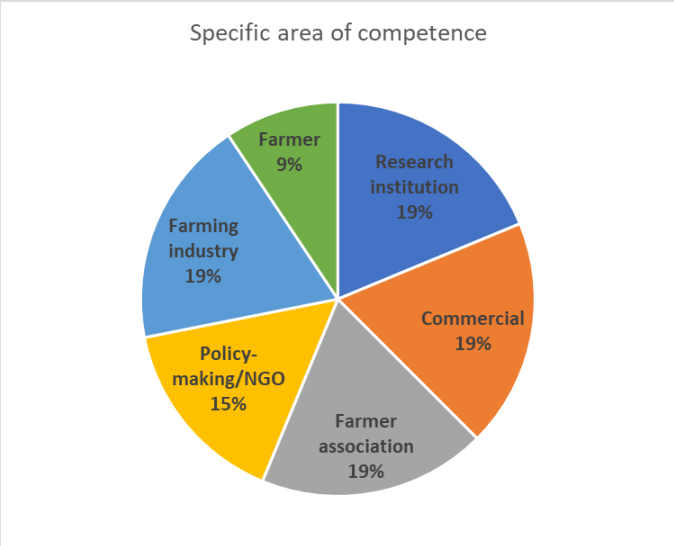
November 19th, 2021

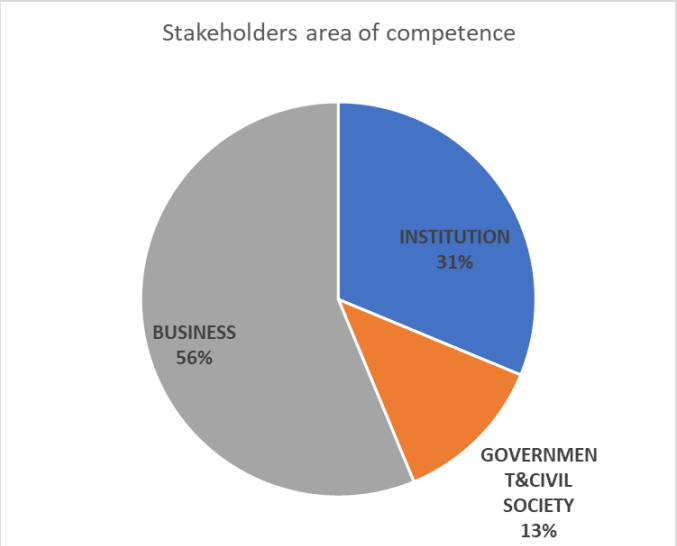
09:30 – 9:35	**Warm up and introduction**	Janusz KRUPANEK (Event organiser/Multi-actor strategy leader)
9:35 – 9:40	**WeLASER project overview**	Pablo GONZALEZ-DE-SANTOS (Project coordinador)
9:40 –10:25	**What we have achieved so far and what is ahead – status of WeLASER invention development**	WP leaders
10 min	*WP2 – Laser-based weeding system: Development and impact*	*Futonics Laser GmbH, (FUT)*
10 min	*WP3 – Weed-meristem perception system*	*Laser Zentrum Hannover (LZH)*
15 min	*WP4 – Autonomous vehicle for laser weeding*	*AGREENCULTURE (AGC), University of Bologna (UNIBO), Centre for Automation and Robotics (CSIC)*
10 min	*WP5 – Industrial integration and evaluation*	*Centre for Automation and Robotics (CSIC)*
10:25 – 10:35	**Break**	
10:35 – 10:45	**EU policy related to sustainable weed control in agriculture**	Aira Sevón IFOAM - International Federation of Organic Agriculture Movements
10:45 – 10:55	**Sustainable weed control: benefits and challenges – organic farming perspective**	Aira Sevón Organic farm, Finland
10:55– 11:05	**How can weeding with laser beams support biodiversity?**	Christian Andreasen University of Copenhagen
11:05 – 11:10	**Environmental performance of WeLASER invention – project activities**	Janusz Krupanek Instytut Ekologii Terenów Uprzemysłowionych (IETU)
11:10 – 12:00	**Discussion:**	

	What are the benefits and what are the environmental concerns of WeLASER implementation in practice	Janusz KRUPANEK (WP1 Leader)
12:00 – 12:10	**Wrap up and next steps**	Janusz KRUPANEK Pablo GONZALEZ-DE-SANTOS
12:10	**Closure**	

Annex 2 – Attendees

The Third WeLASER Stakeholders' Event gathered over 40 participants including farmers, representatives of research and agricultural institutions, policymakers, NGOs and project partners.





WeLASER Consortium

CSIC	Pablo GONZALEZ-DE-SANTOS
	Roemi FERNANDEZ
	Luis EMMI
FUT	Karsten SCHOLLE
	Anja Ahrens
	M Kaule
LZH	Merve WOLLWEBER
	Michael HUSTEDT
	Hendrik SANDMANN
UCPH	Christian ANDREASEN
COAG	Alvaro ARETA
UNIBO	Giuliano VITALI
	Maurizio CANAVARI
	Cristiano FRAGASSA
AGC	Suzanne Baron
IETU	Janusz KRUPANED
	Wanda JAROSZ
UGENT	Margo Degieter
	Duc TRAN
	Joachim Schouteten
VDBP	Paul VAN ZOGGEL

Annex 3 – Key results of expert feedback and the discussion

The discussion was predominantly based on expert´s views who presented key environmental aspects of WeLASER invention and outlined environmental and health benefits of WeLASER. A feedback from an interview of farmers in the Kymi Organic Coop in Finland related to WeLASER technique was presented. Environmental aspects were also highlighted during presentations of the work performed in particular workpackages.

Experts and stakeholders pointed at the need for enhancing environmental and health benefits in WeLASER system application. It was expressed by the participants that environmental issues in WeLASER constitute a significant aspect in further development of the invention and its practical applications. Lesser environmental contamination is viewed as the key benefit. Healthy food was also indicated as a relevant consideration.

Another question posed by the expert is whether WeLASER can be used in organic farming. The main features of the technology and its application potential has to be better explained in further project proceedings. The suitability of WeLASER technique for farms with regard to their area and scale of operations was discussed. According to farmers' views presented by the expert, the WeLASER technique can bring opportunities especially for conventional farmers. On the other hand, in large, conventional farming other opportunities for environmental improvements are also observed including those based on precision agriculture, such as the use of mechanical weeding robots and precision chemical weeding.

Use of WeLASER in organic farming would depend on particular conditions of a given farm as they are more diversified in its production scope, conditions and scale. In organic farming there is already used a wide set of environmentally friendly approaches to weed management, meeting the organic farming principles. According to the expert 90% of organic farmland has no need for plant protection products. The alternative solutions include for example: close cropping, tillage. There is also a new activity in Finland where no-till system is tested.

The issue of the impact of automation of farming work and precision agriculture on farms structure in Europe was raised as there are concerns whether smaller farms can be less competitive in Agriculture 3.0 and 4.0. The interesting question is to what extent WeLASER can raise the efficiency in applications in both types of farm structures and whether it can change the competition between them. The opportunities to serve both needs of large farms and small organic farms have to be addressed in project developments. In small organic farms it can replace the manual work and single robot can be effective and efficient.

It has to be thoroughly considered whether laser technique comply with principles of organic agriculture (principles of ecology, health and care) as well as appropriate requirements of conventional farming. From that perspective approval process has to be carried out if WeLASER has to be accepted in respective sectors. It includes verification of its efficiency, determining of Key Performance Indicators, evaluating its impacts on crops and the environment. A question arises whether existing systems for machineries, technical standards and certification of agricultural performance are sufficient to secure trust in the new technique.

It was generally agreed that WeLASER can be beneficial for biodiversity in agricultural landscapes. Lesser impact on soil compaction was argued by the expert in comparison with mechanical and chemical weeding based on heavy machinery. This can be avoided when using smaller machines. Regarding protection of soil life the tests of the laser impact are promising. The experiments of laser treatment results show that only a tiny area of soil can be affected during the laser action on plant meristems.

Moreover, ecosystem services can be potentially enhanced through operational schemes of selective weed management based on the designed agrirobot functionality, e.g., cover crops and nitrogen fixation crops have to be recognized and preserved. The autonomous robot can be more selective than the traditional techniques but it might require specific approach in the artificial intelligence program design. It was explained that the artificial intelligence is trained in the first place to recognize the crop plant and the rest of plants spotted in the treated area is removed

from the field. The training is specific for a given crop. In new circumstances it has to be retrained or trained specifically to a new crop, new conditions or weeding requirements.

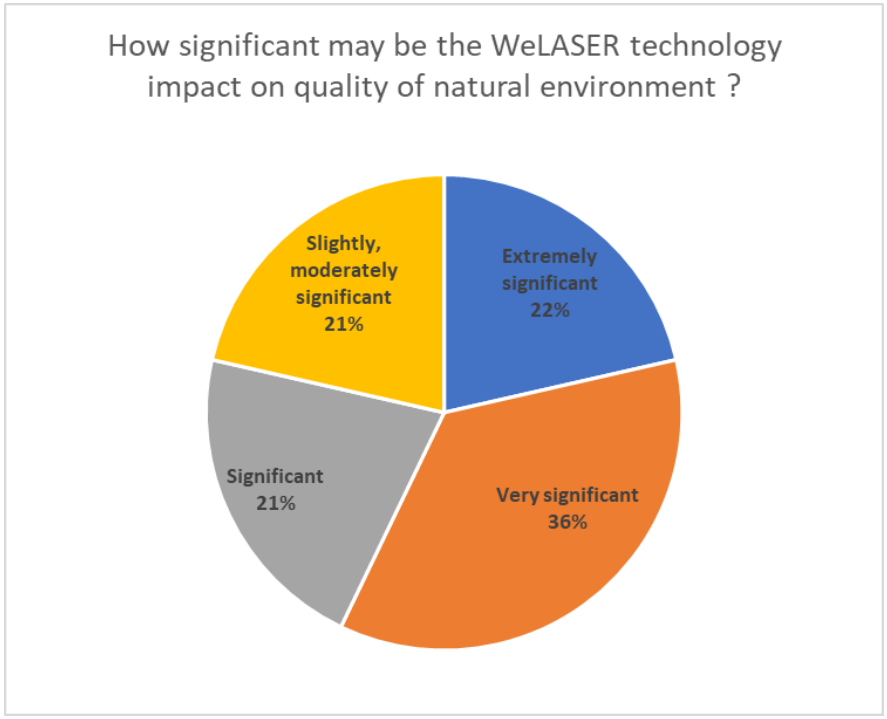
There is also the question how, where and in which situations WeLASER could be used in farming practice. The potential scenarios of usage have to be better understood. It is important to recognize the opportunities, barriers and conditions of using the WeLASER technique. These include stage of weed development, the temporal window of operation (also in relation to the velocity), cases (crop, weed and their development stages) which are excluded. It is envisaged that the technology is suitable for certain weeding scenarios. For example, in organic agriculture it is recognized that it has potential for weeding of vegetables and farming in rows, covering annuals and perennial weeds such as thistle. It can be effectively used, for example for weeding rape seed in early growth phase without harming pollinators. One of the farmers' concerns presented by the expert is the need for specific surface conditions in the field with respect to field surface characteristics. The key environmental issues for consideration in implementing WeLASER are: energy intensity, healthiness to land and crops, effects on pollinators and natural predators of certain pests and animals. From that perspective the technique can potentially address the Integrated Pest Management rules and can be favorable to biodiversity.

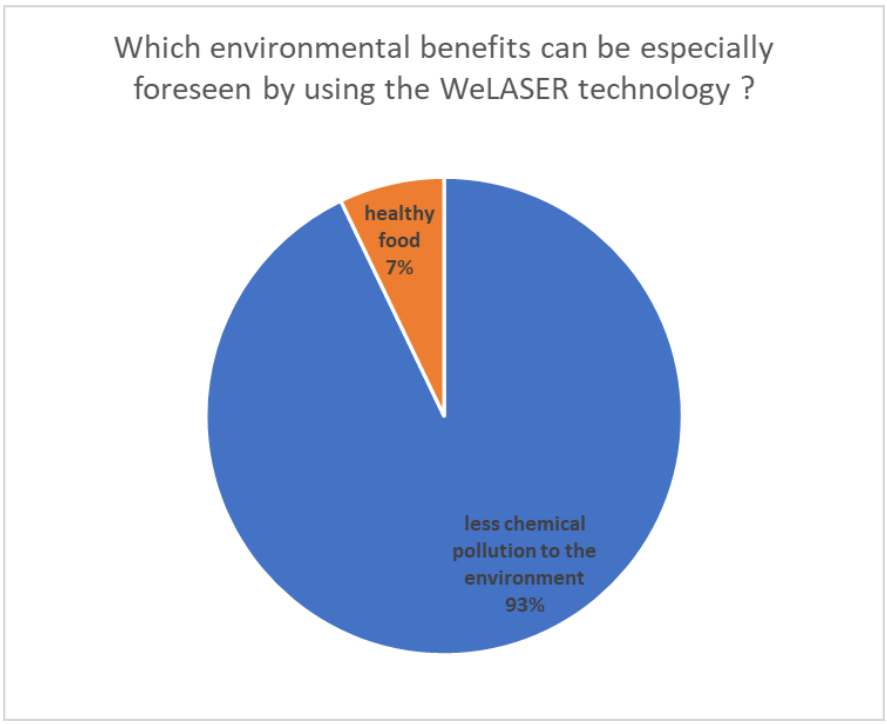
The question of efficiency of WeLASER Agri robot was discussed. One option suggested by the participants can be an extension of the implement coverage of the working area but in this case it would require higher weight. In the project a double system of four laser units is proposed in the second phase of its development after completion of the current project. In large fields to enhance weeding efficiency and environmental benefits, the opportunities for using fleets of robots can be considered. Continuous, autonomous work can play a role in this respect. In organic farming use of single robots with diversified functionalities can be of value. Flexibility of application/efficient use is one of the factors of overall and environmental efficiency: track width, operating mode on slopes, ground clearance, combination and integration of techniques (intra and inter row weeding) including chemical, mechanical and laser, flexible use of the implement in tractors or change of implements in the autonomous vehicle, addressing other plant pathogens (fungi, insects), specific needs of organic farming, crop production systems

It was explained that the project addresses environmental and health issues on technical and strategic levels. It gives a good ground for future verification of the technology and its implementation as the key points are to be clarified during the project. On technical level the specific assessment of the components is carried out e.g. impact of laser action on the soil and overall evaluation of its performance. For technical components both benefits and potential impacts on environment are taken into account. The direct and indirect impacts on the environment are addressed. Protective measures for humans and the environment researched in the project were highlighted by the expert. These include e-fence, protective curtains for laser system, very precise performance of the laser as the basic feature.

In the strategic part of the project, sustainability assessment of WeLASER application in life cycle perspective is considered including social, economic and environmental aspects. It is underlined that operational issues have to be taken into account in the research. It is agreed that the key to the success, is the overall efficiency of the robot. The benefits of WeLASER application can be fully exploited in relation to various EU policies and especially the Common Agricultural Policy. It can be envisaged that CAP reform will favor the technique if the environmental, economic, and social benefits are proven. The EU Farm to Fork strategy aims to reduce the use of herbicides and pesticides (e.g., reduce use of herbicides with 50%) and fertilizer use, reduced use of antimicrobials and increase area of organic farming to more than 25%.

Annex 4 – Results from polls





Annex 5 – Presentations

- WeLASER Third Stakeholders Event –Welcome and introduction - Janusz Krupanek, IETU

Project and its activities - overview

- WeLASER project overview - Pablo Gonzalez-de-Santos, CSIC
- WP2 – Laser source and experiments - K. Scholle, A. Ahrens, P. Fuhrberg, H. Sandmann, M. Wollweber, M. Saberi, C. Andreasen
- WP3 –Weed-meristem perception system - Merve Wollweber, (LZH)
- WP4 – Autonomous vehicle for laser weeding - AGC, CSIC, UNIBO
- WP5 – Industrial Integration and Evaluation - Luis Emmi, CSIC

Thematic session: key environmental requirements in relation to farmers' and societal needs and respective EU policies.

- EU POLICY RELATED TO SUSTAINABLE WEED CONTROLORGANIC FARMING APPROACH - Aira Sevón, Finland
- WeLASER - Sustainable Weed Control: Benefits & Challenges – Cereal Organic Farming Perspective - Aira Sevón, Finland
- How can weeding with laser beams support biodiversity? Christian Andreasen, University of Copenhagen
- Environmental performance of WeLASER invention – project activities - Janusz Krupanek, IETU