



Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

D6.4 - Communication, dissemination and exploitation activities and results (III)



Funded by the Horizon 2020 programme of the European Union

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Disclaimer

The views and opinions expressed in this document are solely those of the project, not those of the European Commission.

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EXECUTIVE SUMMARY

This deliverable provides a broad overview of the communication, dissemination and exploitation activities carried out within the WeLASER project, updating “D6.3 - Communication, dissemination and exploitation activities and results (II)”, delivered on 30 September 2022, and providing information on the dissemination and exploitation activities planned during the project.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGC:	Agreenculture
CATI:	Computer Assisted Telephone Interviewing
COAG:	Coordinator of Farmer Organizations and Livestock Rural Initiative of Spain
CSIC:	Spanish National Research Council
DoA:	Description of the Action (A part of the Grant Agreement)
FUT:	Futonics
IETU:	Institute for Ecology of Industrial Areas
IoT:	Internet of Things
KPI:	Key Performance Indicators
LZH:	Laser Zentrum Hannover
M1 – M42:	Month within the period of project development
PESTEL:	Political (P), Economic (E), Social (S), Technological (T), Environmental (E), and Legal (L).
UCPH:	University of Copenhagen
UGENT:	Ghent University
UNIBO:	University of Bologna
VDBP:	Van den Borne Projecten
WP:	Work Package

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1. PURPOSE OF THE DOCUMENT

The aim of this final report on communication, dissemination and exploitation activities is to provide a thorough overview of the related activities carried out during the project. This overview is a valuable tool and provides a detailed insight into these types of activities throughout the entire project.

2. INTRODUCTION

2.1. About WeLASER

WeLASER aims to merge current technologies to build, assess and push into the market a precision weeding system based on high-power laser sources and autonomous mobile systems with the main objective of eliminating the use of herbicides while improving productivity and competitiveness; such a system would eradicate health risks and environmental adverse effects associated with the use of herbicides.

In the context of a world-growing population and higher need of reducing the use of pesticides and fertilisers, WeLASER seeks more sustainable management. Mechanical solutions contribute to deteriorate the soil properties, harm beneficial soil organisms and provide poor results for in-row weeding. However, the WeLASER solution focuses on non-chemical weed management based on applying lethal doses of energy on the weed meristems using a high-power laser source. An AI-vision system discriminates crops from weeds and detects the position of the weed meristems to point the laser at them using a laser scanner. An autonomous vehicle carries these systems all over the field. A smart controller coordinates these systems and uses IoT and cloud computing techniques to manage agricultural knowledge. This technology will provide a clean solution to the weeding problem and will help to decrease significantly the chemicals in the environment.

2.2. About WP6 on Knowledge spread

Regarding knowledge spread, WeLASER WP6 main objective is to create visibility for the consortium by planning a fruitful communication and dissemination strategy to promote the project results. To this aim involvement of all actors in the diffusion of knowledge is structured through the multi-actor strategy. Communication actions provide targeted information to multiple audiences according to the strategies defined. Dissemination activities diffuse the technological and scientific advances of WeLASER to the research community.

To maximise the project impact, a continuously updated exploitation plan specifies the management of the full-exploitation chain activities focusing on the market analysis and market strategy, distribution and pricing models. Commercialisation, exploitation, and market deployment plan beyond the duration of the project is also addressed.

3. WeLASER STAKEHOLDERS AND AUDIENCE

Stakeholders are an essential point to consider when defining the WeLASER dissemination and communication plans as they are a key target from the outset of the project not only to spread the WeLASER activities, but also to promote the uptake of WeLASER project results. Also, according to the multi-actor involvement strategy, all stakeholders will monitor and contribute to the activities related to communication, dissemination and exploitation.

As part of the multi-actor involvement strategy, a first identification of stakeholders was carried out until mid-November 2020 and continued throughout the duration of the project. Stakeholders were identified, balance-selected and engage from four different groups, which are in line with the categories covered by the dissemination and communication plan:

❖ Academic and research

- Scientific and education community: universities, high education and research institutes;
- Education and training institutions, educational institutions and schools;
- National and international research centres;
- Students community: engage the student community in their different levels (undergraduate, graduate, M.Sc. and Ph.D.) is of paramount importance for training new professionals and covering the new expected jobs.
- Standardisation institutions: institutions for standardisation through their tools and committees to develop new standards. For instance, the International Organization for Standardization (ISO), the International Electro-technical Commission (IEC), CENELEC - Comité Européen de Normalisation Électrotechnique and collaboration, CEN National Standardization Bodies/CENELEC National Committees and the national trade associations representing different sectors of business and industry.

❖ Businesses

- Industrial community: machinery associations at national and European level. Machinery firms, robotics companies, laser industry. Farming machinery-related industry.
- End users: farmers and farmer associations at national, European and international levels, crop protection associations, organic farming associations, cooperative and cooperatives associations.
- Investors: individual and institutional investors, agricultural and investment groups, banks, investment funds, crowdfunding tools and institutions.



❖ Decision-makers and Policy-makers

- Local, regional, national governments and EU policy-makers, government funding bodies and agencies.
- Policy influencers: advocacy groups and associations pertinent as influencers and thought leaders in their communities and sectors.
- European Innovation Partnership for Agricultural productivity and sustainability (EIP-AGRI).
- European Commission and Research Executive Agency.

❖ General public

- Society at large: civil society and general stakeholders
- General media.
- Professional and specialised media.

4. CONTENT FOR COMMUNICATION AND DISSEMINATION

All WeLASER templates and supporting material for communication and dissemination was created and agreed between M1 and M2 of the project.

4.1. Logos

The WeLASER logos were created and agreed in M1 of the project and all specifications around design, colour and presentation were detailed. Every communication involving graphic content (i.e. printed media, online website and social media channels, emails, newsletters, presentations, publications etc.) on all WeLASER channels to external audiences has to include the WeLASER logo in an appropriate format.



Fig. 4.1. WeLASER logo with slogan.



Fig. 4.2. WeLASER logo without slogan.



Fig. 4.3, WeLASER logos adapted for social media.



Fig. 4.4. WeLASER logos adapted to other formats.

As established in the Grant Agreement, all dissemination of results display the EU emblem and include the text: *“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101000256”*.

4.2. Templates

The WeLASER templates were defined and agreed in M1 of the project. Specifically, templates for the following types of documents were created:

- POWERPOINT format template for presentations.
- WORD format template for deliverables.
- WORD format template for newsletters.
- WORD format template for the agendas and minutes of the meetings.

WeLASER templates are gathered in Annex 1.

4.3. Roll-up

The WeLASER roll-up design was defined and agreed in M2 of the project. This design provides the WeLASER consortium with a common and high-impact resource for fairs, congress, field days and other dissemination events. Posters presented in section 5.1.11 are based on this roll-up design.





Co-funded by the Horizon 2020 programme of the European Union

Fig. 4.5. WeLASER roll-up.

4.4. Virtual background

The WeLASER virtual background design was defined and agreed in M2 of the project. This resource is used in on-line events and virtual meetings, allowing a common and useful format, especially in the context of COVID-19 restrictions.



Fig. 4.6. WeLASER virtual background.

5. DISSEMINATION AND COMMUNICATION ACTIVITIES

WeLASER dissemination activities have been dedicated to communicating the technological and scientific advances of WeLASER to the industrial and academic community. Specifically, dissemination has aimed to increase awareness and understanding of what is being done, to report on the progress of the project, and involve and obtain input from these audiences, while promoting and encouraging acceptance and recognition to facilitate the path towards market implementation of the project results and outputs.

Actions have focused on peer-reviewed scientific publications through Gold and Green Open Access approaches, where participants from academia commit to contribute with publications in scientific conferences and journals indexed in the Journal Citation Report (JCR) at national and international levels.

Dissemination began in M6, when the first results appeared, and continued until the end of the project's development.

Communication activities in WeLASER were devoted to generating the proper messages regarding the project activities and the project results to be scattered through the media to reach the general audience, professionals and the local, national and EU governments with the aim of improving awareness and trust in new weeding technology.

The activities were focused on the launch and maintenance of the project website, and the creation and management of social media accounts. D6.1; D6.2; D6.3 reported about the creation of this communication material. Another important part of this activity was devoted to the elaboration and issue of the “Practice Abstracts” of the Agricultural European Innovation Partnership (EIP-AGRI) common format to be made available to the interested communities through the on-line EIP-AGRI database. Communication started in M1 and continued until M39.

5.1. Activities planned and developed

5.1.1. Journal articles

WeLASER members coming from academia submitted manuscripts to journals indexed in the Journal Citation Report (JCR) to inform the scientific community about the project outcomes, as scientists from universities and research centres traditionally look for new interesting results in peer-reviewed scientific journals. Achieving publication in this type of journals will also be a measure of the quality of the project results.

During the WeLASER project several articles were published (Table 5.1).



Table 5.1. WeLASER journal articles.

1	Title	Crop Management with the IoT: An Interdisciplinary Survey
	Authors	Giuliano Vitali, Matteo Francia, Matteo Golfarelli, Maurizio Canavari
	Type	Article in journal
	DOI	10.3390/agronomy11010181
	ISSN or eSSN	20734395
	Title of the journal	Agronomy
	Number	11(1)
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2021
	Pages	1-18
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access
2	Title	“Deep Neural Networks to Detect Weeds from Crops in Agricultural Environments in Real-Time: A Review”
	Authors	Ildar Rakhmatuili, Andreas Kamilaris, and– Christian Andreassen
	Type	Article in journal
	DOI	10.3390/rs13214486
	ISSN or eSSN	20724292
	Title of the journal	Agronomy
	Number	13 (21)
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2021
	Pages	1-24
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access
3	Title	“Laser Weeding with Small Autonomous Vehicles: Friends or Foes?”
	Authors	Christian Andreassen, Karsten Scholle and Mahin Saberi
	Type	Article in journal
	DOI	10.3389/fagro.2022.841086
	ISSN or eSSN	4841086
	Title of the journal	Frontiers in Agronomy
	Number	Vol. 4
	Publisher	Frontiers in Agronomy
	Place of publication	
	Year of publication	2022
	Pages	1-9
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

4	Title	“A Scalable Device for Undisturbed Measurement of Water and CO2 Fluxes through Natural Surfaces”
	Authors	Giuliano Vitali, Marco Arru and Eugenio Magnanini
	Type	Article in journal
	DOI	10.3390/s23052647
	ISSN or eSSN	14248220
	Title of the journal	Sensors
	Number	23(5), 2647
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2023
	Pages	1-12
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

5	Title	“Exploiting the Internet Resources for Autonomous Robots in Agriculture”
	Authors	L. Emmi, R. Fernández, P. Gonzalez-de-Santos, M. Francia, M. Golfarelli, G. Vitali, H. Sandmann, M. Hustedt and M. Wollweber
	Type	Article in journal
	DOI	10.3390/agriculture13051005
	ISSN or eSSN	20770472
	Title of the journal	Agriculture
	Number	13(5), 1005
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2023
	Pages	1-22
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

6	Title	“European stakeholders’ perspectives on implementation potential of precision weed control: the case of autonomous vehicles with laser treatment”
	Authors	Duc Tran, Joachim J. Schouteten, Margo Degieter, Janusz Krupanek, Alvaro Areta, Luis Emmi
	Type	Article in journal
	DOI	10.1007/s11119023100375
	ISSN or eSSN	15731618
	Title of the journal	Precision Agriculture
	Number	Vol. 24
	Publisher	SPRINGER
	Place of publication	Gernamy
	Year of publication	2023
	Pages	2200-2222
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

7	Title	“Farmers’ acceptance of robotics and unmanned aerial vehicles: A systematic review” https://access.onlinelibrary.wiley.com/doi/pdf/10.1002/agj2.21427
	Authors	Margo Degieter; Hans De Steur; Duc Tran; Xavier Gellynck; Joachim J. Schouteten
	Type	Article in journal
	DOI	10.1002/agj2.21427
	ISSN or eSSN	00021962
	Title of the journal	Agronomy Journal
	Number	115
	Publisher	John Wiley
	Place of publication	USA
	Year of publication	2023
	Pages	2159–2173
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

8	Title	“Side-effects of laser weeding: quantifying off-target risks to earthworms (<i>Enchytraeids</i>) and insects (<i>Tenebrio molitor</i> and <i>Adalia bipunctata</i>)”
	Authors	Christian Andreasen, Eleni Vlassi, Kenneth S. Johannsen and Signe M. Jensen
	Type	Article in journal
	DOI	10.3389/fagro.2023.1198840
	ISSN or eSSN	51198840
	Title of the journal	Frontiers in Agronomy.
	Number	Vol. 5
	Publisher	Frontiers in Agronomy
	Place of publication	
	Year of publication	Frontiers in Agronomy
	Pages	1-10
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

9	Title	“Enabling Autonomous Navigation on the Farm: A Mission Planner for Agricultural Tasks”
	Authors	Cordova-Cardenas, R.; Emmi, L.; Gonzalez-de-Santos, P.
	Type	Article in journal
	DOI	10.3390/agriculture13122181
	ISSN or eSSN	20770472
	Title of the journal	Agriculture
	Number	13(12), 2182
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2023
	Pages	1-19

	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

10	Title	“Crop Identification and Growth Stage Determination for Autonomous Navigation of Agricultural Robots”
	Authors	Cortinas, E.; Emmi, L.; Gonzalez-de-Santos, P.
	Type	Article in journal
	DOI	10.3390/agronomy13122873
	ISSN or eSSN	20734395
	Title of the journal	Agronomy
	Number	13(12) 2873
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2023
	Pages	1-22
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

11	Title	“An Efficient Guiding Manager for Ground Mobile Robots in Agriculture”
	Authors	Emmi, L.; Fernández, R.; Gonzalez-de-Santos, P.
	Type	Article in journal
	DOI	10.3390/robotics13010006
	ISSN or eSSN	2218-6581
	Title of the journal	Robotics
	Number	13(1), 6
	Publisher	MDPI
	Place of publication	Switzerland
	Year of publication	2023
	Pages	1-22
	Public publication	YES
	Pear review	YES
	Open access	Gold Open Access

5.1.2. Forthcoming Journal Articles

A number of scientific publications are planned for the WeLASER project during 2024. These are currently under evaluation or in preparation. They are as follows:

1. **Title:** Farmers' perception of innovative laser-based weed control technology. Perspectives of WeLASER robot application
Authors: Janusz Krupanek, Beata Michaliszyn, Joachim Bronder, Wanda Jarosz, Duc Di Minh Tran, Joachim Schouteten, Margo Degieter.
Submission planned: January 2024,
Journal: Sustainability (MDPI).
2. **Title:** Social aspects of high-power laser based weeding robot implementation in Life Cycle Perspective

Authors: Janusz Krupanek, Beata Michaliszyn, Joachim Bronder, Wanda Jarosz,
Submission Planned: January 2024,
Journal: Sustainability (MDPI)

3. **Title:** Life Cycle Costing of innovative laser-based weed control technology
Authors: Janusz Krupanek, Beata Michaliszyn, Duc Di Minh Tran, Joachim Schouteten, Margo Degieter,
Planned submission: January 2024
Journal: International Journal of Life Cycle Assessment/ Journal of Cleaner Production (Elsevier)
4. **Title:** Environmental performance of autonomous laser weeding robot – a case study
Authors: Janusz Krupanek, Pablo Gonzales de Santos, Luis Emmi, Merve Wollweber, Hendrik Sandmann, Karsten Scholle, Duc Di Minh Tran, Joachim Schouteten, Christian Andreasen.
Submitted: November 202
Journal: International Journal of Life Cycle Assessment (Elsevier)
5. **Title:** Empowering farm navigation for autonomous robots;
Authors: Luis Emmi and Pablo Gonzales-de-Santos;
Planned submission: January 2024
Journal: Precision Agriculture / Journal: Computers and Electronics in Agriculture / Biosystem Engineering.
6. **Title:** Autonomous Robots for Precision Agriculture in Edge-Cloud Continuum;
Authors: Luis Emmi, Matteo Francia, Matteo Golfarelli, and Pablo Gonzalez-de-Santos;
Planned submission: February 2024
Journal: Computers and Electronics in Agriculture.
7. **Title:** Datasets for robot navigation in maize and sugar beet;
Authors: Luis Emmi and Pablo Gonzales-de-Santos.
Planned submission: January 2024

5.1.3. Publications and presentations in conferences and workshops

The WeLASER partners attended relevant conferences to inform the scientific community about the project results through publications in proceedings and engage attendees through public presentations promoting scientific and technical discussions. During the WeLASER project, the following activities were developed in this area.

1. M. Wollweber

Presentation at the IIRB (International Institute of Sugar Beet Research) online seminar held on 4th of May 2021: “Laser applications for sustainable plant production” .

https://www.iirb.org/fileadmin/IIRB/Seminars/2021/Programme_IIRB_Seminar_2021.pdf

2. G.Vitali.

Presentation at the 107th Congress of Italian Society of Physics held online 13-17 September

2021. (IoT in Environmental Physics - Book of Abstracts - ISBN: 978-88-7438-127-2 - pg.309.
<https://welaser-project.eu/wp-content/uploads/2021/12/Societa-Italiana-di-Fisica-107-National-Congress-Vitali.pdf>
3. Merve Wollweber
“Thermische Beikraut Bekämpfung Technologien für die konservierende Bodenbearbeitung“ (Technologies for thermal weed treatment in conservation soil cultivation). Fortbildung Pflanzenbau 2021, Landesbetrieb Landwirtschaft Hessen, Bildungsseminar Rauschholzhausen; 9./10.11.2021, online.
 4. Merve Wollweber
“Unkrautbekämpfung mit dem Laser “(Weeding with lasers). OptecNet Jahrestagung, 24./25.11.2021, Hanover, Germany.
 5. Christian Andreasen, Mahin Sabari–Ildar Rakhmatullin,
“Weed control with laser beams using autonomous vehicles: pros and cons”, World FIRA 2021, Toulouse, France, 7-9 December 2021.
<https://welaser-project.eu/wp-content/uploads/2021/12/FIRA2021-Andreasen-et-al-.pdf>
 6. J. Herrera, L. Emmi, P. González-deSantos,
“Enabling navigation for– autonomous robots in early-stage crop growth”, World FIRA 2021, Toulouse, France, 7-9 December 2021.
<https://welaser-project.eu/wp-content/uploads/2021/12/FIRA2021-Herrera-et-al.pdf>
 7. Andreasen, I. Rakhmatullin, M. Saberi and Z. Zang;
Weed control with laser beams: an eco friendly alternative to herbicides and mechanical weed control 4th International “Conference on Photonics Research”, Muğla, Turkey, April 22-28, 2022.
<https://welaser-project.eu/wp-content/uploads/2022/07/Christian-Andreasen-presentation-Photonics.pdf>
 8. Christian Andreasen, MahinSabari, Karsten Scholle, and Pablo Gonzalez-de-Santos;
Laser Weeding with an Autonomous Vehicle, 19th European Weed Research Symposium, “Lighting the future of Weed Science”, Athens, Greece, 20-23 June 2022.
<https://welaser-project.eu/wp-content/uploads/2022/06/Laser-Weeding-EWRS-Poster-2022.pdf>



9. Merve Wollweber and Tammo Ripken.
“Laser Weeding – A New Technology for Sustainable Weed Management”. SLPC2022 -The 4th Smart Laser Processing Conference at Optics & Photonics International Congress (OPIC 2022). 18-22 April 2022, Yokohama, Japan.
10. Luis Emmi, Jesus Herrera-Diaz and Pablo Gonzalez-de-Santos;
Toward Autonomous Mobile Robot Navigation in Early-Stage Crop Growth, ICINCO 2022: 19th International Conference on Informatics in Control, Automation and Robotics, Lisbon, Portugal, 14-16 July 2022.
<https://welaser-project.eu/wp-content/uploads/2022/08/Emmi-Herrera-Gonzalez-de-Santos-ICINCO-2022.pdf>
11. Luis Emmi, Rebeca Parra and Pablo Gonzalez-de-Santos;
Digital representation of smart agricultural environments for robot navigation, HAICTA 2022: 10th International Conference on ICT in Agriculture, Food & Environment, Athens, Greece, 22-25 September 2022.
<https://welaser-project.eu/wp-content/uploads/2022/08/PUBLICATION-Digital-representation-of-smart-agricultural-environments-for-robot.pdf>
12. Duc Tran; Joachim J. Schouteten; Margo Degieter; Janusz Krupanek; Wanda Jarosz; Alvaro Areta; Luis Emmi; Hans De Steur; Xavier Gellynck;
Can autonomous vehicles with laser treatment be the future of weed control in Europe? A pestle review and SWOT analysis, 186th EAAE Seminar: 17th International European Forum (Igls-Forum*) on System Dynamics and Innovation in Food Networks (Oral presentation), Garmisch-Partenkirchen, Germany, 13-17 February 2023.
13. Margo Degieter, Duc Tran, Hans De Steur, Xavier Gellynck, Joachim J. Schouteten;
A systematic review of farmers’ adoption and willingness to adopt field robots and unmanned aerial vehicles, 186th EAAE Seminar: 17th International European Forum (Igls-Forum*) on System Dynamics and Innovation in Food Networks (Oral presentation), Garmisch-Partenkirchen, Germany, 13-17 February 2023.
14. Duc Tran; Margo Degieter; Joachim J. Schouteten; Xavier Gellynck; Hans De Steur;
Farmers’ preferences for laser weeding treatment, SGA: Annual conference of Swiss Society for Agricultural Economics and Rural Sociology (Oral presentation), Zurich, Switzerland, 20-21

April 2023.

15. Margo Degieter; Hans De Steur; Duc Tran; Xavier Gellynck; Joachim J. Schouteten;
Determinants of farmers' adoption of robotics and drones: A systematic review, SGA: Annual conference of Swiss Society for Agricultural Economics and Rural Sociology (Oral presentation), Zurich, Switzerland, 20-21 April 2023.
16. Margo Degieter; Duc Tran; Hans De Steur; Xavier Gellynck; Joachim J. Schouteten;
Exploring Farmers' Perspectives on Laser-Based Weeding, 23th BAAE PhD Symposium Agricultural and Natural Resource Economics, Ghent, Belgium, 7 June 2023.
17. Duc Tran; Margo Degieter; Joachim J. Schouteten; Xavier Gellynck; Hans De Steur;
How do farmers prefer laser-weeding? A pan-European survey, 14th ECPA: European Conference on Precision Agriculture (Poster presentation), Bologna, Italy, 2-3 July 2023.
<https://air.unimi.it/retrieve/382d20ad-1877-488f-94db-76df80d6e030/ECPA-2023-Book-of-Abstracts-Posters.pdf>
18. M. Wollweber;
Laser safety during laser-based weed control with autonomous vehicles, 14th ECPA European Conference on Precision Agriculture (Poster presentation), Bologna, Italy, 2-3 July 2023.
<https://air.unimi.it/retrieve/382d20ad-1877-488f-94db-76df80d6e030/ECPA-2023-Book-of-Abstracts-Posters.pdf>
19. Vitali G., Arru M., Fernandez R., Lattanzi P., Emmi L., Fragasso C;
An IoT efence for agri-robots, 14th ECPA European Conference on Precision Agriculture (Poster presentation), Bologna, Italy, 2-3 July 2023.
<https://air.unimi.it/retrieve/382d20ad-1877-488f-94db-76df80d6e030/ECPA-2023-Book-of-Abstracts-Posters.pdf>
20. Scholle, K, Schäfer, M, Kaule, M, Gieselmann, A, Fuhrberg, P;
High power 2 μ m wavelength fiber laser for precision weeding, 14th ECPA European Conference on Precision Agriculture (Poster presentation), Bologna, Italy, 2-3 July 2023.
<https://air.unimi.it/retrieve/382d20ad-1877-488f-94db-76df80d6e030/ECPA-2023-Book-of-Abstracts-Posters.pdf>
21. Margo Degieter; Duc Tran; Joachim J. Schouteten; Xavier Gellynck; Hans De Steur;



Farmers' Attitudes Towards Laser Based Weeding, XVII EAAE Congress (Poster presentation), Rennes, France, 29 August – 1 September 2023.

22. Luis Emmi, Ruth Cordova-Cardenas, and Pablo Gonzalez-de-Santos;

A mission planner for autonomous tasks in farms, ROBOT 2023 The Sixth Iberian Robotics Conference, Coimbra, Portugal, 22-24 November 2023.

<https://digital.csic.es/bitstream/10261/340190/1/agriculture-13-02181.pdf>

23. Andreasen C., Vlassi E., Johannsen K.S., Salehan, N., Colque-Little C.;

Weed control with a 2 μ m fiber laser beam: The effect on some annual and perennial weeds, APWSS 2023: The 28th Asian-Pacific Weed Science Society Conference, Phuket, Thailand. P. 168, 26-29 November 2023.

https://static-curis.ku.dk/portal/files/332039509/IWSC_2022_Fiberlaser_abstract.pdf

5.1.4. Summer Schools

From 10th to 12th July 2023 a Summer School was organised in Spain (CSIC). It was a short course to introduce intelligent autonomous robotics for agriculture focused on the specific example of weeding with laser. The school was focused on two objectives: to disseminate the results of the project and to train future system managers and technicians.

Fifty-nine (59) students were registered in the course;

- 43 students from Bangladesh, Belgium, France, Germany, Hungary, India, Italy, Morocco, Serbia, Spain, Turkiye, etc., were connected online.
- On the last day, a demo was conducted at the Centre for Automation and Robotics (CSIC), Madrid, Spain, attended by 14 students.
- The event was also followed online.

5.1.5. Lectures in MSc and PhD courses

This activity is focused on lectures and presentations at different levels (undergraduate, graduate, M.Sc. and Ph.D.) to engage the student community, as it is of paramount importance for training new professionals and covering the new expected jobs. Graduates are valuable as technicians and M.Sc. and Ph.D. as prospective researchers in the field. Table 5.2 includes some lectures taught during the WeLASER project.

Table 5.2. Lectures in MSc and PhD courses.

Type of activity	Name of the activity	Reference	Place
Course	Grundkursus Plantebeskyttelse (Basic course in plant protection) by C. Andreasen (UCPH)	5440-B4-4F21;	UCPH
Course	Pesticide Use, Mode of Action and Ecotoxicology by C. Andreasen (UCPH)	5440-B3-3F21	UCPH
Course	Afgrøde Lære (Crop Science) by C. Andreasen (UCPH)	5440-B4-4F21;	UCPH
Course	Plante Videnskab (Robotics in Agriculture) by C. Andreasen (UCPH)	5440-B2-2E21	UCPH
Lecture	“Navigation Strategies for Field Mobile Robotics: WeLASER project case study” by L. Emmi (CSIC)	Doctoral program in Computer Engineering. May 3, 2022	Faculty of Informatics, Complutense University of Madrid

5.1.6. Patents

The knowledge generated in WeLASER will be analysed by the Project Management Team to decide what results are to be protected and what results could be disseminated. The strategies for both protection and dissemination of results are set up in the IPR management strategy. During the project development, the following patents have been applied (See further details in Deliverable D6.8):

1. MODULAR SYSTEM FOR MONITORING VEGETATED AREAS AND REMOTE ACCESS DETECTION, ESPECIALLY SUITABLE FOR OPEN FIELD AREAS by Giuliano Vitali, Marco Arru, Cristiano Fragassa, Andrea Verdecchia, and Eugenio Magnanini (UNIBO). Code number: 102023000007887.
2. METHOD AND SYSTEM FOR IMPROVED GUIDING OF ROBOTS IN CROP FIELDS by Luis Emmi and Pablo Gonzalez-de-Santos (CSIC). Application number: EP23383311.

As software is not susceptible to being patented, CSIC has protected the source code

1. “DIGITAL REPRESENTATION OF AGRICULTURAL ENVIRONMENTS TO

NAVIGATE WITH AUTONOMOUS ROBOTS” through blockchain and a notary for authorship accreditation.

5.1.7. Participation in external related events

The consortium participates in the main technical exhibitions and fairs with the specific goal of promoting contacts and disseminating the achievements to industrial and professional associations. The main exploitable outcomes of the project have been presented at the fair best fitted to the end of the project.

1. Presentation at “Sustainable Agriculture and Natural Resources” online cluster event organized by the European Research Executive Agency (REA), and held on May 20, 2021 (attended by WeLASER project coordinator and the Technical & Innovation manager).
2. Presentation at “H2020 Plant Health related projects” online cluster event organized by the European Research Executive Agency (REA)) in cooperation with the European Commission (DG Agriculture and Rural Development), and held on September 23, 2021 (attended by WeLASER project coordinator, the Technical and Innovation Manager, the Dissemination manager, and WP6 (Knowledge spread and innovation management leader).
3. Presentation of project WeLASER during Forum Innowacji w Rolnictwie Stare Pole. Forum on Innovation in Agriculture Stare Pole, 7th September 2022, Janusz Krupanek, Wanda Jarosz, Beata Michaliszyn-Gabryś, IETU.
4. Öko-Feldtage 2022 (<https://oeko-feldtage.de/>) in Villmar-Aumenau (Germany) from 28th to 30th of June 2022. Presentation with roll-ups, videos and a live demo of laser weeding as one of 20 innovation examples that were invited to the fare. Approximately 11,500 visitors – among them the German federal minister for Food and Agriculture Cem Özdemir – attended this largest German field day event on a 20-hectare area.
5. COAF presented WeLASER in DATAGRI 2022. Datagri Forum is a reference event in Europe and Latin America to discover the next technological trends in the sector worldwide. <https://www.datagri.org/>
6. Public IETU Seminar IETU, Janusz Krupanek, title: WeLASER - Eko-innowacyjnej odchwaszczanie laserem, WeLASER /Eco-innovative weeding with laser, 16th of November 2023.
7. Agritechnica 2023: WeLASER was presented at Agritechnica, the world’s leading trade fair on agricultural machinery. In 2023, Agritechnica showcased 2,812 exhibitors from

52 countries and had more than 470,000 visitors from 149 countries.

8. LZH presented WeLASER in a Webinar within the COST action: Towards zero Pesticide AGRiculture: European Network for sustainability (TOP-AGRI-Network) <https://wissen.julius-kuehn.de/top-agri/>
9. Merve Wollweber, Tammo Ripken; Laser weeding: technical approaches and challenges for different agricultural applications, Photonic Technologies in Plant and Agricultural Science – Part of SPIE LASE, San Francisco, USA, 31 January 2024.

5.1.8. Field and training days

Four field days were organised during the project:

1. **First field day** organised by COAG in Madrid (Spain).

On July 26th, 2023, the first Field Day was organised by COAG in the facilities of the Centre for Automation and Robotics (CAR-CSIC), Arganda del Rey (Madrid, Spain). The main objective was to introduce end-users, professionals, authorities, and students to the equipment. They were able to see the prototype in action and an exchange about its functioning and possibilities was established. The conclusions are available in [PA-56](#).

2. **Second field day** organised by UCPH in Copenhagen (Denmark).

On August 18, 2023, the WeLASER autonomous vehicle equipped with the laser system was demonstrated at the research facility Højbakkegaard, Taastrup, belonging to the University of Copenhagen. Stakeholders from all over Denmark were invited to the demonstration. About 45 people from seed and horticultural industries, farm advisory services, agricultural innovators, farmers, and researchers finally attended the event. The conclusions are available in [PA-55](#).

3. **Third field day** organised by VDBP in Reusel (Netherlands).

On August 24 to 26, 2023, the third WeLASER Field Day was organized by VDBP within the PRECISION FARMING DAYS (Reusel, The Netherlands), an event where precision machines, sensors, robots, software, and drones for agriculture are exhibited for farmers, professionals, students, and curious people. Over 50 suppliers offered their solutions in booths and fields and gave more than 20 demonstrations to over 650 visitors. WeLASER consortium used this event to communicate and disseminate the project results. The conclusions are available in [PA-58](#).

4. **Final field day** organised by CSIC in Madrid (Spain).

On September 28, 2023, the final event was organised by CSIC and COAG in the Centre for Automation and Robotics (CAR-CSIC) facilities in Arganda del Rey (Madrid, Spain). The main objective of this Field Day was to present the final prototype to end-users, professionals,



authorities, and students. All the stakeholders and attendees could check the system in action in real farm conditions and a fruitful interaction was developed. The general press was also invited to this Final Event to enhance the dissemination and communication of the results. The conclusions are available in [PA-59](#).

The main objective of these **field days** was to introduce end-users, professionals, authorities and students to the equipment by organising exhibitions and demonstrations as well as training activities.

COAG, the farmers' association participating in WeLASER, kept its represented farmers and other farmers' associations from other EU countries informed and received information on their needs and expectations.

5.1.9. WeLASER stakeholder Events

As a part of the Multi-Actor Approach strategy, five (5) stakeholder events were planned. Due to COVID-19 restrictions these events were held online.

The **First Stakeholder Event** was organised by COAG on November 26th, 2020. The main objectives were to (i) stimulate the involvement of stakeholders in the decision level of the consortium and (ii) include the stakeholders in the definition of the system characteristics. Over a total of 60 participants, 21 stakeholders, joined together in this first event. The information provided to the stakeholders, the discussion and the stakeholder assessment are detailed in deliverable D1.1-Multi-actor involvement plan and activities (I). The main key points raised by the stakeholders were summarized in the [PA-2](#).

The **Second WeLASER Stakeholder Event** was organized by IETU and held online on May 25th, 2021. The discussion was focused on (i) the security and safety issues, (ii) the infrastructures needed for efficient performance of the robot, and (iii) the barriers and economic opportunities for implementation of the WeLASER system. Legal and practical aspects of agro-robotics safety, the efficiency of the machine and economics were presented by invited experts and consortium members. In addition, a panel discussion was held with farmers focusing on barriers and challenges for the real application of the WeLASER system. Over 40 professionals representing end users, industry, researchers, policy makers and NGOs interested in this project got together at this event. The meeting discussion and the stakeholder assessment are detailed in deliverable "D1.1-Multi-actor involvement plan and activities (I)". The main key points raised by the stakeholders were summarised in [PA-11](#).

The **Third WeLASER Stakeholder Event** was organised an online event (videoconference) due to the situation caused by Covid-19 on November 19th, 2021. It was focused on key

environmental requirements in relation to farmers' and societal needs and respective EU policies. The discussion was predominantly based on the views of the experts who presented key environmental aspects of WeLASER invention and outlined environmental and health benefits of WeLASER. Feedback from an interview of farmers in the Kymi Organic Coop in Finland related to WeLASER technique was delivered. Environmental aspects were also highlighted during presentations of the work performed in particular work packages. Experts and stakeholders pointed out the need for enhancing environmental and health benefits in the WeLASER system application. The main key points raised by the stakeholders were summarised in [PA-20](#).

The **Fourth WeLASER Stakeholder Event** was held on 24th November 2022 gathering over 40 participants including farmers, representatives of research and agricultural institutions, policymakers, NGOs and project partners. The event was an opportunity to present the key developments in the project and discuss the future implementation of the invention. It was focused on the results of WeLASER mobile robot integration and field tests. The main key points raised by the stakeholders were summarised in [PA-41](#).

The **Fifth and last Stakeholder Event** was organised by COAG and held in the Centre for Automation and Robotics, CSIC (Arganda del Rey, Madrid, Spain) on July 26th, 2023. The main objective of this Stakeholder Event was to address the implications of the future Regulation on the sustainable use of plant protection products (SUR Regulation), as well as the future alternatives in crop protection products. More than 40 experts from European institutions, national authorities, NGOs, crop protection industry, farmers, farmers associations and other agents provided their visions. The main key points and conclusions were summarised in [PA-53](#) and [PA-54](#).

5.1.10. Newsletter

Newsletters (6) were published on M6, M12, M18, M24, M30 and M36. Some were translated into the consortium languages and distributed to targeted audiences through WeLASER social networks, partners' social networks, and mailing lists and are available on the WeLASER website (<https://welaser-project.eu/newsletter/>).

Furthermore, these newsletters were sent to 220 COAG local offices in Spain and 31 organisations in Europe through the European Coordination Via Campesina (ECVC, <https://www.eurovia.org/>). It was also sent to the updated email list of project stakeholders and can be downloaded from the project website.



5.1.11. Project flyer and posters

The WeLASER flyer was created and published in M2. It was widely disseminated at the beginning of the project to make people aware of the existence of the WeLASER initiative, and it is used in dissemination activities and distributed to targeted audiences during the project development. It is also available on the WeLASER website (https://welaser-project.eu/wp-content/uploads/2021/07/WeLASER-Flyer_English.pdf). The flyer was distributed to 31 organisations in Europe via European Coordination Via Campesina (ECVC, <https://www.eurovia.org/>) and to COPA-COGECA members (70 organisations in the EU, <https://copa-cogeca.eu/>) via email. WeLASER posters were designed for each of the stakeholder events and based on this roll-up design (Fig. 5.1).



Fig. 5.1. WeLASER posters.

5.1.12. Website

The project website www.welaser-project.eu is one of the most versatile dissemination tools; it was released in M2. The WeLASER website contains updated information for different audiences with three main purposes:

- (i) to provide external open information to interested professional parties on the project and its activities,
- (ii) to provide external open information to the general public and
- (iii) to provide both a private area for communication between the members of the consortium and a central repository of documents of several kinds, as restricted

deliverables, presentations at project meetings and other project-related information.

The WeLASER website aims to be a reference for people interested in the project objectives, activities and results. The WeLASER website is devoted to depict the project objectives, outline its main goals, defines the roles of partners, states a timeline of work, etc. and is an essential mechanism for communication and dissemination of the project results. Furthermore, the website is properly updated the project work, communicating future events and news on the project progress and its activities.

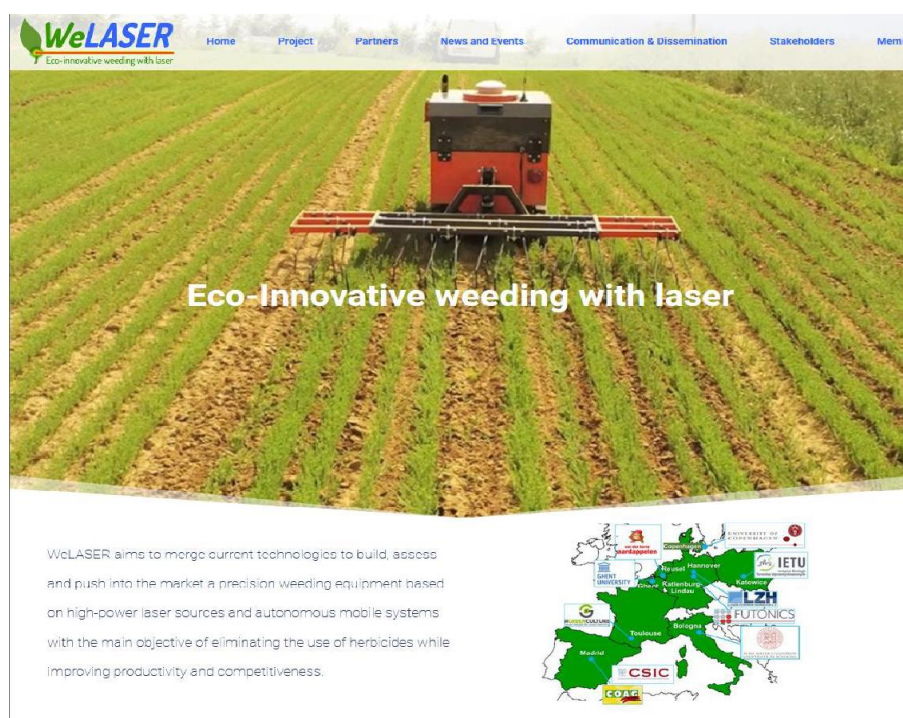


Fig. 5.2. WeLASER website home page.

CSIC is the responsible partner for WeLASER website design and management. The main structure has been subcontracted according to the Grant Agreement. CSIC is in charge of updating the website as needed and is open to receive inputs and suggestions from the partners concerning the website contents. The set up and management of the information for the project website was detailed in Deliverable “D6.1 -Launch of the project website and social media channels and accounts”. The main statistics of the WeLASER website are presented in Annex 2.

5.1.12.1. Social media

As part of WeLASER strategy in communicating and disseminating project activities and results to all the potentially interested parties, social media platforms were active means for sharing information quickly, efficiently and in real-time. Different types and pieces of information were broadcasted depending on both the characteristics of every platform and our

objectives at dissemination time. CSIC is the responsible partner for WeLASER social media design and COAG is responsible for the management. All WeLASER partners contribute, directly and through their own social media platforms, to enrich this online presence.

During the last phase of the WeLASER project, a special social media campaign was conducted to enhance the impact of the results obtained. The campaign took place from 6th to 22nd December 2023 in X (Twitter) and Facebook, according to the needs detected to improve the impact of these two WeLASER social media and to optimise the budget disposed. A specific target audience segmentation was done:

- Geographic: Germany, France, Italy, Poland
- Age: 18 - 65+
- Interests: Agriculture & others related
- Estimated audience size: 2,500,000 - 2,900,000

The campaign obtained good results on both platforms, with a total impact of +1.2 million users and +5 million impressions and especially highlighting the Cost per Click (CPC) on Facebook with 4.85% on website clicks. This impact is reflected in the statistics of the WeLASER website (Annex 2).

- Although X (Twitter) has generated a greater volume of impacts at a very competitive cost (€0.14/1000 impressions), allowing it to disseminate and create knowledge about the project; Facebook has allowed us to achieve good efficiency in the objective set in the campaign: redirect target audience to the website.
- The ads that included a video as audiovisual material are those that have undoubtedly stood out in impact, allowing the user to learn about the project through the statements of linked profiles.

Results on Facebook:

- Click on links: 14.043
- Overall impact: 289.533 users
- Cost Per Click (CPC): 0,11€
- %CPC CLICKS: 4,85%

Results on X (Twitter):

- Click on links: 11.434
- Overall impact: 950.119 users
- Impressions: 4.565.780 impacts
- Cost Per Click (CPC): 0,14€

- %CPC CLICKS: 1,20%

WeLASER is present on the following platforms:

5.1.12.1.1. YouTube

YouTube is an online video-sharing platform that allows users to upload, view, share, add to playlists, report, comment on videos, and subscribe to other users. YouTube offers a wide variety of user-generated and corporate media videos. YouTube is an extraordinary tool to disseminate videos on project results. The WeLASER YouTube channel is accessed through this [link](#).

The WeLASER YouTube channel presents the aspect illustrated in Fig. 5.3. Main statistics of WeLASER YouTube channel are presented in Annex 2.

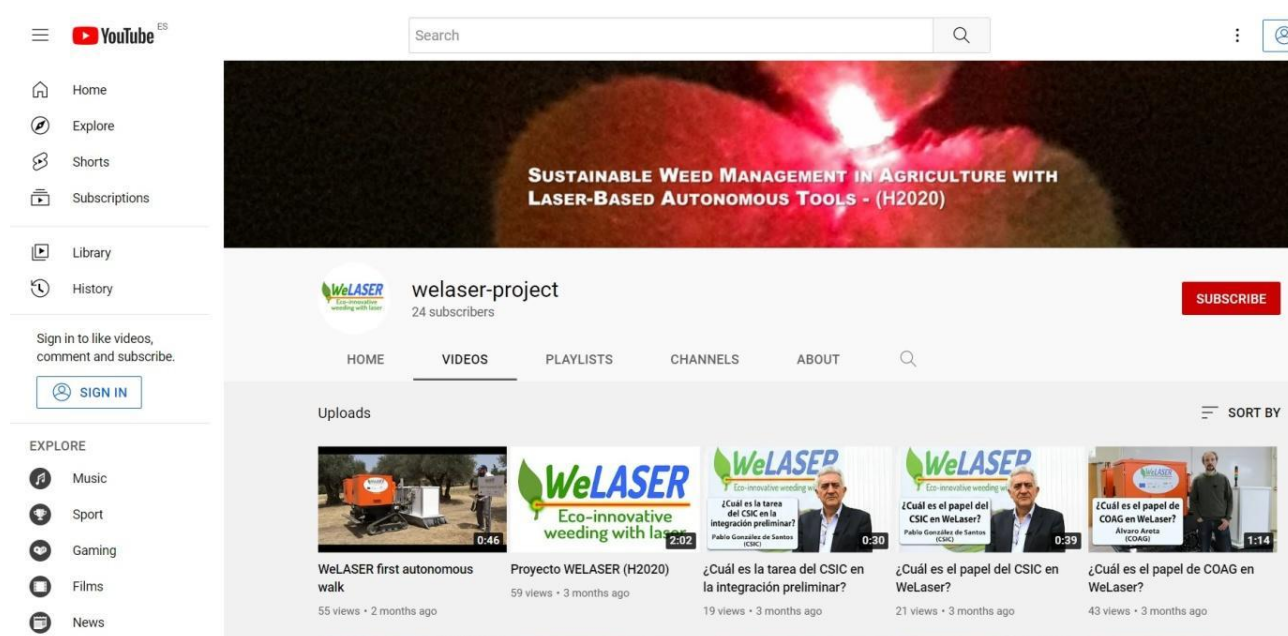


Fig. 5.3. WeLASER home page on YouTube.

5.1.12.1.2. Twitter

Twitter is a micro-blogging and social networking service on which users post and interact with messages known as "tweets". Twitter is an effective way for quick communication. WeLASER twitter is accessed through <https://twitter.com/welaserproject>. Figure 5.4 illustrates the main page of WeLASER Twitter. Main statistics of WeLASER Twitter are presented in Annex 2.



Fig. 5.4. WeLASER homepage on Twitter.

5.1.12.1.3. Facebook

Facebook is an online social media and social networking service very effective in communication. It is used for general text and picture communication. WeLASER Facebook can be accessed through this [link](#). WeLASER main page in Facebook is illustrated in Fig. 5.5. The main statistics of the WeLASER Facebook page are presented in Annex 2.

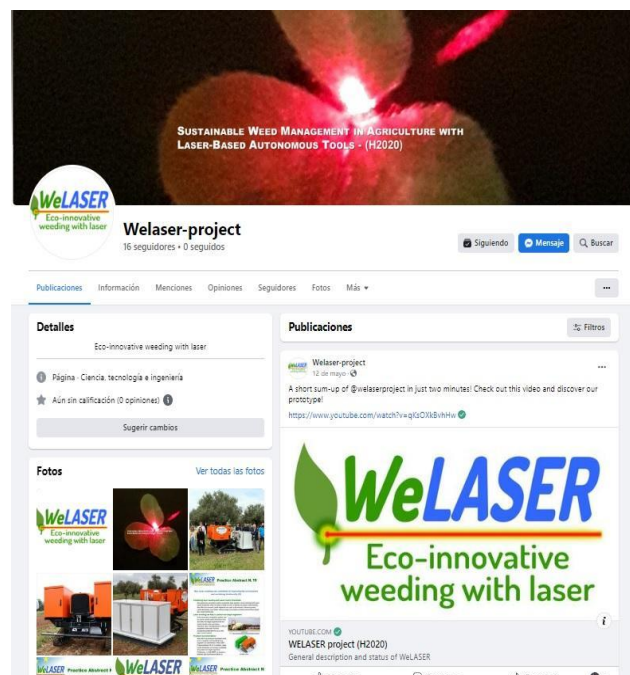


Fig. 5.5. WeLASER home page in Facebook.

5.1.12.1.4. LinkedIn

LinkedIn is a business and employment-oriented online service used for professional networking. It is used for interaction with professionals. WeLASER LinkedIn is accessed through this [link](#).

The home page is illustrated in Fig. 5.6. The main statistics of the WeLASER LinkedIn are presented in Annex 2.

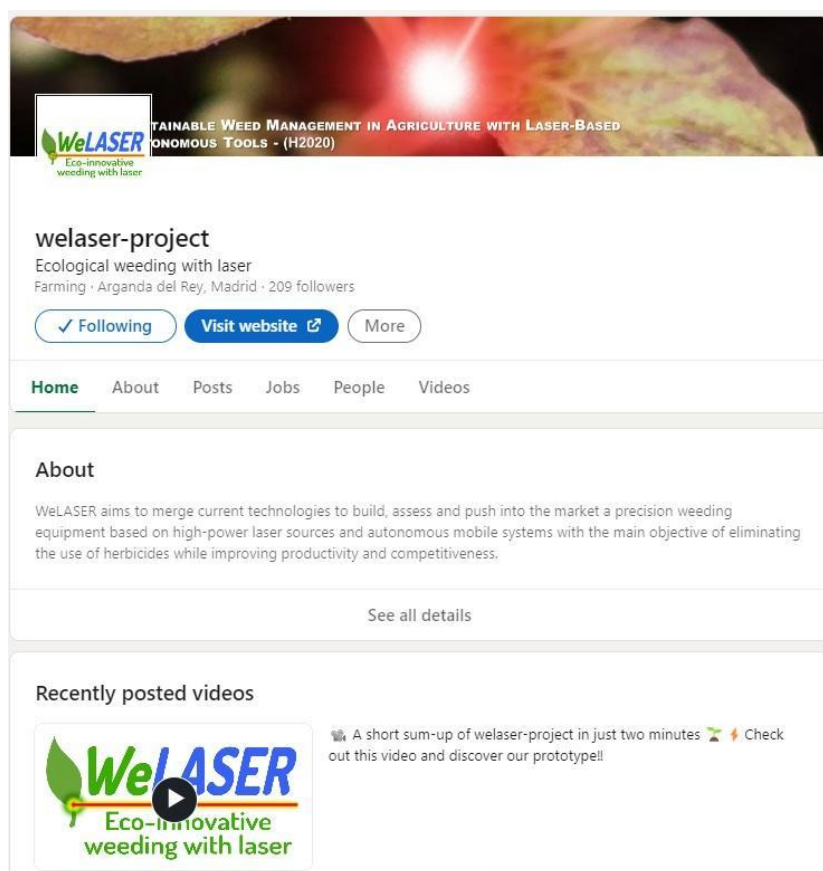


Fig. 5.6. WeLASER home page on LinkedIn.

The project website and professional media platforms will be maintained by the WeLASER coordinator for at least 4 years beyond the project development. Expenses caused by this maintenance will be supported by the coordinator (CSIC) as a part of the project's indirect costs.

5.1.12.2. General and Professional media

Companies, end-users and general stakeholders were informed about the project results through press releases published in the trade press, non-scientific and non-peer-reviewed publications. The general public was also considered as a target audience and general media were involved in the communication activities. WeLASER used these important channels to achieve the expected objectives, as summarised in Table 5.3.

In order to increase the impact and enhance the communication of the final results a special effort was made at the end of the WeLASER project. A final press release was launched for the whole EU in English, but also in several languages (French, Spanish, Polish, Italian, Dutch, German and Danish) for the national media of the countries of WeLASER partners. Also, a final press dossier was prepared with more comprehensive and detailed information, and a

video also supported the action, in particular for online media and social networks. This communication action reached an EU of 10.9 million impacts. The press clipping (EU and national level) is included in Annex 3.

Table 5.3. WeLASER Press releases and non-scientific and non-peer reviewed publications.

Press releases	Partner
WeLASER: the technological solution that aims to end chemical treatments in the weed management https://welaser-project.eu/press-releases/	WeLASER
Nace “WeLASER”, la solución tecnológica que pretende acabar con los tratamientos químicos en la eliminación de malas hierbas http://coag.chil.me/post/nace-e2809cwelasere2809d-la-solucion-tecnologica-que-pretende-acabar-con-los-tra-325945	COAG
Un proyecto del CSIC utilizará el láser para eliminar malas hierbas de los cultivos sin necesidad de pesticidas https://www.csic.es/es/actualidad-del-csic/un-proyecto-del-csic-utilizara-el-laser-para-eliminar-malas-hierbas-de-los	CSIC
WeLASER: Technische Alternative im Unkrautmanagement https://www.lzh.de/de/publikationen/pressemitteilungen/2021/welaser-technische-alternative-im-unkrautmanagement	LZH
WeLASER project has successfully achieved its preliminary system integration https://welaser-project.eu/wp-content/uploads/2022/05/NdP-WeLASER-2-22-05-03-EN-vdef-3.pdf	WeLASER
El proyecto WeLASER alcanza con éxito la integración preliminary de su prototipo https://welaser-project.eu/wp-content/uploads/2022/05/NdP-WeLASER-2-22-05-03-version-ES.pdf	WeLASER
WeLASER project enters its final stage https://welaser-project.eu/wp-content/uploads/2022/09/NdP-WeLASER-3-22-09-EN-vdef.pdf	WeLASER
El proyecto WeLASER entra en su etapa final https://welaser-project.eu/wp-content/uploads/2022/09/NdP-WeLASER-3-22-09-ES-vdef.pdf	WeLASER
WeLASER, CLOSER TO PESTICIDE FREE AGRICULTURE https://welaser-project.eu/wp-content/uploads/2023/12/UK-Englishpdf.pdf	WeLASER
WeLASER, MÁS CERCA DE LA AGRICULTURA SIN PLAGUICIDAS	WeLASER

https://welaser-project.eu/wp-content/uploads/2023/12/SPAIN_Spanish.pdf	
WeLASER, STEEDS DICHTER BIJ EEN PESTICIDEVRIJE LANDBOUW https://welaser-project.eu/wp-content/uploads/2023/12/NETHERLANDS_Nerlandes.pdf	WeLASER
WeLASER, CORAZ BLIŻEJ ROLNICTWA WOLNEGO OD PESTYCYDÓW https://welaser-project.eu/wp-content/uploads/2023/12/POLAND_Polishpdf.pdf	WeLASER
WeLASER, SEMPRE PIÙ VICINI ALL'AGRICOLTURA SENZA PESTICIDI https://welaser-project.eu/wp-content/uploads/2023/12/ITALY_Italian.pdf	WeLASER
WeLASER, NÄHER AN PESTIZIDFREIER LANDWIRTSCHAFT https://welaser-project.eu/wp-content/uploads/2023/12/GERMANY_German.pdf	WeLASER
WeLASER, DE PLUS EN PLUS PROCHE D'UNE AGRICULTURE SANS PESTICIDES https://welaser-project.eu/wp-content/uploads/2023/12/FRANCE_French.pdf	WeLASER
WeLASER, tættere på skadedyrsfrit landbrug https://welaser-project.eu/wp-content/uploads/2023/12/Denmark_Danish.pdf	WeLASER
Press Dossier	Parnert
Final Press Dossier WeLASER Project (English) https://welaser-project.eu/wp-content/uploads/2023/12/PRESS_DOSSIER_ENG.pdf	WeLASER
Final Press Dossier WeLASER Project (Spanish) https://welaser-project.eu/wp-content/uploads/2023/12/DOSSIER-DE-PRENSA_ESP.pdf	WeLASER
Non-scientific and non-peer reviewed publications (popularised publications)	
CAMPO GALEGO: https://www.campogalego.es/welaser-la-solucion-tecnologica-que-pretende-acabar-con-los-tratamientos-quimicos-en-la-eliminacion-de-malas-hierbas/	
INTEREMPRESAS https://www.interempresas.net/Horticola/Articulos/320261-COAG-colabora-tratamiento-suprime-completofitosanitarios-toda-aplicacion-quimica.html	
AGROINFORMACIÓN: https://agroinformacion.com/welaser-un-tratamiento-que-suprime-por-completo-los-	

fitosanitarios-y-toda-aplicacion-quimica-en-la-eliminacion-de-malas-hierbas/
AGRODIGITAL: https://www.agrodigital.com/2020/12/01/welaser-la-solucion-tecnologica-que-pretende-acabar-con-los-tratamientos-quimicos-en-la-eliminacion-de-malas-hierbas/
CAMPO DE ASTURIAS: https://www.elcampodeasturias.es/blog/2020/11/30/welaser-la-solucion-tecnologica-que-acabara-con-malas-hierbas-sin-tratamientos-quimicos/
INFOAGRO: https://www.infoagro.com/noticias/2020/investigan_un_tratamiento_suprime_por_completo_los_fitosanitarios_y_to.asp
AGRONEWS CASTILLA Y LEÓN https://www.agronewscastillayleon.com/coag-colabora-en-un-tratamiento-que-suprime-por-completo-los-fitosanitarios-y-toda-aplicacion
PROFESIONALES HOY https://profesionaleshoy.es/jardinaria/2020/11/30/welaser-una-solucion-tecnologica-para-eliminacion-demalas-hierbas-sin-tratamientos-quimicos/23410
EI DÍA DE SEGOVIA: https://www.eldiasegovia.es/Noticia/Z8FB3A914-CBE6-92E8-9A838F9E7F73053E/202012/Nace-WeLASER-el-sistema-que-quiere-acabar-con-el-herbicida
AGROBANK: https://agrobankcaixabank.com/Noticias/nace-welaser-adios-a-las-malas-hierbas
CAMPO CASTILLA Y LEÓN: https://www.campocyl.es/category/sanidad-vegetal/nace-welaser-la-solucion-tecnologica-para-acabar-con-los-tratamientos-quimicos-y-eliminar-malas-hierbas/
AGROCLM: https://www.agroclm.com/2020/11/30/estudiaran-uso-de-laser-para-acabar-con-tratamientos-quimicos-en-eliminacion-de-malas-hierbas/?fbclid=IwAR2k3QCAIfyewQGUgxfMZn9z34fxuJ
INNOVAGRI: https://www.innovagri.es/actualidad/welaser-la-solucion-tecnologica-que-pretende-acabar-con-las-malas-hierbas-sin-tratamientos-quimicos.html
DIARIO DE ÁVILA: https://www.diariodeavila.es/Noticia/Z8FB3A914-CBE6-92E8-9A838F9E7F73053E/202012/Nace-WeLASER-el-sistema-que-quiere-acabar-con-el-herbicida
LA TRIBUNA DE TOLEDO: https://www.latribunadetoledo.es/Noticia/Z8FB3A914-CBE6-92E8-9A838F9E7F73053E/202012/Nace-WeLASER-el-sistema-que-quiere-acabar-con-elherbicida
LA TRIBUNA DE ALBACETE:

https://www.latribunadealbacete.es/Noticia/Z8FB3A914-CBE6-92E8-9A838F9E7F73053E/202012/Nace-WeLASER-el-sistema-que-quiere-acabar-con-elherbicida
DIARIO PALENTINO: https://www.diariopalentino.es/Noticia/Z8FB3A914-CBE6-92E8-9A838F9E7F73053E/202012/Nace-WeLASER-el-sistema-que-quiere-acabar-con-elherbicida
EL ECONOMISTA: https://revistas.eleconomista.es/agro/2020/diciembre/el-laser-como-alternativa-a-los-productos-quimicos-para-eliminar-malas-hierbas-EA5727042
TECNOVINO: https://www.tecnovino.com/desarrollaran-un-robot-para-eliminar-con-laser-las-malas-hierbas-de-los-cultivos/?utm_source=mailpoet&utm_medium=email&utm_campaign=espana-lider-mundial-en-superficie-de-vinedo-de-produccion-ecologica-tecnovino-759_265
DIE LINDE: https://dielinde.online/12638/laserstrahlen-statt-pestizide/
DEUTSCHER PRESSE INDEX: https://www.deutscherpresseindex.de/2021/03/25/welaser-technische-alternative-im-unkrautmanagement/
OPTICS.ORG https://optics.org/news/12/3/52
F3 https://f3.de/future/laserstrahlung-alternatives-unkrautmanagement-1300.html
LASER SYSTEMS EUROPE https://www.lasersystemseurope.com/feature/how-can-ai-benefit-industrial-laser-systems-users
FUTURE FARMING https://www.futurefarming.com/tech-in-focus/welaser-robot-to-kill-weeds-using-a-powerful-laser/
ELECTRO OPTICS https://www.electrooptics.com/news/ai-powered-lasers-remove-weeds-fields
LASER SYSTEMS EUROPE https://www.lasersystemseurope.com/news/ai-powered-lasers-remove-weeds-fields-0
EILBOTE-ONLINE.COM https://www.eilbote-online.com/artikel/welaser-die-dritte-alternative-im-unkrautmanagement-38786
HANNOVER.DE https://www.hannover.de/Service/Presse-Medien/Hannover.de/Aktuelles/Wirtschaft-Wissenschaft-2021/Technische-Alternative-im-Unkrautmanagement
IDEX-HS

https://www.idex-hs.com/news-events/industry-news/welaser-project-refines-laser-based-weed-control/
CORDIS https://cordis.europa.eu/project/id/101000256/fr
KONSTRUKTION & ENTWICKLUNG https://www.konstruktion-entwicklung.de/so-wird-der-laser-zum-autonomen-unkrautvernichter
ECOINVENTOS: https://ecoinventos.com/welaser/?utm_source=dlvr.it&utm_medium=twitter
FRESH FRUIT PORTAL: https://www.freshfruitportal.com/news/2022/03/15/laser-system-to-kill-weeds-with-surgical-precision/
Non-scientific and non-peer reviewed publications in technical press
P. González de Santos, Luis Emmi, Roemi Fernández, La utilización del láser como alternativa sostenible a los herbicidas: Proyecto WeLASER, Tierras, Nº 294, pp. 56-60, 2021, ISSN 1889-0776 / 269-3752 (digital). In Spanish.
Interview with P. Gonzalez-de-Santos on the Onda Agrarian program of the radio station Onda Cero, May 7, 2022. https://www.ondacero.es/programas/onda-agraria/programas-completos/onda-agraria-07052022_20220507627615a5e547f100017f7f5e.html

5.1.12.3. Practice Abstracts

An important part of the dissemination activities is devoted to the elaboration and issue of the “Practice Abstracts” of the Agricultural European Innovation Partnership (EIP-AGRI) common format to be made available to the interested communities through the on-line EIP-AGRI database. The EIP-AGRI common format facilitates knowledge flows on innovative and practice-oriented projects from the start till the end of the project. The use of this format also enables farmers, advisers, researchers and all other actors across the EU to contact each other. WeLASER Practice Abstracts are available on the [EIP-AGRI website](#) and on the WELASER website as indicated in Table 5.4, which contains the title and links of the Practice Abstracts issued during the full project.

Table 5.4. WeLASER Practice Abstracts.

	Title	Link
PA1	An efficient and profitable weeding system friendly with the environment and health: WeLASER project is on its way.	https://welaser-project.eu/download/pa-1_english/
PA2	Stakeholders help defining the WeLASER system specifications	https://welaser-project.eu/download/welaser-pa-2-english/
PA3	Selecting target crops for laser weeding testing	https://welaser-project.eu/download/welaser-pa-3-english/
PA4	Selecting plants for the initial laser-weeding test	https://welaser-project.eu/download/welaser-pa-4-english/
PA5	Strategies for weeding with laser	https://welaser-project.eu/download/welaser-pa-5-english/
PA6	IoT in robotic systems for agriculture	https://welaser-project.eu/download/welaser-pa-6-english/
PA7	Cloud Computing in robotic systems for agriculture	https://welaser-project.eu/download/welaser-pa-7-english/
PA8	Laser technology for weed management	https://welaser-project.eu/download/welaser-pa-8-english/
PA9	Weed management – safety requirements for laser outdoor usage	https://welaser-project.eu/download/welaser-pa-9-english/
PA10	Extending agricultural robot capabilities for weeding with laser – WeLASER navigation strategies	https://welaser-project.eu/download/welaser-pa-10-english/
PA11	Stakeholders provide insight into key aspects of WeLASER implementation in practice	https://welaser-project.eu/download/welaser-pa-11-english/
PA12	Laser weeding in organic production	https://welaser-project.eu/download/welaser-pa-12-english/
PA13	Futonics develops a new high-power laser module for weed eradication	https://welaser-project.eu/download/welaser-pa-13-english/
PA 14	PESTEL analysis of the WeLASER solution	https://welaser-project.eu/download/welaser-pa-14-english/

PA 15	IoT for safe robotic agriculture	https://welaser-project.eu/download/welaser-pa-15-english/
PA 16	Integration of IoT and robotic data	https://welaser-project.eu/download/welaser-pa-16-english/
PA 17	Is WeLASER using the correct laser technology?	https://welaser-project.eu/wp-content/uploads/2021/12/PA-17-English-FUT.pdf
PA 18	How laser weeding can contribute to improving the environment and sustaining biodiversity (I)	https://welaser-project.eu/wp-content/uploads/2021/12/PA-18-English-UCPH.pdf
PA 19	How laser weeding can contribute to improving the environmental sustaining biodiversity (II)	https://welaser-project.eu/wp-content/uploads/2022/03/PA-19-English-UCPH.pdf
PA 20	Stakeholders point at enhancing environmental and health benefits of WeLASER system application	https://welaser-project.eu/wp-content/uploads/2022/03/PA-20-English-IETU.pdf
PA 21	Preliminary competitive analysis of the WeLASER solution	https://welaser-project.eu/wp-content/uploads/2021/12/PA21-English-UGENT.pdf
PA 22	Focus Group Interview strengthens understanding of the WeLASER technique implementation	https://welaser-project.eu/wp-content/uploads/2021/12/PA-22-English-IETU-UGENT.pdf
PA 23	Deep learning helps autonomous navigation in early-stage growth crops	https://welaser-project.eu/wp-content/uploads/2022/01/PA-23-English-CSIC.pdf
PA 24	Safety Issues with Laser Weeding (1) Heat and Fire Risks	https://welaser-project.eu/wp-content/uploads/2022/02/PA-24-English-UCPH.pdf
PA 25	Safety Issues with Laser Weeding (2)	https://welaser-project.eu/wp-content/uploads/2022/02/PA-25-English-UCPH.pdf
PA 26	Safety Issues with Laser Weeding (3)	https://welaser-project.eu/wp-content/uploads/2022/02/PA-26-English-UCPH.pdf
PA 27	Belgian/Dutch Focus Group Interview to get insights into the future implementation of the WeLASER technique	https://welaser-project.eu/wp-content/uploads/2022/03/PA-27-English-UGENT.pdf
PA 28	WeLASER Focus Group Interview in Spain: main results	https://welaser-project.eu/wp-content/uploads/2022/03/PA-28-English-COAG.pdf
PA 29	Polish Focus Group Interview to get insights into the future implementation of the WeLASER technique	https://welaser-project.eu/wp-content/uploads/2022/03/PA-29-English.pdf

PA 30	The multi-actor approach in WeLASER: a midterm overview	https://welaser-project.eu/wp-content/uploads/2022/03/PA-30-English-COAG.pdf
PA 31	Risks from exposure to laser radiation during weed control	https://welaser-project.eu/wp-content/uploads/2022/03/PA-31-English-LZH.pdf
PA 32	Possible release of hazardous substances during weed control using laser radiation	https://welaser-project.eu/wp-content/uploads/2022/03/PA-32-English-LZH.pdf
PA 33	Boundary conditions for the operation of a laser robot	https://welaser-project.eu/wp-content/uploads/2022/03/PA-33-English-LZH.pdf
PA 34	OECD works on the safety of robotic agricultural machinery	https://welaser-project.eu/wp-content/uploads/2022/04/PA-34-English-COAG.pdf
PA 35	Managing high-tech equipment in agriculture	https://welaser-project.eu/wp-content/uploads/2022/06/PA-35-English-CSIC-UNIBO.pdf
PA 36	WeLASER project preliminary system integration: some results and next steps	https://welaser-project.eu/wp-content/uploads/2022/08/PA-36-English-COAG.pdf
PA 37	WeLASER status at the project midterm	https://welaser-project.eu/wp-content/uploads/2022/08/PA-37-English-CSIC.pdf
PA 38	Analysis the Technology Readiness Level of WeLASER	https://welaser-project.eu/wp-content/uploads/2022/12/PA-38-English-CSIC.pdf
PA 39	Human-Machine interfaces for controlling autonomous robots easily	https://welaser-project.eu/wp-content/uploads/2022/12/PA-39-English-CSIC.pdf
PA 40	Futonics achieves a new laser power source featuring 500 W in continuous mode	https://welaser-project.eu/wp-content/uploads/2022/12/PA-40-English-FUT.pdf
PA 41	WeLASER developments meet with stakeholders' interest and raise expectations	https://welaser-project.eu/wp-content/uploads/2022/12/PA-41-English-IETU.pdf
PA 42	How do laser beams affect earthworm mortality in the soil?	https://welaser-project.eu/wp-content/uploads/2023/03/PA-42-UCPH.pdf
PA 43	How do laser beams affect ladybugs?	https://welaser-project.eu/wp-content/uploads/2023/03/PA-43-English-UCPH.pdf
PA 44	How do laser beams affect larvae?	https://welaser-project.eu/wp-content/uploads/2023/04/PA-44-English-UCPH.pdf

PA 45	How do laser beams affect beetles?	https://welaser-project.eu/wp-content/uploads/2023/04/PA-45-English-UCPH.pdf
PA 46	How do laser beams affect pupae?	https://welaser-project.eu/wp-content/uploads/2023/04/PA-46-English-UCPH.pdf
PA 47	Robotization of agricultural tasks	https://welaser-project.eu/wp-content/uploads/2023/05/PA-47-English-CSIC.pdf
PA 48	Getting the work field Layout	https://welaser-project.eu/wp-content/uploads/2023/05/PA-48-English-CSIC.pdf
PA 49	Field map generation	https://welaser-project.eu/wp-content/uploads/2023/05/PA-49-English-CSIC.pdf
PA 50	Generating missions with WeLASER	https://welaser-project.eu/wp-content/uploads/2023/05/PA-50-English-CSIC.pdf
PA 51	Mission execution and supervision	https://welaser-project.eu/wp-content/uploads/2023/05/PA-51-English-CSIC.pdf
PA 52	Crop row detector and follower	https://welaser-project.eu/wp-content/uploads/2023/09/PA-52-English-CSIC.pdf
PA 53	WeLASER 5th Stakeholder Event: main results (1/2)	https://welaser-project.eu/wp-content/uploads/2023/09/PA-53-English-COAG.pdf
PA 54	WeLASER 5th Stakeholder Event: main results (2/2)	https://welaser-project.eu/wp-content/uploads/2023/09/PA-54-English-COAG.pdf
PA 55	Demonstration of the WeLASER system in Denmark	https://welaser-project.eu/wp-content/uploads/2023/09/PA-55-English-UCPH.pdf
PA 56	Demonstration of the WeLASER system in Spain	https://welaser-project.eu/wp-content/uploads/2023/09/PA-56-English-COAG.pdf
PA 57	Can Canada thistle be controlled with laser beams?	https://welaser-project.eu/wp-content/uploads/2023/09/PA-57-English-UCPH.pdf
PA 58	Demonstration of the WeLASER system in The Netherlands	https://welaser-project.eu/wp-content/uploads/2023/09/PA-58-English-CSIC-LZH.pdf
PA 59	Final demonstration of the WeLASER system	https://welaser-project.eu/wp-content/uploads/2023/10/PA-59-English-COAG.pdf

PA 60	Can couch grass (<i>Elymus repens</i>) be controlled with a laser?	https://welaser-project.eu/wp-content/uploads/2023/10/PA-60-English-UCPH.pdf
PA 61	Who are potential buyers of WeLASER in Europe?	https://welaser-project.eu/wp-content/uploads/2023/11/PA-61-English-UGENT.pdf
PA 62	Unlocking Revenue Potential of WeLASER	https://welaser-project.eu/wp-content/uploads/2023/11/PA-62-English-UGENT.pdf
PA 63	How does laser irradiation affect weed seeds?	https://welaser-project.eu/wp-content/uploads/2023/11/PA-63-English-UCPH.pdf
PA 64	How does laser irradiation affect crop seeds?	https://welaser-project.eu/wp-content/uploads/2023/11/PA-64-English-UCPH.pdf
PA 65	Some small dicotyledonous weed seedlings may be challenging to control with laser	https://welaser-project.eu/wp-content/uploads/2023/12/PA-65-English.pdf
PA 66	A systematic review of farmers' acceptance of robotics and unmanned aerial vehicles	https://welaser-project.eu/wp-content/uploads/2023/12/PA-66-English-UGENT.pdf
PA 67	The multi-actor approach in WeLASER: a final overview	https://welaser-project.eu/wp-content/uploads/2023/12/PA-67-COAG-English.pdf
PA 68	The WeLASER Cloud Platform	https://welaser-project.eu/wp-content/uploads/2023/12/PA-68-UNIBO-English.pdf
PA 69	FAQ at Agritechnica 2023 – What are the governing factors regarding performance or limits?	https://welaser-project.eu/wp-content/uploads/2023/12/PA_69-LZH_English.pdf
PA 70	FAQ at Agritechnica 2023 – Can I already buy laser weeding machines?	https://welaser-project.eu/wp-content/uploads/2023/12/PA-70-LZH_English.pdf
PA 71	WeLASER weeder is a promising eco-innovative technology in Life Cycle Perspective	https://welaser-project.eu/wp-content/uploads/2023/12/PA-71_English-IETU.pdf
PA72	Farmers' perceptions of innovative laser technology for weed removal. Prospects for the application of the WeLASER robot	https://welaser-project.eu/wp-content/uploads/2023/12/PA-72-English-IETU.pdf
PA73	Innovative WeLASER device is a future-proof technology supporting sustainable agriculture	https://welaser-project.eu/wp-content/uploads/2023/12/PA-73_English-IETU.pdf
PA74	The WeLASER project reached the end of its first phase.	https://welaser-project.eu/wp-content/uploads/2023/12/PA-74-English-CSIC-V3.pdf

Table 5.5. Number of PAs issued by partner.

Partner	Number of PAs
1 CSIC	14.5
2 FUT	3.5
3 LZH	7.5
4 UCPH	19.5
5 AGC	--
6 COAG	9.5
7 UNIBO	5.5
8 IETU	7.5
9 UGENT	6.5
10 VDBP	--
Total	74

Note: Sharing authorship is counted as 0.5.

6. DISSEMINATION AND COMMUNICATION MONITORING

Table 6.1 Measurements (KPI) to assess dissemination during months M1-M39 of the project development

Key Performance Indicators				
Target audience	Type of dissemination activity	Measurement	Months 1-39	
			Current measures	Grant Agreement
The Scientific Community	Journal articles	Number of articles	11 Forthcoming: 7	30
		Number of references	>74	30
		Text views	>42039	
	International conference papers and presentations	N. of papers/presentations	23	30
	Summer School	Number of students	59	30
Student community	Lectures in MSc courses	Number of courses	4	17
	Lectures in PhD courses	Number of courses	1	17
The Industrial Community	Patents	Number of applications	2	2
	Participation at external related events	Number of events	8	5
The end users	Dissemination to farmers	N. of field and training days	3	3
The general stakeholders	Newsletter	N. of copies sent/downloaded/views	- 254 views on the project website. - 220 offices	300

			and 31 organisations - 25 stakeholders	
	The project flyer and posters (Flyer and Poster)	N. of copies sent/downloaded	- 220 offices and 101 organisations	1500
	Project Website	Website visits	17,4K views 6.6K users	11000
	Practice Abstracts	Number	74	72
	Social media	Followers/tweets/etc.	Twitter: 214 Followers 586 tweets Youtube: 39 subscribers 42 videos 4386 views Facebook: 38 followers Linkedin: 358 followers	
	Professional media	Number of messages/videos/Press releases	1750	1750
	General media	Evidence of debates in the media	5	10

7. EXPLOITATION PLAN¹

To ensure the findings in the WeLASER project are sufficiently exploited, we detail an exploitation plan as follows. The exploitation plan for WeLASER is divided into six sections, each offering invaluable insights into the potential of WeLASER in six sections.

Section 1: Market Research. This foundational section provides a market landscape for WeLASER adoption. The qualitative and quantitative studies focus primarily on the European market, meticulously examining WeLASER's potential and competitive positioning. These

¹ Deliverable D6.4 is a document made public by the EU, which contains the WeLASER Exploitation Plan. Some partners considered that the Exploitation Plan presented sensitive data for their businesses and interests and decided not to disclose that information (General Assembly held on December 15, 2023). Therefore, the plan presented below is a simplified version of the WeLASER Exploitation Plan available to the consortium and the EC through the "member area" of the WeLASER website ([WeLASER](#) → Members → WeLASER Exploitation Plan → WeLASER Exploitation Plan [Download]).

insights drive pragmatic marketing strategies tailored to unlock WeLASER's potential.

Section 2: Competitive Analysis. WeLASER's competitiveness is assessed in this section. Through a comprehensive comparative analysis, WeLASER was benchmarked against existing weed control solutions, with a keen focus on potential laser-weeding alternatives. This crucial examination illuminates WeLASER's unique advantages and value propositions.

Section 3: Business Model. Leveraging the Business Model Canvas framework, this section scrutinises WeLASER's value proposition, customer segments, distribution channels, customer relationships, key activities, key resources, cost structure, and revenue streams. This holistic understanding paves the way for a robust business strategy.

Section 4: Marketing Plan. Using the 4Ps framework (Product, Pricing, Place, Promotion), this section details strategies to highlight WeLASER's strengths, effectively price our product, identify target markets, and design compelling promotional campaigns. Also, a year-by-year commercialisation roadmap that leads WeLASER's market entry was detailed.

Section 5: Financial Plan. In this section, the market size is discussed, the profitability is assessed, the cost-effectiveness of weed control with WeLASER is scrutinised, and an investment analysis to elucidate the sound financial footing of the venture is performed.

Section 6: Subsystem Exploitation Plan. In this section, the exploitation plans of the WeLASER subsystems as stand-alone systems (laser source, weed-meristem recognition system, autonomous vehicle, smart navigation management, IoT devices, and cloud systems) are reviewed.

The exploitation plan identifies organic farming in the European Union (EU) as the primary market for WeLASER solutions. With a long-term vision, WeLASER aims to expand its presence to North America, capitalising on the growing interest in precision agriculture. To streamline commercialisation, WeLASER will leverage dealership networks, reducing the burden of sales and administration costs. The financial plan underscores the importance of achieving a performance threshold to ensure a viable business investment for end-users (i.e., farmers).

7.1. Market research

Market research plays a pivotal role in comprehending the potential of introducing a new product into the market. Given the strategic geographical location of WeLASER production, the primary focus lies on the European market. This strategic emphasis allows to gain a profound understanding of WeLASER's commercial viability and to tailor pragmatic marketing strategies for the post-project period.

In the market analysis, we employed a dual approach, integrating both qualitative and quantitative methodologies. The qualitative market research delved into an in-depth

examination of the WeLASER system (Section 1). Meanwhile, the quantitative market research extended its scope beyond the confines of the WeLASER system to explore the broader potential of laser-weeding techniques as a whole (Section 2). This deliberate approach was selected for the quantitative market research phase as we observed the emergence of alternative laser-weeding systems. Such alternatives are expected to offer a more cost-effective solution compared to the use of autonomous vehicles. Additionally, a comprehensive investigation into this broader domain provides invaluable insights and recommendations for the further evolution of laser-weeding systems like WeLASER.

7.1.1. Qualitative market research

Qualitative market research stands as the initial phase in the comprehensive market research process undertaken for the WeLASER project, aimed at delving into the commercialisation potential of WeLASER. The outcomes of our qualitative market research have been documented and are publicly available in the Precision Agriculture journal (See more: Tran et al., 2023).

Within this qualitative market research endeavour, two primary activities were conducted:

1. PESTLE (Political, Economic, Social, Technological, Legal, Environmental) Analysis:
This analytical approach, carried out through desk research, offered a panoramic overview of the potential of WeLASER, encompassing the realms of Political, Economic, Social, Technological, Legal, and Environmental factors.
- 2.
3. SWOT (Strength, Weakness, Opportunity, Threat) Analysis: Facilitated through focus group discussions, the SWOT analysis delved into the strengths, weaknesses, opportunities, and threats pertaining to the WeLASER project.
- 4.

In the forthcoming subsections, we will initially provide a comprehensive overview of the Materials and Methods employed in these qualitative market research activities. Subsequently, we will present the key findings extracted from the corresponding Open Access publication, elucidating the pivotal insights gained through this extensive exploration.

7.1.1.1. Materials and Methods

The qualitative market study applied a mixed method to investigate the potential of the adoption of WeLASER, with three stages (Fig. 7.1).



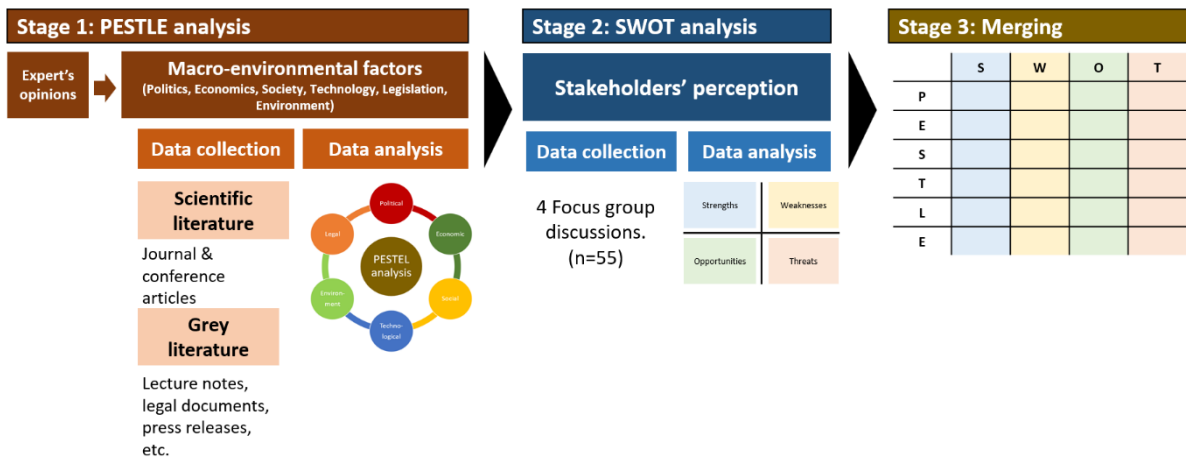


Fig. 7.1: Three stages of data collection and analysis

In the first stage, the PESTLE factors related to the adoption of WeLASER were determined. The assessment of these six macro-environmental factors (PESTLE) of a business is referred to as a PESTLE analysis (Perera, 2017). PESTLE analysis provides a comprehensive landscape of the current business environment, which assists business managers and industry leaders to make their long-term business plans and shape their organisation orientation (Kremer & Symmons, 2015). In this study, the PESTLE assessment was conducted via a literature review to provide a factual overview of the potential of the adoption of WeLASER. The literature review was initiated by the consultations of experts. The perception of stakeholders towards the adoption of WeLASER via four focus group discussions including a SWOT analysis in the second stage. SWOT analysis was applied in many studies to capture stakeholder perceptions of innovations (Rutsaert et al., 2014; Olum et al., 2018) due to its ease to use and popularity among participants. While the PESTLE analysis provides a broad picture of the business environment regarding the adoption of WeLASER, the SWOT analysis highlights the most important factors from the stakeholders' perspective, which might later help machinery producers detail their business strategies. Lastly, the factors found in the PESTLE and SWOT analysis were merged and classified into each other categories to provide a comprehensive picture of the adoption potential of WeLASER.

Table 7.1. Description of the six experts in stage 1.

ID	Dimensions	Occupation title
1	Politics	Board member of IFOAM Organics Europe, Chair of the Board of Directors of an organic cooperative
2	Economic, Society	Professor in Agribusiness Economics
3	Technology	Agricultural technology developer, project manager
4	Legislation	Professor in Agricultural Law
5	Environment	Specialist in life cycle assessment for industrial areas
6	Environment	Professor in Plant and Environmental Sciences

PESTLE analysis

To initiate the PESTLE analysis, six experts were invited to consult the literature review on the adoption of the WeLASER (Fig. 7.2)

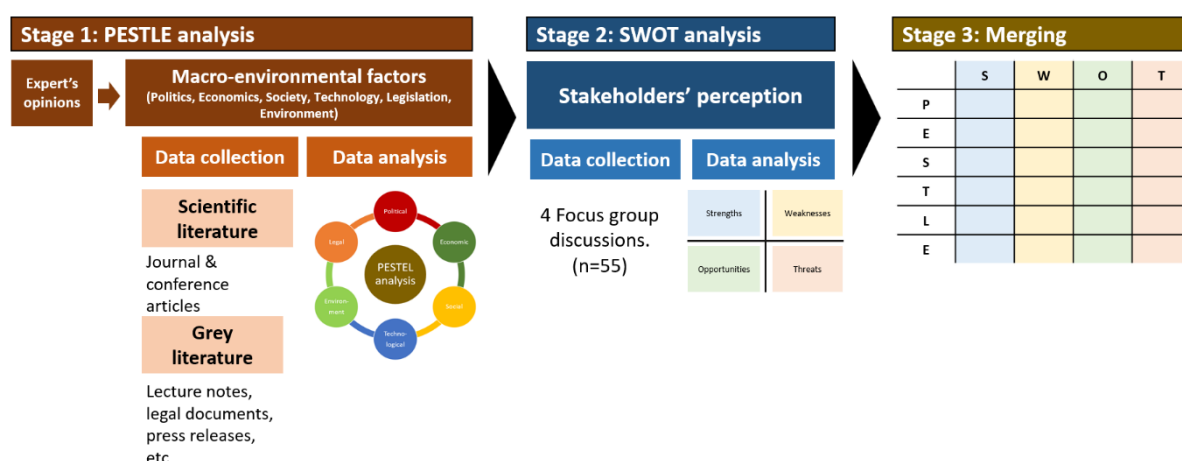


Fig. 7.2. The experts were recruited based on their expertise corresponding to the six dimensions of the PESTLE analysis (Table 7.1). Each expert provoked the key issues in the adoption of WeLASER, which later guided the literature review based on the PESTLE thematic framework. The literature review was composed of a wide range of sources namely the scientific literature, grey literature such as lecture notes, legal documents, and press releases.

Focus group discussions.

In the second stage, four focus group discussions were organised with a wide range of stakeholders to examine stakeholders' perceptions towards WeLASER applications. The procedures of the four focus group discussions were uniform, but the languages of

communication varied depending on the participants. The first focus group as a pilot was conducted in English and involved stakeholders with international experience from Belgium, Denmark, Finland, Germany, Italy, Poland, Spain, and Switzerland. Based on the pilot, three country-specific focus group discussions were organised in Belgium/Netherlands, Poland, and Spain; which covered three main European regions namely Western, Eastern, and Southern Europe respectively (Hobbs, 2021). These national focus group discussions aimed to explore stakeholders' perspectives in country-specific contexts and were conducted in corresponding national languages namely Dutch, Polish, and Spanish.

These focus group discussions were virtually organised from December 2021 to February 2022 due to the COVID-19 pandemic. In total, 55 participants attended the focus group discussions, and no participants attended more than one focus group discussion. Table 7.2 shows the number of participants in each focus group discussion. All statements and personal data of the participants were processed to ensure anonymity.

Table 7.2. Participants in focus group discussions.

Focus group <i>(By languages of discussion)</i>	English	Dutch	Polish	Spanish	Total
Farmers and representatives of agricultural cooperatives	7	7	2	5	21
Machinery developers, dealers, and providers	1	3	1	3	8
Researchers	5	3	2	1	11
Advisory bodies and/or policymakers	2	1	11	2	15
Total	15	13	16	11	55

Focus group procedure and SWOT analysis

In each focus group discussion, the participants were first given a brief description of the main configuration of a WeLASER prototype containing four components: (1) a laser treatment system, (2) a weed-crop recognition system, (3) an autonomous vehicle, and (4) a smart central control. After the introduction of the WeLASER prototype, the participants were asked to write the factors related to the Strengths, Weaknesses, Opportunities, Threats (SWOT) of the adoption of WeLASER on virtual sticky notes (Fig. 7.3). Each factor was written on one sticky note. Then, the participants had a discussion round to clarify the meaning of the written factors, which later might be merged or removed in case of duplication. Finally, the participants were requested to anonymously give votes for three factors/sticky notes in each category of SWOT that they found the most important. The content of the sticky notes and their corresponding votes were recorded for later analysis.

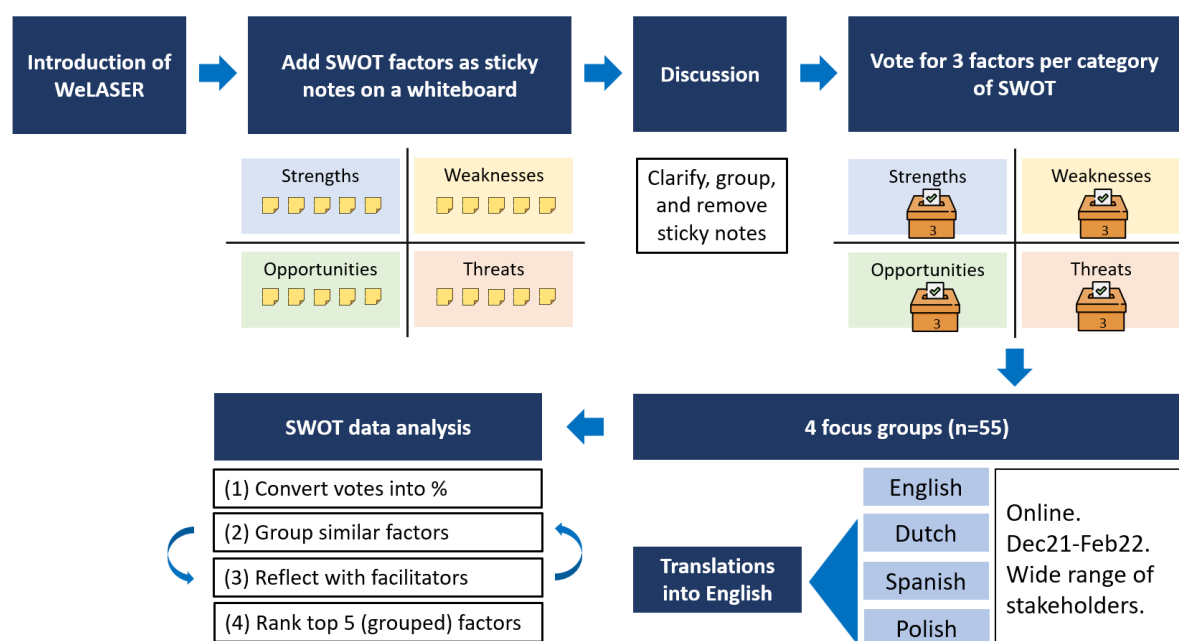


Fig. 7.3. Procedure of the focus group discussions.

Except for the first discussion in English, the SWOT data of each focus group discussion were translated into English. Since the number of participants in each focus group discussion was different, the votes for each factor were not comparable amongst focus groups (e.g., the group with more participants had factors with more votes). Hence, the votes were converted into the percentages of participants who voted in each workshop to neutralise the differences in the number of participants. After standardising the voting scores, the factors in each SWOT category were grouped based on their content. The focus group facilitators were asked to validate the new groups of factors to avoid misinterpretation and biases. Then, five (grouped) factors with the highest votes (%) in each SWOT category were selected for further discussion in a SWOT analysis.

7.1.1.2. Results

7.1.1.2.1. PESTLE analysis

Political factors

Agricultural chemical uses including pesticides and herbicides are heavily regulated in the EU (Bonanno, Materia, Venus, & Wessler, 2017; Kudsk & Mathiassen, 2020). Directive 2009/128/EC aims to achieve sustainable use of agricultural chemicals in the EU by promoting the use of Integrated Pest Management, and alternative approaches or techniques, such as non-chemical alternatives to pesticides (European Commission, 2021b).

The Green Deal issued by the EU in 2020 has outlined ambitious goals for agricultural sectors

(Helga, Trávníček, Meier, & Bernhard, 2022). According to the Green Deal, the EU aims to reduce the use and the risk of chemical pesticides by 50%, reduce nutrient losses by at least 50% and achieve 25% agricultural area under organic farming by 2030. The Organic actions in the Green Deal state the need to identify alternatives to contentious inputs and other plant protection products through funding for Horizon European projects (European Commission, 2021a). Simultaneously, the European Commission has considered the reform of the common agricultural policy to be compatible with the Green Deal. The Common Agriculture Policy (CAP) reform emphasises the local conditions and needs by adopting a more flexible performance, and result-based approach to achieve the sustainability goals of the EU (European Commission, 2020). Particularly, CAP allocates 25% of the budget for direct payments to eco-schemes, providing sufficient incentives for climate and eco-friendly practices and approaches.

The unfavoured regulations for chemical weed control pave the way for the adoption of alternative solutions such as WeLASER. Also, the incentives (e.g., funding) for organic farming and other sustainable practices in Europe can be trickled down to the development of WeLASER.

Economic factors

WeLASER can be specifically useful for organic farming as it eliminates the need for chemical pesticides and significantly reduces manual weed control, which is normally required in organic farming. In the EU, the market for organic products is booming as the EU organic retail sales reached €44.7 billion in 2020 (equivalent to a 5.3% increase) allowing farmers to add value to their products (Helga et al., 2022). Meanwhile, organic farmland expansion in 2020 only increased by 5.3%, which indicates that the growth of the organic market is faster than that of organic farmland (Helga et al., 2022). Even though the average growth in organic agricultural land in the EU was about 65% from 2009 to 2019, EU Member States still need to make more progress to achieve the goal of the Green Deal for 25% of organic farmland by 2030. By now, only Austria has achieved this target. Furthermore, EU consumers favour organic-labelled products and are willing to pay premium prices for such products (Janssen & Hamm, 2012; Schouteten, Gellynck, & Slabbinck, 2019). Given the increased demand of the organic market and the expansion of organic farmland in the EU, the prospect of sustainable weed control approaches such as WeLASER can be highly promising.

WeLASER can eliminate the need for manual weed control in organic farming. Depending on hand weeding, weed control costs and related machinery investments in the EU can vary from €50 to €1500 per ha per year (European Parliamentary Research Service, 2021). Given the high farm labour cost in the EU (Farm Europe, 2021), autonomous systems such as WeLASER can potentially reduce production costs in the long term.

Supply chain disruptions can negatively impact the development of new technology such as WeLASER. Indicatively, the COVID-19 lockdown measures have caused shipping delays and skyrocketing shipping costs, which later led to disruption in the global supply chain (E. Barrett, 2021). This disruption has a domino effect. For example, the shortage of semiconductors has halted the production of several technological industries (Baraniuk, 2021). Similarly, machinery developers may face difficulties in importing necessary electronic components for WeLASER. Besides, WeLASER requires high energy consumption for operations as it constitutes several functions such as laser treatment, weed recognition, and mobility tasks. Hence, the energy crisis in the EU, which was exacerbated by the Russia-Ukraine conflict, can negatively impact the operation costs of WeLASER (Dahm, 2022). If WeLASER does not depend on fossil fuels, the impact of the energy crisis can be reduced. However, some renewable energy options such as solar panels may be insufficient to provide electrical power for high-performed industrial machines such as WeLASER.

Nevertheless, similar to other precision agriculture techniques, the adoption of WeLASER might be hindered due to its high investment cost as stated in several previous studies (Pathak, Brown, & Best, 2019; Reichardt, Jürgens, Klöble, Hüter, & Moser, 2009).

Social factors

The laser radiation of WeLASER can harm nearby humans and animals during its operation. This issue is especially pressing in Nordic countries, where people can freely access private farmland for recreation and exercise due to the “right to roam”. Human and animal safety can be ensured by several interventions (Andreasen, Scholle, & Saberi, 2022). First, infrared cameras and sensors (e.g., stereovision, LIDAR, thermography sensors) can be mounted on WeLASER to detect obstacles, and control automatic manoeuvres or shut down the system to avoid humans and animals (Reina et al., 2016). Second, operators can wear laser-protecting glasses, clothing, and gloves when approaching the running WeLASER. Third, laser-absorbed curtains and screens should be installed to prevent laser beams from reflecting into surrounding areas. During dry seasons, laser beams can ignite dry materials in the field and cause severe fire, especially when the operation of WeLASER is without human supervision completely. Hence, heat or smoke detectors in WeLASER can be necessary for some specific settings.

The drastic development of robots and AI has enabled some non-standardised tasks such as selective weeding, which used to be reserved for human labour, to be conducted autonomously (Marinoudi, Sørensen, Pearson, & Bochtis, 2019; Young & Pierce, 2014). Furthermore, the disruption of migrant seasonal workers in the EU due to strict COVID-19 travel measures has accelerated the adoption of robotic solutions in agricultural sectors (Mitaritonna & Ragot, 2020). Even though the current agricultural robots cannot completely



replace human labour, they can substantially reduce the need for low-skilled human labour in the future (Vermeulen, Kesselhut, Pyka, & Saviotti, 2018; Marinoudi et al., 2019). Therefore, the WeLASER with its highly autonomous system and advanced artificial intelligence (AI) sensors can also negatively impact the employment rate, especially for low-skilled agricultural workers, in the long run.

Technological factors

The experts pointed out that laser treatment efficiency depends on cultivation stages. Particularly, previous studies indicated that the laser treatment is most effective if applied to weed meristems in the cotyledon or two permanent leaf stages when weed plants are still small (Mathiassen et al., 2006; Marx et al., 2012). A bigger plant size requires a higher lethal weeding dose (Ascard, 1995), which might be not feasible for laser treatment as high-powered laser beams can split into two during the weeding process and harm crops (Rakhmatulin & Andreassen, 2020).

The rapid modernisation of the agricultural sector can be beneficial for the development of sustainable practices such as WeLASER (Knickel, Ashkenazy, Chebach, & Parrot, 2017). Indicatively, the learning from unmanned aerial vehicles operation regarding safety issues, and automation design can be extended to the research of WeLASER (Wang et al., 2019). Besides, some functional components of WeLASER (such as recognition systems and autonomous vehicles) have been developed in other existing machinery (Shaner & Beckie, 2014; Raja et al., 2019); hence, these components can be inherited from or combined flexibly with other systems to accelerate the adoption process. For example, laser and recognition systems can be mounted on tractors to (1) avoid the development time for autonomous vehicles, (2) save space in farm warehouses with fewer machines, and (3) reduce additional costs for new machinery. In essence, the progressive development of robotic platforms has had in recent years (Gonzalez-De-Santos et al., 2020) can also enhance both the advance and the adoption of WeLASER. However, simultaneously, the development of other physical weed control techniques using microwaves, UV radiation, electrostatic fields, and electrocution can be direct market competitors for WeLASER (Young & Pierce, 2014).

Legal factors

There is no specific regulatory regime for the use of digital technologies in agriculture and autonomous agricultural robots in the EU. Hence, the applicable legal framework for the WeLASER is the combination of several types of legal acts related to different fields in both the EU and national laws. Particularly, three main legal fields can be of interest, namely safety, civil liability, and privacy in terms of data protection and sharing.

EU product safety legislation aims to ensure that only safe products can be placed on the

internal market of the union. Hence, agricultural robots like WeLASER must meet the essential health and safety requirements laid down in the applicable EU safety legislation such as the machinery directive, and the safety and health of workers at work directive. Concerning laser safety regulations, several regulations and standards can be considered such as Directive 2014/35/EU on Low Voltage, Directive 2006/25/EC on Artificial Optical Radiation, EN 60825-1 for laser classification and safety requirements, EN ISO 11553-1 and 11553-2 for safe machine construction, EN 60825-4 to realise laser-safe enclosure/housing for the laser-irradiation unit, EN 60204-1 for adequate electrical equipment of machines, EN ISO 13849-1 and 13849-2, EN 61508-1 and EN 62061 to correctly choose SRP/CS and design safety system architecture.

ISO 19487 for agricultural machinery and tractors is not fully applicable for highly autonomous vehicles in WeLASER. The majority of the current production safety frameworks were written before the digitalisation age. Hence, these legislation frameworks do not contain all the provisions that explicitly address the challenges and needs of emerging technologies. The machinery regulation is under revision, and a new machinery directive is proposed to tackle issues that may arise due to the technical progress in agriculture (CECIMO, 2021). Also, OECD Standard Codes for the Official Testing of Agricultural and Forestry Tractors are working in this area (OECD, 2022).

Civil liability legislation is also crucial in the case of the WeLASER. On the one hand, liability rules ensure the victims that are damaged by the agricultural robots get sufficient compensation. On the other hand, these rules provide economic incentives for the liable party to avoid causing such damage. Currently, the EU law framework on civil liability is based on (1) the highly harmonised EU rules on the liability of the producer of a defective product (the product liability directive – 85/374/EEC), which covers most business-to-consumer relations, and (2) other non-harmonised national liability regimes. If an accident occurs with agricultural robots, the relations of the owners, managers, manufacturers, the designers of the systems, and the victims should be considered. Since the WeLASER is autonomous, the device can make decisions without external control and influence. This feature makes it difficult to define responsibility in the case of accidents. Furthermore, WeLASER is designed to work in privately owned farmland, thus the rules for self-driven vehicles cannot be applicable in this case. Given these specific legal issues regarding agricultural robots, the EU institutions and Member States are still seeking new solutions to these issues. Meanwhile, national laws can be applied to deal with specific cases. One of the solutions for the liability issues can be to install data login systems that can help identify the real responsibility between the manufacturers and users.

Agricultural robots like WeLASER can collect valuable data on topography, production yield,



and other specific production data (Wolfert, Ge, Verdouw, & Bogaardt, 2017). Yet, the legal and regulatory frameworks around the collection, sharing and use of such data remain lacking. Wiseman et al (2019) argued that the lack of transparency and clarity related to data ownership, portability, privacy, trust, and liability may hamper the willing-to-adopt smart farming technology like WeLASER. Hence, it is critical to identify the ownership and governance of the data generated by WeLASER to avoid any potential hurdles for farmers regarding data management.

Environmental factors

The common chemical and mechanical weed control imposed several negative impacts on the environment (Rani et al, 2021; Mileusnić, Saljnikov, Radojević, & Petrović, 2022). Concerning chemical weed control, water pollution due to pesticides deteriorates the aquatic biosystem in surface water such as streams, lakes, and ponds (Scholz et al., 2012). Silva et al. (2019) found 76 pesticide residues in 317 agricultural topsoil samples, which account for 80% of the tested soils in 16 main cropping systems in 11 EU Member States. Also, chemical pesticides have substantial negative impacts on biodiversity. Sánchez-Bayo & Wyckhuys (2019) indicated that chemical pollution including pesticides is the second most important driver that diminishes insect populations worldwide. The scientific community agrees that pesticides are one of the main factors causing the decline in terrestrial biodiversity (Brühl & Zaller, 2019). The loss in biodiversity of insects and non-target weeds can result in an insufficient feed supply for higher-order animals. The residue of pesticides in the food chain can heavily affect predators, raptors, and humans due to bioaccumulation. Meanwhile, mechanical weed machinery can cause soil compaction due to the implementation of heavy and large tractors (Batey, 2009). Soil tillage can disturb soil structure, reduce soil fertility, and harm beneficial organisms living on soil surfaces (Chatterjee & Lal, 2009; Andreasen et al., 2022).

To the best of the authors' knowledge, there is a lack of investigation of CO₂ emissions and energy consumption for laser-weeding systems. However, Coleman et al (2019) indicated that site-specific weed control treatments can reduce 97%-99% of energy use compared to the corresponding conventional herbicidal, thermal, and machinal weed controls. As WeLASER is a precision agriculture approach, it also potentially requires minimal energy consumption. Besides, based on a Life Cycle Assessment by Lagnelöv et al. (2021), self-driving battery electric tractors produced substantially less CO₂ compared to their counterparts using fossil fuel. Hence, the choice of energy source will critically affect WeLASER's impact on global warming.

As a sustainable approach without chemical use, WeLASER can address the environmental issues caused by current conventional weed control practices. Since a laser beam is tiny (2-3

mm diameters), the treated area of WeLASER is very small. Indicatively, if the laser beam has a diameter of 3 mm and there are 100 weed plants/m², then the exposed area is equal to $1.5^2 \times \pi = 710 \text{ mm}^2$, which is 0.71% of the total area. Also, the experts expected that an WeLASER is lighter than common mechanical weeders. Hence, the negative impact of laser treatment on surrounding organisms is significantly minimised compared to that of mechanical weeders.

Undesirable weather such as rain or drought can be an issue for WeLASER operations. During rainy periods, the ground can be too slippery for WeLASER movement. In this regard, Lucet, Lenain, & Grand (2015) introduced a path-tracking control for field robots, which helps the examined robots speed up to 7 m/s in a wet grass terrain. Such an advanced kinematic model may be required to assure the movement stabilisation of WeLASER in adverse weather conditions. Besides, agricultural vehicles can more likely cause soil compaction with wet soil (Ren et al., 2019); hence designing WeLASER as a light vehicle is desirable to assure its efficient operation in rainy periods. Also, water drops can redirect laser beams and/or protect the weeds from laser treatments. Lightning can also harm the vehicle in the field. Meanwhile, dry fields with inflammable materials such as straw, and dried leaves can easily catch fire due to the laser beams. Hence, smoke sensors and surveillance of WeLASER and the treated area should be considered to avoid fire risks in some fields (Andreasen et al., 2022).

Farmland with obstacles such as stones, power poles, water lines, etc. can impede the movement of WeLASER. Nevertheless, the latest technological advances and the fusion of different sensor technologies are allowing safer navigation in the field (Reina et al., 2016). Besides, the vibration due to moving on uneven surfaces can divert laser beams to crop plants, thus reducing the efficacy of WeLASER. Hence, seedbed preparation might be essential to ensure the optimal function of WeLASER (Andreasen et al., 2022).

7.1.1.2.2. SWOT analysis

Figure 7.4 illustrates the SWOT factors that were important for the adoption of WeLASER from the stakeholders' perceptions. The following section will explain the meaning of the SWOT analysis based on the interpretation of the participants in the four focus groups, then reflect these findings upon the extant literature of stakeholders' perceptions towards precision agriculture adoption.



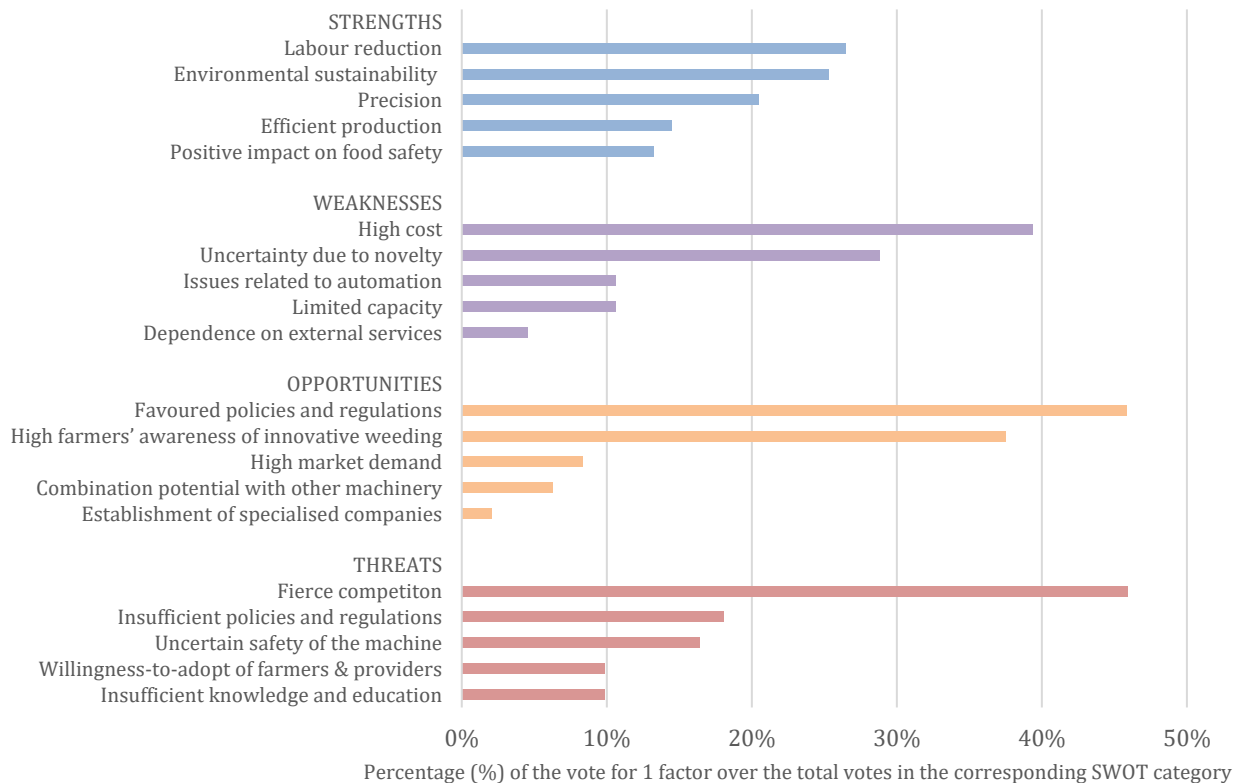


Fig. 7.4. Important SWOT factors* for the adoption of WeLASER from the stakeholders' perspective (n=55).

*The factors were considered important if they were among the five most highly voted factors of the participants in the focus groups. Low-voted factors were not displayed.

Strengths

Labour reduction. The stakeholders stressed that the increased shortage of agricultural labour in Europe and the subsequently high low-skilled labour costs make autonomous systems such as WeLASER more appreciated by farmers.

Environmental sustainability. The stakeholders in the focus group discussions perceived environmental sustainability as the main advantage of WeLASER. Given its precise laser treatment, WeLASER has a small impact on living creatures and surrounding areas (less soil disturbance), thus protecting biodiversity. Furthermore, WeLASER omits herbicide use in weed control. Hence, it reduces the dependence on phytosanitary products and the emergence of herbicide-resistant weeds. According to the stakeholders, WeLASER is likely less heavy compared the conventional mechanical weeders, thus reducing the risk of soil compaction.

Precision. As WeLASER is assisted by a recognition system, WeLASER can target in-row weeds and avoid damaging crops. According to the stakeholders, the recognition system and vehicle component of WeLASER can allow it to identify and eradicate weeds flexibly and

precisely, which in turn minimises the dependence of WeLASER on uniform crop rows. This feature is particularly useful in the case of intercropping where crop row structures may vary among crops.

Efficient agricultural production. The stakeholders perceived that WeLASER is a promisingly efficient production method. By using remote control and supervision systems, one operator can manage several robots working in the field simultaneously. WeLASER can theoretically work 24/7 so it can maximise the time used and provide great flexibility for farmers, thus easing farmers' worries about weed control.

Positive impact on food safety. Food safety can be improved by applying WeLASER as this method does not generate chemical residues in food products. Also, the withdrawal period for weed control treatment when using herbicides is no longer necessary.

Weaknesses

High cost. Even though WeLASER is not commercially available in Europe, the stakeholders anticipated that a high price would be the most concerning drawback (with nearly 40% votes).

Uncertainty due to novelty. Some stakeholders were concerned that novel techniques like WeLASER might not provide sufficient evidence of their effectiveness. Most WeLASER have only demonstrated optimal conditions in laboratories or designated fields. Meanwhile, diverse real-life conditions such as undesirable weather, uneven landscape, etc. may hamper the performance of WeLASER. Also, the indistinctive morphology of certain weeds can require more time for the weed recognition system to learn and adapt to local situations. These concerns of the stakeholders showed that they were not confident with such a novel technology as WeLASER.

Limited capacity. Based on the stakeholders' experience, the capacity of treatment (hectare per day) of agricultural robots like WeLASER is often limited even when working 24/7 due to the time-consuming performance of recognition systems. Weed control is only intensive in certain periods of the year. Hence, slow speed and small surface coverage of individual WeLASER can result in the requirement of several WeLASER in the field at once. This practice can be subsequently not economically viable for farmers.

Issues related to automation. Some stakeholders stated that the automation features can be viewed as a shortcoming due to several issues. First, an autonomous vehicle is subject to stealing and sabotage behaviours of competitors as human supervision is not granted. Second, malfunction incidents in the field may not be sufficiently monitored and avoided such as in the case of fire ignited by laser beams. Third, current regulations regarding autonomous systems require certain security to ensure human safety and property liability (Spykman, Gabriel, Ptacek, & Gandorfer, 2021). According to the stakeholders of this study, such



additional requirements may induce more costs for farmers. Fourth, for navigation and remote control purposes, an autonomous system may rely on a global navigation satellite system (GNSS) and/or Internet connection (Tzounis, Katsoulas, Bartzanas, & Kittas, 2017). However, many farms are still outside the range of 4G even in developed countries (Tang et al., 2021; USDA, 2019). Hence, the autonomous system might face difficulties functioning without (stable) Internet connections in remote areas.

Dependence on external services. Some stakeholders mentioned that as a sophisticated system, WeLASER may require specialised technical services for maintenance and operation. Indicatively, the transport of WeLASER between farms may need the support of container trucks. These additional prerequisites can demotivate farmers to invest in WeLASER.

Opportunities

Favoured policies and regulations. The increasingly stringent policies and legislations for chemical weed control promote the adoption of sustainable alternatives. As discussed in the PESTLE analysis, WeLASER fits well in the vision and legal framework of agricultural production in Europe.

High farmers' awareness of innovative weed control. Rapid agricultural modernisation is also beneficial for the development and adoption of WeLASER. According to the stakeholders, farmers' awareness of innovative techniques has been increasing in the last decades, which paves the way for the adoption of similar tools such as WeLASER.

High market demand. Some stakeholders stated that conventional agricultural producers can promote their sustainable production by hinging on the adoption of innovative solutions such as WeLASER. The expansion of organic farming has increased investment in innovative techniques such as WeLASER (Ulmann, 2020). According to the stakeholders of the current study, the adoption of WeLASER can also set a competitive advantage for early adopters as this technique may outperform the current weeding methods in the long run.

Combination potential with other machinery. Some farmers mentioned that WeLASER can be combined with their current precision agricultural machinery. Precision weed control techniques such as WeLASER can detect and kill in-row weeds, but since the weed recognition task is time-consuming, the operation speed of WeLASER (around 1 – 2 km/h) is significantly slower than that of common mechanical weeders (around 4 – 6 km/h). Meanwhile, common mechanical weeders sufficiently kill inter-row weeds, but they cannot target in-row weeds (Rabier, Stas, Manderyck, Huyghebaert, & Limbourg, 2017). For some crops such as sugar beet, using only mechanical weeders is not sufficient to maintain a decent yield as in-row weeds are dominant (Rabier et al., 2017). The combination of mechanical weeders and WeLASER would be of interest if the operation speed of WeLASER can be improved after

mechanical weeders have eradicated inter-row weeds. Also, WeLASER can be integrated with other existing robotics systems such as field mapping robots (Slaughter, Giles, & Downey, 2008) to maximise the efficiency of the current systems (e.g., irrigation, fertilisation) and accelerate the adoption process.

Establishment of specialised companies in agricultural services. Some stakeholders indicated that the recent establishment of specialised companies in agricultural services helps to address the need for additional services for precision agricultural machinery such as WeLASER. Precision machinery often requires specialised technicians for maintenance and even trained operators for field operation. Hence, farmers sometimes have limited access to innovative farming techniques due to unavailable service support (Silvi et al., 2021). Our stakeholder proposed that farmers can periodically rent agricultural machinery from such service providers for a reasonable price. This approach is cost-effective for both farmers and machinery providers as (1) agriculture production is seasonal and (2) letting machines idle for a long time can cause more unnecessary maintenance expenses.

Threats

Fierce competition. Some machinery developers and dealers were concerned that the long development process of WeLASER can pose a threat to the competitiveness of this application. Chemical and mechanical weed control has advanced with precision systems to meet stringent regulations and market demands. For instance, precision sprayers for site-specific weed management are now common in many large-scale farms albeit these still use chemicals (Späti, Huber, Logar, & Finger, 2022). Other alternative physical solutions to chemical weed control also intensify the fierce competition in agricultural machinery for WeLASER. Meanwhile, it is unclear whether the commercial model of WeLASER can compete with the existing solutions for organic farming in terms of profitability and technical performance. Hence, providing an investment analysis to prove viable economic returns of WeLASER would be the solution to convince farmers of the potential of WeLASER.

Insufficient policies and regulations. Despite the favoured policies for WeLASER, some current regulations may be considered obstacles to the adoption of WeLASER. Indicatively, the green energy policies may hamper the potential use of a combustion engine in WeLASER. If the strict legislation for autonomous machines is not adequately adapted for agricultural machinery, the legal requirements would discourage the widespread adoption of WeLASER. Besides, the stakeholders mentioned in this study that the lack of incentives such as direct payments to early adopters can slow down the adoption. However, the stakeholders raised the concern that even if subsidies for early adopters are available, beneficiaries can still face difficulties in accessing such support due to the complicated bureaucratic procedures.



Uncertain safety of the machine. Some stakeholders were worried that WeLASER can be subject to theft and vandalism as it operates with limited human supervision. Furthermore, as WeLASER can also collect and contain sensitive data regarding field mapping and production, such systems can be vulnerable to cyberattacks. In line with the stakeholders of this study, German farmers also agreed that data protection plays an important role in the adoption of autonomous field robots. Besides, the liability of WeLASER can be difficult to define as the current regulations do not stipulate specific terms for agricultural robots in the case of accidents.

Insufficient knowledge and education of farmers. Some stakeholders mentioned that formal education in agronomy cannot catch up with the rapid development of agricultural machinery. This is in line with the extant literature, which indicated that the current limited education and knowledge of farmers hinder the adoption of smart farming (Pivoto et al., 2018; Michels, von Hobe, & Musshoff, 2020). Some stakeholders suggested that machinery interfaces should be more user-friendly so that farmers can easily utilise their machines. Nevertheless, training for farmers in precision techniques is needed to promote the widespread adoption of WeLASER (Barrett & Rose, 2022; Redhead et al., 2015). Meanwhile, suitable promotion (e.g., field demonstration activities, and agricultural machinery trade fairs) can also attract more farmers' attention to innovations, which subsequently leads to more interest in a better understanding of such technology.

Low willingness-to-adopt of farmers and related service providers. Given the above-mentioned drawback of WeLASER, farmers may hesitate to adopt such a novel technique. Indicatively, the farmers' survey by Spykman et al (2021) showed a relatively low rate of intention to adopt field robots (22%) in Germany. Besides, some stakeholders stated that to adopt innovative machinery, farmers often require clear facts regarding the machine's performance, which new techniques may fail to deliver. Furthermore, companies that only provide agricultural machinery and the service of conventional mechanical weeders may also be unwilling to add innovative tools to their portfolio due to the fear of low profitability in the initial stage. In this regard, Spykman et al (2021) underlined that the unavailability of robots and market immaturity are among the most problematic factors hampering the adoption of field robots from the farmers' perspective.

7.1.1.3. Conclusions

European stakeholders had a positive attitude towards WeLASER because this solution addresses the challenges of labour shortage and the negative environmental impact of conventional weed control solutions (e.g., damaged biodiversity, soil disturbance and compaction, and CO₂ emissions). Also, the precision treatment of WeLASER allows more

flexibility in crop cultivation, while the autonomous optimise the production by the ability to work 24/7. WeLASER eliminates the need for herbicides, thus reducing the risk of the residue of harmful chemicals in food.

Among the weaknesses, high cost is perceived as the most critical one. An investment analysis of WeLASER is essential to convince farmers of the potential of the solution. Also, stakeholders were uncertain about the performance of WeLASER as they perceived that WeLASER can have limited capacity, issues with the autonomous function, and dependence on external services. Especially, an autonomous solution without supervision sparks concerns regarding human safety, machine safety (e.g., theft, vandalism, causing a fire) and liability regulations. Furthermore, integrating an autonomous component may slow down the introduction of a laser weeding solution as a whole. Developers can consider mounting laser components on tractors as an alternative to autonomous vehicles. Regardless of the mobility approaches, technical factors and their implications in field operation should be transparently communicated with farmers so they can make informed decisions and have trust in the new solution. These marketing communications can be provided at field demonstrations, trade fairs, or via connection with farmers' organisations and cooperatives.

7.1.2. Quantitative market research

The quantitative market research endeavours to achieve three primary objectives:

1. **Estimate Farmers' Willingness-to-Pay:** One of our primary objectives is to gauge farmers' willingness-to-pay for WeLASER, which is vital for pricing strategy determination.
2. **Identify Determinants of Willingness-to-Pay:** We aim to identify the factors influencing both willingness-to-pay for WeLASER, enabling us to tailor our marketing strategies effectively.
3. **Identify Characteristics of Potential Adopters of laser-weeding:** We seek to delineate the characteristics that distinguish potential adopters of laser-weeding, aiding in targeted marketing efforts.

In the subsequent sections, we will elucidate the design of the farmer survey as the principal means for collecting data in our quantitative market research. Following data collection, we will proceed to interpret the survey results and engage in a comprehensive discussion regarding the marketing implications derived from our findings.

7.1.2.1. Methods and materials

Survey design

To gather primary data for our quantitative market research, we conducted an online survey structured into four integral parts:

Part 1: Farm Characteristics. This section focused on essential aspects of farms,



encompassing farm type (conventional, organic, regenerative, or mixed), current weed control methodologies, utilisation of precision agriculture techniques, crop cultivation preferences, and detailed inquiries about weeding costs (both in terms of time and monetary resources).

Part 2: Choice Experiment. In this part, we employed a choice experiment to discern farmers' willingness-to-pay for various attributes associated with a laser-weeding machine. These attributes included mobility mode, efficacy, service provisions, and energy sources. This experiment aimed to gauge the relative importance of these features in influencing adoption decisions.

Part 3: Intention to Adopt and Willingness-to-Pay. This segment was dedicated to assessing farmers' intention to adopt laser-weeding technology and their corresponding willingness-to-pay. It featured a series of scientifically constructed questions grounded in the established constructs of the Technology Acceptance Model (TAM). A detailed breakdown of the items and measurement metrics can be found in Table 7.6.

Part 4: Sociodemographic Information of Farmers. The final section delved into the sociodemographic characteristics of the survey participants. It encompassed fundamental inquiries about participants' age, gender, income, educational attainment, annual turnover, country of cultivation, and the particulars of their farming practices. Comprehensive information on the items and their measurement criteria is available in both Table 7.4 and Table 7.5.

Before commencing the survey, informed consent was diligently provided to all respondents. This consent furnished them with a clear understanding of the survey's objectives, with an assurance that no deceptive practices were employed. Respondents were afforded the autonomy to withdraw from the survey at any point without facing any queries and were also encouraged to raise any concerns regarding their privacy or the survey process. For reference, the English version of the survey questionnaire is available in Appendix A.

Data collection employed a convenience sampling approach through two primary channels:

1. Farmer Panel of a Market Agency: A segment of responses was obtained through a farmer panel affiliated with a reputable market agency named [INQUIRY](#).
2. Distribution via Agricultural Association Networks: The survey was disseminated through agricultural association networks, reaching a broader spectrum of potential respondents.

After screening to remove incomplete or invalid responses, we retained a total of 298 responses for subsequent analysis. These responses represented farmers hailing from seven European Member States, namely Belgium, Denmark, Italy, the Netherlands, Germany, Poland, and Spain.

Given the variance in sample sizes across countries due to the convenience sampling technique, a strategic decision was made to cluster the sample based on respondents' geographical regions. Consequently, a binary dummy variable was created: it assumes a value of 1 for respondents in "northern" countries (e.g., Belgium, the Netherlands, Germany, and Denmark), owing to their notable advancements in the adoption of precision agriculture practices (Degieter, De Steur, Tran, Gellynck, & Schouteten, 2023). Conversely, it takes on the value of 0 for respondents in other countries (e.g., Italy, Poland, and Spain).

Eliciting WTP responses

In this survey, we opted for the contingent valuation method (CVM) to solicit farmers' responses regarding their willingness to pay (WTP) for WeLASER. CVM is a well-established approach that requires respondents to explicitly articulate their WTP for a product. This method falls within the category of stated preference methods, allowing respondents to express their preferences for a product without engaging in any actual monetary trade-offs (Venkatachalam, 2004). It is important to acknowledge that the hypothetical nature of the CVM method introduces the potential for hypothetical bias (Venkatachalam, 2004). This bias often manifests as respondents overstating their WTP for a product, primarily because they are not required to make an actual financial commitment (Venkatachalam, 2004).

To represent the cost of WeLASER in this study, three price levels (i.e., €100 000, € 200 000, and € 300 000) were chosen based on our market research on publicly available prices of weeders and considering the approximate estimated cost of the prototype of WeLASER (See Deliverable 1.3). Depending on the language of the survey, the price levels were converted to national currencies (i.e., Polish Zloty (1EUR=4.75PLN), Danish Krone (1EUR=7.44 DKK)) if the examined countries were not located in the Eurozone. A bidding process was used to elicit the willingness to pay for the WeLASER (See Fig. 7.5). The farmer respondents were randomly provided one of the three examined prices of WeLASER (see Table 7.3). If the respondents said "yes" for the first bid, the second bid with a higher price – x^{high} , which is € 100 000 higher of the initial bid price, would be asked. If the respondents said "no" for the first bid, the second bid subsequently would be shown with a lower price – x^{low} , which is minus € 100 000 of the initial bid price. If the respondents kept saying "no" (or "yes") for two times, the third bid would be provided with the lowest bid (or the highest bid). If the respondents said "no" to the lowest examined price (€100 000) or said "yes" to the highest examined price (€ 300 000) at any stage, the bid process stopped.



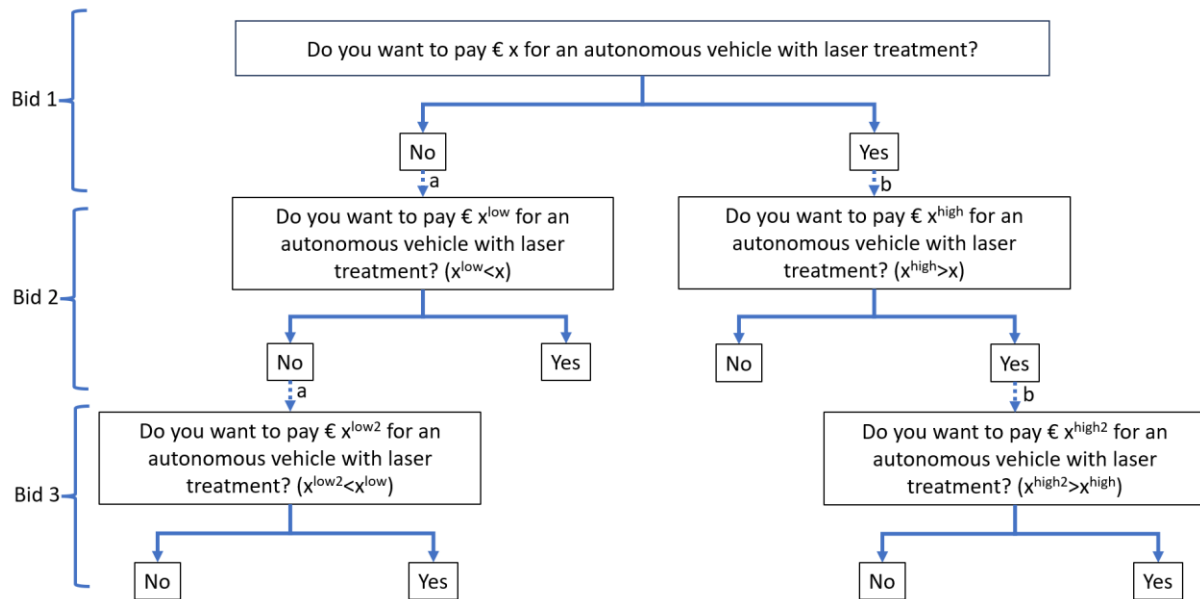


Fig. 7.5. Bidding process for WeLASER.

Note: first bid (x), the second higher bid (x^{high}), the second lower bid (x^{low}), the third higher bid ($x^{\text{high}2}$), the third lower bid ($x^{\text{low}2}$). ^aThe follow-up bid was only shown if $x/x^{\text{low}} > €100\,000$. ^b the follow-up bid was only shown if $x/x^{\text{high}} < €300\,000$.

Table 7.3. Bidding design.

Bid 1	Bid 2 (B1= "No")	Bid 2 (B1= "Yes")	Bid 3 (B2= "No")	Bid 3 (B2= "Yes")
Initial bid	Lower bid (x^{low})	Higher bid (x^{high})	Lower bid ($x^{\text{low}2}$)	Higher bid ($x^{\text{high}2}$)
100 000	-	200 000	-	300 000
200 000	100 000	300 000	-	-
300 000	200 000	-	100 000	-

Based on this bidding design, we could identify the four ranges of WTP for the WeLASER machine, namely $[0; 100\,000]$, $[100\,000; 200\,000]$, $[200\,000; 300\,000]$, and $[300\,000; \infty)$.

Measurement of determinants of WTP

Empirical studies have shown that the WTP for products can be affected by psychological factors (i.e., perceived usefulness, perceived ease of use, environmental concerns) and socio-economic factors (e.g., education, income) (Späti et al., 2022). We retained many of these determinants in this survey (see The surveyed farmers exhibited a mildly positive perception regarding the usefulness of laser-weeding and its ease of use, as indicated by the scores exceeding 3 in Table 7.6 (PU, PEU > 3). Similarly, social influences and technological interests garnered slightly positive responses among the surveyed farmers. The examined environmental issues displayed some variability, with Cronbach's alpha indicating internal consistency levels below 0.6 for these items, which may be due to the confusion of

respondents with the inverse scales used to measure this construct. In contrast, the intention to adopt laser-weeding technology appears to be generally positive, with an average score of 3.43.

For each psychological construct, we used a list of (3-4) related items to measure it, each item was measured by a five-point scale (Table 7.6). The Cronbach's alpha of the examined items of one construct was above 0.6, indicating a good internal consistency (Cronbach, 1951). Therefore, the summated mean of the construct was calculated based on the mean of the examined items.

Econometric model

Farmer respondents' WTP was elicited via the Bid 1-3 in Fig. 7.1. The true WTP of the respondent i , is a latent variable, which can be formulated in (1 below):

$$WTP_i = \beta X_i + \varepsilon_i \quad (1)$$

where β is a vector of the coefficient and ε is an error term. X_i is a vector.

In this study, the true WTP was unobserved but could be estimated based on a range of observed data. Based on the bidding process, the true WTP can be defined as a value lying between a lower bound (L_i) and upper bound (U_i). When respondents indicated they would buy the WeLASER machine at the price of € 300 000, the WTP values are in the form of right-censored data as the upper bound is infinity. In other cases, the WTP values are in the form of interval data as the upper bounds and lower bounds are finite. As the WTP values are either censored data or interval data, interval regression can be employed to estimate the true WTP value as the dependent variable by using the predictors varying from socioeconomic variables to psychological variables in the survey.

In practice, customers would not pay an infinite amount of money for a product. Hence, we decided that in the case the range of WTP is $[300\ 000; \infty)$, the upper bound is limited to €300 001. This practice also helps reduce the possibility of overestimated WTP in our analysis. We follow the mathematical suggestion of Ha, Shakur, & Do (2019) to estimate the probability of WTP $C [L_i, U_i]$ as shown below.

$$\begin{aligned} \Pr(L_i \leq WTP \leq U_i) &= \Pr(L_i \leq \beta X_i + \varepsilon_i \leq U_i) = \Pr(L_i - \beta X_i \leq \varepsilon_i \leq U_i - \beta X_i) \\ &= \left(\Phi \left(\frac{U_i - \beta X_i}{\sigma} \right) - \Phi \left(\frac{L_i - \beta X_i}{\sigma} \right) \right) \end{aligned} \quad (2)$$

Maximum likelihood estimation was employed to estimate β and σ . The log likelihood for Equation (2) is:

$$LnL = \sum_{i=1}^n \left[\ln \left(\Phi \left(\frac{U_i - \beta X_i}{\sigma} \right) - \Phi \left(\frac{L_i - \beta X_i}{\sigma} \right) \right) \right] \quad (3)$$

where n is the number of observations.

In our model, we considered a list of predictors of WTP including **continuous variables** namely age, perceived usefulness (PU), social influence (SI), technology interest (TI), successor and **dummy variables** namely agricultural training, north EU region, hire personnel, machine owner, manual weeding, organic farming, having precision agricultural techniques. Among the psychological factors, PEU was excluded from the model due to its high correlation with PU.

Customer characteristics analysis

We provided eight scenarios in which farmers would be more likely to adopt WeLASER and asked farmers to indicate their intention to adopt WeLASER in a five-point Likert scale (1- Very unlikely to adopt, 3- Neutral, 5-Very likely to adopt). The scenarios were created based on the findings in qualitative market studies (Tran et al., 2023). We then compared the farmers' characteristics between those who have the average intention to adopt in eight scenarios above or equal 3 with those who have low average intention to adopt (below 3). The comparison between these two groups provides an insight into the characteristics of the potential adopters of WeLASER.

7.1.2.2. Results

Sampled farms and farmers' characteristics

A diverse array of crop types was observed among survey participants, with cereals emerging as the predominant main crop, representing 56% of respondents' agricultural practices. Conventional farming methods were prevalent among the surveyed farms, accounting for the majority, while approximately 24% identified as practitioners of organic farming. Notably, around half of the farmers reported utilising their own equipment for weed control, whereas approximately 28% opted to enlist the services of a professional technician for this purpose. Manual weed control was employed by more than 41% of farmers within the sample. Additionally, nearly half of the surveyed farmers had adopted some form of precision agriculture technique, reflecting a growing trend in modern farming practices. Further elaboration and data can be found in Table 7.4.

Table 7.4. Farm characteristics (n=298).

Code	Variable description	Count	Percentage	Mean	SD
	Crop type*				
Cereals	Cereals	167	56.04%		
Roots	Roots	112	37.58%		
Oilseeds	Oilseeds	50	16.78%		
Fruits	Fruits	79	26.51%		
Veg	Vegetables	98	32.89%		
Vine	Vine	66	22.15%		
Olives	Olives	50	16.78%		
Seedlings	Seedlings	36	12.08%		
	Other crops	40	13.42%		
	What is your farm type?				
	Conventional	144	48.32%		
	Regenerative	38	12.75%		
organic	Organic	72	24.16%	0.24	0.43
	Converting to regenerative/organic	18	6.04%		
	Mixed (conventional and regenerative/organic)	26	8.72%		
	How do you control weed at your farm?				
weed1	Hire low-skilled labour to manually remove weed	46	15.44%		
weed 2	Sub-contract professionals to do weed control with their equipment	56	18.79%		
weed 3	Hire agricultural technicians to operate your owned equipment	33	11.07%		
weed 4	Operate by yourself with rented equipment	46	15.44%		
weed 5	Operate by yourself with your owned equipment	152	51.01%		
weed 6	Manually remove weed by yourself	90	30.20%		
weed 7	I use chemicals for weed control	120	40.27%		
	Derived variables from weed control approaches				
hirer	Hiring professional for weed control (1=Yes,0=No): merged weed2&3			0.28	0.45
owner	Weeding machine owner (1=Yes,0=No): merged weed3&5			0.58	0.49
manual	Manual weeding (1=Yes,0=No): merged weed1&6			0.41	0.49
precision	Applied precision agriculture technique (Yes)	146	48.99%		
	Coverage map	44	14.77%		

	Precision planting	42	14.09%		
	Internet of Things and Farm management systems	23	7.72%		
	GIS (Geographic Information System)	27	9.06%		
	GNSS (Global Navigation Satellite System)	37	12.42%		
	Auto-Steer	49	16.44%		
	Variable Rate Technology (VRT) for seeding	28	9.40%		
	Variable Rate Technology (VRT) for spraying	51	17.11%		
	Remote Sensing	23	7.72%		
	Data Collection and Analytics	43	14.43%		
	Others	4	1.34%		

Note: Farmers with no crop cultivation practice were excluded from the dataset.

The demographic composition of the farmer sample reveals a preponderance of middle-aged individuals, with an average age of 43. The majority of respondents identified as male. Approximately half of the sample held a high school degree as their highest level of education.

The distribution of nationalities within the surveyed sample was not uniform across the countries involved. Danish farmers constituted the largest share, accounting for 32% of the sample, followed by Dutch and Flemish, Italian, Polish, Spanish, and German participants.

Upon classifying respondents into two distinct sub-groups, "North EU" (encompassing Denmark, Belgium, Netherlands, and Germany) and "non-North EU" (comprising Italy, Spain, and Poland), we achieved a balanced division, yielding two relatively equal-sized groups, as detailed in Table 7.5.

Table 7.5. Socio-demographics of farmers.

Code	Variable description	Count	Percentage	Mean	SD
age	Age (continuous)			43.14	15.02
male	Male (dummy)	222	74.50%	0.74	0.44
agriedu	Having agriculture training/education (dummy)	196	65.77%	0.66	0.47
	Highest education level				
highschool	High school or below	139	46.64%		
	Bachelor's degree	94	31.54%		
	Master's degree/Study diploma	58	19.46%		
	Doctorate	7	2.35%		
	Survey language				
	Italian	49	16.44%		
	Danish	97	32.55%		

	Polish	48	16.11%		
	Dutch + Flemish (Belgian)	64	21.48%		
	German	3	1.01%		
	Spanish	37	12.42%		
	Region				
North EU	1=Denmark, Belgium, Netherlands, Germany. 0=Italy, Spain, Poland.	164	55.03%	0.55	0.50

Descriptive statistics of psychological constructs

The surveyed farmers exhibited a mildly positive perception regarding the usefulness of laser-weeding and its ease of use, as indicated by the scores exceeding 3 in Table 7.6 (PU, PEU > 3). Similarly, social influences and technological interests garnered slightly positive responses among the surveyed farmers. The examined environmental issues displayed some variability, with Cronbach's alpha indicating internal consistency levels below 0.6 for these items, which may be due to the confusion of respondents with the inverse scales used to measure this construct. In contrast, the intention to adopt laser-weeding technology appears to be generally positive, with an average score of 3.43.

Table 7.6. Psychological construct determinants.

Code	Description	Mean	SD
	Q: To which extent do you agree with the below statements? (1=Highly disagree, 5=Highly agree)		
PU	Perceived usefulness= Summated mean of the corresponding items (Cronbach's alpha = 0.76)	3.30	0.78
PU1	I believe that laser-weeding will lead to a lower production cost	3.14	1.06
PU2	I believe that laser-weeding will be time saving	3.32	1.12
PU3	I believe that laser-weeding will kill weeds effectively	3.30	0.99
PU4	I believe that laser-weeding will be safe	3.44	0.92
PEU	Perceived ease of use = Summated mean of the corresponding items (Cronbach's alpha = 0.75)	3.50	0.82
PEU1	I believe that working with laser-based weeding equipment is easy to learn	3.36	1.03
PEU2	I believe that with proper instruction, I can operate the laser-based weeding equipment	3.66	0.95
PEU3	I believe that it is easy to become skilful in working with laser-based weeding equipment	3.47	1.02
EC	Environmental concerns = Summated mean of the corresponding items (Cronbach's alpha = 0.52)	3.37	0.72
EC1	The use of chemical inputs has a negative impact on the health of people and animals	3.48	1.21
EC2	It is important to farm in an environmentally friendly way	3.92	0.93
EC3	The use of chemicals in agriculture makes sense as long as it leads to an	2.90	1.20

	increase in profits (inverse scale)		
EC4	Maximising profits is more important than protecting the environment (inverse scale)	3.18	1.12
SI	Social influence = Summated mean of the corresponding items (Cronbach's alpha = 6.41)	3.57	0.74
SI1	I think that other farmers would like to see environmental-friendly practices used on my farm	3.35	1.03
SI2	I think it would make a good impression on society if I used environmental-friendly practices	3.84	0.90
SI3	My family members and/or my neighbours expect me to put effort into environmental-friendly practices in my farm.	3.51	0.98
TI	Technological interest = Summated mean of the corresponding items (Cronbach's alpha = 0.72)	3.66	0.78
TI1	I am very curious about new technical innovations	3.81	0.99
TI2	I am always interested in using the latest technical devices	3.63	0.96
TI3	I want to use technical products more frequently than I currently do	3.54	0.99
	Q: In which scenario, would you be likely to adopt a laser-weeding solution? (1=Very unlikely to adopt – 5=Very likely to adopt).		
adopt	Intention to adopt = Summated mean of the corresponding items (Cronbach's alpha = 0.82)	3.43	0.66
adopt1	The solution has low operation cost (cost/hour).	3.79	1.09
adopt2	The solution has high working capacity (hectare/hour).	3.70	1.12
adopt3	The solution is proved to be eco-friendly.	3.62	1.13
adopt4	The solution is applicable for organic farming.	3.31	1.26
adopt5	The machinery is compatible with other machinery in the farm.	3.58	1.09
adopt6	The technical assistance is always available.	3.59	1.12
adopt7	There is shortage of agricultural workers.	3.47	1.15
adopt8	(Agricultural) labour is costly.	3.46	1.14

Willingness-to-pay estimation

The results of the interval regression (See Table 7.7) showed farmers who were younger, had agricultural training, hire personnel for weed control, did manual weeding, had an organic farm, had adopted precision agriculture techniques and had positive perceptions towards laser-weeding were more likely to pay more for WeLASER. For instance, according to the model results, one-year younger farmers have an increased willingness-to-pay of 880 EUR (0.88 x 1000€ unit of WTP).

Furthermore, our analysis revealed several noteworthy findings. First and foremost, individuals with prior agricultural training, as indicated by a dummy variable, demonstrated a substantial increase in their willingness-to-pay (WTP) for WeLASER, with an increment of

€35,000.

Moreover, farmers residing in Northern EU regions exhibited a heightened willingness to pay for WeLASER technology. The higher WTP in Northern EU countries may be due to higher GDP (Gross Domestic Product) compared to the countries in the other group (i.e., Poland, Italy, Spain). Likewise, those farmers who engaged in manual weed control or enlisted professional assistance for weed management expressed a greater propensity to allocate higher funds toward WeLASER. Organic farmers and those who had already integrated precision agriculture techniques into their farming practices also displayed a strong inclination to invest more in WeLASER. Furthermore, the perception of WeLASER as a useful tool emerged as a significant factor influencing higher WTP among farmers. However, it's worth noting that several other psychological and social indicators, including "social influence," "technological interest," and the level of certainty regarding a "successor" did not exhibit a significant impact on WTP for WeLASER in our study.

Table 7.7. Result of the interval regression on WTP (n=298).

Unit: €1000	β	SE	
Intercept	13.89	37.55	
age	-0.88	0.35	*
agriedu	35.16	11.24	**
northEU	44.28	11.07	***
hire_personel	44.79	11.94	***
own_machine	-18.79	10.58	
manual	21.64	10.55	*
organic	35.42	15.42	*
precision	52.63	11.38	***
PU	34.88	8.02	***
SI	0.16	8.14	
TI	-11.69	7.98	
successor	4.23	4.58	
Log(scale)	4.4286	0.04	***
Log likelihood	-856		
Chi ²	127		***
Degree of freedom	12		

***, **, * denote the significance levels of 0.001, 0.01, 0.05 respectively.

Note: Among the psychological factors, PU and PEU are highly correlated ($r > 0.6$) thus PEU (with a lower goodness-of-fit when in a tested model compared to PU) was excluded from the model to avoid multicollinearity. Unit of WTP is 1000 €.

Table 7.8. WTP estimation.

WTP	Estimate (unit = 1000 €)
WTP of total sample [95% of CI]	149 [142;157]
WTP of northern countries [95% of CI]	175 [166;184]
WTP of the southern and eastern countries [95% of CI]	118 [108;126]

CI denotes confidence intervals, derived from 1000 bootstrap replicates.

Table 7.8 presents the willingness-to-pay (WTP) figures for the entire sample with regard to WeLASER. Notably, farmers from Northern EU countries, including Denmark, Belgium, the Netherlands, and Germany, exhibit a higher average WTP of €175,000 when compared to their counterparts in other regions (Italy, Spain, Poland).

It is essential to underscore that the estimated WTP model in this study serves the primary purpose of identifying the key determinants of farmers' WTP for WeLASER. Consequently, the WTP values within this study encompass all types of farms, reflecting the diverse farming practices observed among the surveyed participants.

As mentioned in our qualitative market research, the principal target audience for WeLASER is organic farmers. As indicated in Table 7.7, organic farmers generally demonstrate a higher inclination to invest more in WeLASER technology. Therefore, the WTP values presented in Table 7.8 should not be used as the WTP figures to determine the pricing strategy for WeLASER, given the wide-ranging types of farming represented in our sample.

As such, the formulation of WeLASER's pricing strategy cannot rely solely on this WTP estimation. To make informed decisions regarding a substantial investment, such as acquiring WeLASER, farmers require a thorough understanding of the cost-benefit dynamics, which will be comprehensively addressed in Section 5: Financial Plan, which offers insights into the profitability of implementing WeLASER.

Nonetheless, the broader scope of the survey augurs well for the future of laser-weeding technology. If production costs can be effectively reduced to a reasonable threshold, as illustrated in this study, the adoption of laser weeding holds the potential to expand beyond the confines of organic farming. This expansion may eventually lead to the displacement of conventional methods, including herbicides and mechanical weeders, with more sustainable and efficient alternatives.

Characteristics of laser-weeding adopters

Table 7.9 below presents a comprehensive overview of the characteristics associated with potential adopters of laser-weeding technology. Several intriguing insights emerge from this

analysis:

- Cereals and Fruit Farmers: Farmers primarily involved in cereals and fruit production demonstrate a notable inclination toward adopting laser-weeding technology. However, this trend is less pronounced among those engaged in seedling production.
- Ownership and Operation: Potential adopters of laser-weeding technology often prefer to operate their own machines, underscoring a hands-on approach to the technology's integration into their farming practices.
- Conventional Farmers: Surprisingly, conventional farmers, who traditionally employ herbicides for weed control, expressed a heightened interest in adopting laser-weeding technology. This inclination could signify a shift toward more sustainable weed control methods within conventional farming practices.
- Precision Agriculture Adoption: Farmers who have already embraced precision agriculture techniques exhibited a lower intention to adopt laser weeding. This observation may be attributed to their prior exposure to alternative technologies in the current market. They may harbour doubts about transitioning to yet another new technology, influenced by factors such as asset specificity or credit constraints.
- Age and Experience: It's noteworthy that older and more experienced farmers tend to exhibit a higher intention to adopt laser-weeding technology. This finding contrasts with the determinants of willingness-to-pay (WTP) for WeLASER, where younger farmers demonstrated a higher WTP. This apparent contradiction can be elucidated by the fact that a higher intention to adopt does not necessarily translate to a higher WTP. Older and more experienced farmers often possess a better understanding of reasonable machinery pricing and the overall costs associated with weed control. Consequently, they may have a lower WTP, or they may be less inclined to overestimate their WTP. On the other hand, younger farmers may have credit constraints that prevent them from paying more for alternative weed control solutions.
- Psychological Factors: All examined psychological factors reflect significantly higher values within the adopter group. This suggests that laser-weeding adopters hold positive perceptions of laser-weeding, prioritise environmental consciousness, are influenced by social pressures to adopt environmentally friendly practices, exhibit high technological interest, and are more likely to have a successor in place for their farms.



Table 7.9. Comparison of characteristics of WeLASER adopters versus WeLASER non-adopters.

	Adopters	Non-adopters		
	Mean (SE)	Mean (SE)	Mean difference	p-value
Cultivation crop				
Cereals ¹	0.59 (0.03)	0.44 (0.06)	0.15	*
Roots ¹	0.38 (0.03)	0.35 (0.06)	0.03	
Oilseeds ¹	0.16 (0.02)	0.21 (0.05)	-0.06	
Fruits ¹	0.29 (0.03)	0.17 (0.05)	0.126	*
Vegetables ¹	0.32 (0.03)	0.35 (0.06)	-0.03	
Vine ¹	0.22 (0.03)	0.23 (0.05)	-0.01	
Olives ¹	0.19 (0.03)	0.11 (0.04)	0.08	
Seedlings ¹	0.1 (0.02)	0.2 (0.05)	-0.10	*
Weed control approach				
Hire low-skilled labour to manually remove weed	0.16 (0.02)	0.15 (0.04)	0.00	
Sub-contract professionals to do weed control with their equipment	0.16 (0.02)	0.29 (0.06)	-0.13	*
Hire agricultural technicians to operate your owned equipment	0.09 (0.02)	0.2 (0.05)	-0.11	*
Operate by yourself with rented equipment	0.16 (0.02)	0.15 (0.04)	0.00	
Operate by yourself with your owned equipment	0.54 (0.03)	0.39 (0.06)	0.15	*
Manually remove weed by yourself	0.29 (0.03)	0.35 (0.06)	-0.06	
I use chemicals for weed control	0.44 (0.03)	0.26 (0.05)	0.19	**
Hire low-skilled labour to manually remove weed	0.02 (0.01)	0.05 (0.03)	-0.02	
Farm practices				
Farm size (ha)	2754.01 (1887.33)	5458.46 (3757.76)	-2704.44	
Weed time (hour)	768.01 (191.8)	10286.27 (9929.72)	-9518.26	
Applying precision agriculture technique	0.44 (0.03)	0.68 (0.06)	-0.25	***
Weed cost (EUR)	19152.56 (4411.36)	4722.07 (1751.85)	14430.49	
Turnover (EUR)	1,302,533.75 (832995.82)	254,280.8 (140160.04)	1,048,252.95	

Farmers characteristics				
Age	45.1 (0.95)	36.27 (1.88)	8.83	***
Gender	1.25 (0.03)	1.29 (0.06)	-0.04	
Experience	20.82 (0.98)	13.91 (1.76)	6.91	**
Education level	1.75 (0.06)	1.86 (0.1)	-0.11	
Agricultural training ¹	0.66 (0.03)	0.64 (0.06)	0.03	
Northern EU	0.53 (0.03)	0.62 (0.06)	-0.09	
Psychological factors ²				
Successor	3.05 (0.08)	2.55 (0.14)	0.51	**
Perceived usefulness	3.45 (0.05)	2.78 (0.09)	0.66	***
Perceived ease of use	3.66 (0.05)	2.91 (0.09)	0.75	***
Environmental concerns	3.46 (0.05)	3.06 (0.07)	0.40	***
Technological interest	3.82 (0.05)	3.11 (0.09)	0.71	***
Social influence	3.69 (0.05)	3.12 (0.09)	0.57	***

¹ measured as dummy variables, ² measured by five-point Likert scale.

7.1.2.3. Conclusion

The prospective customers for WeLASER are likely to be characterised as young farmers with agricultural backgrounds, predominantly located in Northern EU countries. They are more inclined to hire professionals for weed control, embrace organic farming practices, and employ precision agriculture techniques on their farms. As such, when introducing WeLASER to the European market, the spin-off company should strategically target Northern EU regions, with a particular emphasis on engaging with the organic farming sector. Besides, given the restricted use of pesticides in the EU context, WeLASER can potentially be combined with conventional weed control methods to meet increasingly stringent requirements of reducing herbicide use. Leveraging the existing networks of precision agriculture adopters through machinery suppliers can serve as an effective channel for identifying prospective customers. Additionally, our findings suggest that potential adopters of laser-weeding technology are often those engaged in cereal and fruit cultivation. They tend to own their weed control equipment, expressing a desire to transition away from chemical weeding methods. Furthermore, older more experienced farmers show a greater interest in laser-weeding. This finding is contradictory to the high WTP among young farmers for WeLASER. This implies that age may be not a good determinant for adopt nor WTP as other hidden correlated factors such as fiscal policies (favoured for young farmers) may play a more important role. Besides, the potential adopters exhibit higher perceptions of the usefulness and ease of use of laser-weeding and display greater concern for environmental issues. These insights underscore the necessity of

an educational approach to raise awareness and enhance farmers' understanding of laser-weeding technology.

Despite the current modest levels of WTP for WeLASER, the positive attitudes of farmers toward laser-weeding hold promise for the technology's adoption in the future. This indicates an encouraging trajectory for the adoption of laser-weeding techniques as they gain further traction in the agricultural landscape.

7.2. Competitive analysis

Conducting a comprehensive competitive analysis is imperative in refining our marketing strategy and providing a clear depiction of WeLASER's true potential in the market. This analysis serves as the cornerstone for identifying the unique selling points of our product. Given the myriad weed control applications available in the market, pinpointing the principal competitors of the WeLASER vehicle proves to be a complex endeavour. In this report, our objective is to undertake a multifaceted analysis of the competitiveness of the WeLASER application, comprising two distinct dimensions.

Firstly, we embark on a comprehensive comparison of the WeLASER application with broad categories of indirect competitors, namely chemical, mechanical, and other physical weed control approaches. The details of this extensive comparison are elucidated in Section 1, offering valuable insights into how WeLASER distinguishes itself from these conventional methodologies. Furthermore, we have meticulously compiled a collection of innovative weed control applications from various reports and market insights. This compilation provides a glimpse into the current developmental stage of the weed control machinery industry, affording us an understanding of emerging trends and potential opportunities. Secondly, we shift our focus to a direct comparison between the WeLASER application and other potential laser-weeding solutions. This in-depth analysis, comprehensively covered in Section 2, grants us insights into the specific competitive landscape within our niche market.

7.2.1. Comparison with indirect competitors

Given the multitude of weed control approaches available, achieving comprehensive comparisons across all methods can be a daunting task. In this report, the primary objective is to provide a broad comparative analysis between distinct categories of weed control approaches based on their fundamental weed-killing elements. These categories can be broadly classified as chemical, mechanical, and physical treatment methods. In this section, we outline the general characteristics of these weed control approaches. Subsequently, we delve into a comparison between the primary categories of weed control, aiming to shed light on their respective strengths and weaknesses. This comparison will serve as a valuable backdrop against which we can assess the suitability of the WeLASER application. By

juxtaposing WeLASER against these established methods, we can elucidate the unique advantages and potential drawbacks inherent to our approach.

7.2.1.1. Chemical control

Chemical weed control is commonly used in conventional agriculture as it significantly saves production costs due to the cheap and widely available herbicides. Recently, there are increasingly strict policies on the use of crop protection chemicals due to their negative impacts on environments and the emergence of new herbicide-resistant weeds especially in Europe (Petit et al., 2015; Westwood et al., 2018). Thus, chemical weed control has been less attractive to even conventional agriculture (Young & Pierce, 2014). However, a set of innovations in chemical control has been developed recently to optimise the weed control effectiveness and reduce the residue of excessive herbicides released to the agricultural system (Chen, Lan, Fritz, Hoffmann, & Liu, 2021). Nowadays, pesticide sprayers can target specific rows of the crop and avoid spraying the whole field. Precision technologies with high-quality sensors and autonomous systems such as unmanned drones lay a cornerstone in this field (Chen et al., 2021). As weeds are selectively targeted and treated with a proper volume of herbicides, the occurrence of pesticide residues in the environment can be significantly reduced (Weis et al., 2008).

7.2.1.2. Mechanical control

The mechanical weed control approach has been preferable in organic cultivation for a long time as it significantly reduces the cost of manual weed control, especially in Europe, where the labour cost is substantially high (Young & Pierce, 2014; European Commission, 2018). The mechanical weed control tools can be mounted to a tractor and mostly deal with inter-row weeding (Rueda-Ayala, Rasmussen, & Gerhards, 2010). The development of precision agriculture allows mechanical weed control to be more effective. For instance, the crops can be precisely seeded in a row. Based on the predefined row distances, mechanical weeders can also kill in-row weeds. The main drawback of conventional mechanical weeders is that this machinery oftentimes cannot precisely target the weed and easily damages the main crops. The innovation in machine learning and AI allows some mechanical weeders to imitate manual weed control by using robot arms to chip out weeds on the field (Machleb, Peteinatos, Kollenda, Andújar, & Gerhards, 2020).

7.2.1.3. Physical control

Physical weed control contains a wide range of approaches namely fire, flaming, infrared radiation, hot water, steam, electrical energy, microwave radiation, ultraviolet radiation, freezing temperatures, and lasers. Only a few of these approaches are commercially used such as flame weeding and to some extent infrared radiation, steam, and electrocution (Young



& Pierce, 2014). These physical approaches often require high energy levels, so their adoption remains modest. For instance, flaming treatment is proven to be energy-consuming (Datta & Knezevic, 2013). As physical weeders can avoid the use of chemicals, they can be used in both organic and conventional cultivation. Besides, thermal treatment is a crop-specific approach as some crop plants are sensitive to heat treatment. In general, the implementation of these approaches is still limited. A cost-benefit analysis of this approach in comparison to other weed control approaches is needed to promote the adoption of physical weed control methods in the future (Young & Pierce, 2014).

7.2.2. Comparison with the WeLASER application

The WeLASER application is classified as a physical weed control approach. As this technology is still at a nascent stage, some technical issues still need to be addressed. However, to initially compare the competitiveness with different weed control practices, the tentative specification of the WeLASER application (as detailed in the project grant agreement) will be considered for the comparison. Table 7.10 details the main advantages and disadvantages of the WeLASER application with the other main groups of weed control approaches namely other physical weed control, mechanical control, and chemical control.

Regarding in-row weed control, most conventional mechanical weeders cannot target in-row weeds as these mechanical weeders mainly apply tillage and hoeing. However, with the support of precision seeding, the mechanical weeders can be programmed to kill the weeds in-row as they can target the specific space between two crop plants in the field (Rueda-Ayala et al., 2010). This is also the case with the spraying machines for chemical weed control. The development of AI sensors allows the weeders to have the proper vision to target selectively in-row weeds. However, this high level of precision weed control is often a trade-off with the low speed of operation (Roland, Julie, Alain, & Gaetan, 2021). The WeLASER application aims to achieve an accuracy of ± 3 mm of the laser treatment. This high level of accuracy can be a unique selling point for the WeLASER application as other weed control applications mostly have lower accuracy levels, especially when they do not have support from AI sensors or precision seeding.

The relative effectiveness of the mechanical and chemical weed controls is diverse and context specific as there is currently an enormous number of different weed control applications available. For example, in 2017, a study investigated the potential of mechanical weeding in sugar beet cultivation by comparing four weed control schemes including one chemical, two mixed between chemical and mechanical, one mechanical (Rabier et al., 2017). The results showed that mixed treatments were the most effective, but the sole mechanical treatment had the lowest operation cost despite the lowest effectiveness, especially with in-row weeds. Hence, the cost and benefit of each treatment should be analysed and carefully

evaluated by farmers to identify the best treatment or combination of treatments on their farms. Besides the economic aspect of the method, the cultivation approach is also one of the main factors for farmers to choose a weed control method. Organic farming does not allow synthetic herbicides and other plant protection chemicals. Therefore, mechanical, physical weed controls are highly favoured in organic farming as these methods significantly reduce the labour cost of manual weed control. Also, the increasingly stringent regulation on herbicide usage in Europe and the new agricultural trend with the Green Deal have explicitly promoted the development and adoption of sustainable weed control methods (European Commission, 2021a).

The majority of weed control machinery still requires human supervision and operation. However, the development of automation technologies has allowed several conventional weed control approaches to operate autonomously in recent years (Young & Pierce, 2014).

In terms of the energy consumption for operation, physical weed control methods often require significant high-power sources as thermal weed control methods such as flaming, steaming, or laser beaming are notoriously power-consuming (Young & Pierce, 2014). Meanwhile, the mechanical and chemical weeders can be mounted onto tractors and take advantage of the movement of tractors to reduce their energy consumption.

As the physical weed control technologies are mostly at a nascent stage, the initial investment cost for such applications is relatively higher than for other weed control methods. However, regardless of the weed-killing elements, the investment costs can be highly varying depending on the automation and precision level of machinery.

In the report 2021 of FIRA (International Forum of Agricultural Robotics), autonomous robotic weeding was perceived at early semi-commercial prototype to trial phase (See Fig. 7.6). Autonomous spraying drones and manned robotic weeders are commercially available. Meanwhile, autonomous spraying robots are still in the early commercial sales to full market launch phase. In the scope of this report, the WeLASER application fits into the category of “Autonomous robotic weeding”. In essence, the mechanical and chemical weed control methods are still mainstream, whereas the physical weed control methods like the WeLASER application are still limited and mostly in testing phases (Young & Pierce, 2014).



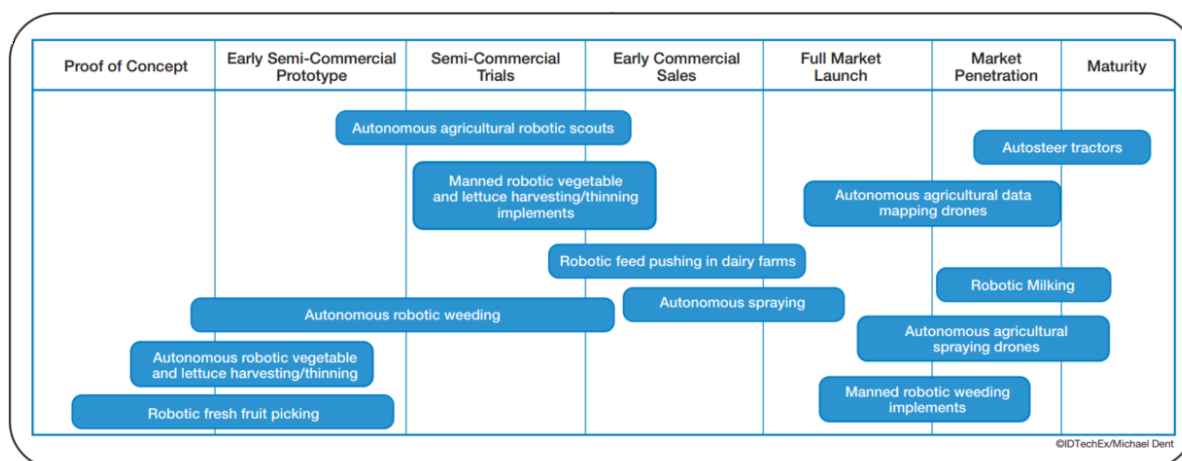


Fig. 7.6. Robots and drones: market and technology readiness by agricultural activity.
Source: Roland, Julie, Alain, & Gaetan (2021)

Besides, as new applications in weed control machinery rapidly emerge, it is impossible to capture all the new applications in the market. Therefore, to provide a glimpse of the current innovative weed control applications, we compile a list of machines from different sources in Table 7.10. In the category of physical weed control methods, we focus on the laser-beaming treatment for weed control with some representatives, as these competitors are the most like the application in the WeLASER project.

7.2.3. Comparison between WeLASER and other laser-weeding solutions

Details on the laser-weeding solutions as competitors of WeLASER can be found in Table 7.11. Among the potential competitors of WeLASER in the market, Carbon Robotics is the only one that has commercialised products but only sells in North America (the US and Canada) and has not entered the European Union market yet. The major competitive advantage of WeLASER compared to Carbon Robotics is that WeLASER uses a fibre laser instead of CO₂ laser. The differences between a fibre laser and CO₂ laser are:

- A fibre laser system is smaller (about 5 times) than CO₂ laser due to the shorter wavelength, which leads to a smaller and lighter system. The fibre laser system is usually lighter compared to the CO₂ laser system; thus, the final vehicle would also be more compact and flexible in the case of WeLASER. Currently, the weight of the first model of Carbon Robotics weighs more than 4 tons. Meanwhile, the expected weight of the WeLASER vehicle is around 1.7 tons. The lighter vehicle can cause less damage to the soil and move more flexibly in different landscape.
- A fibre laser can target smaller objects more precisely, which in turn makes fibre lasers more energy-effective than CO₂ lasers.
- Fibre lasers operate about 25 times faster than CO₂ lasers. Currently, the capacity of the autonomous Carbon Robotics version on-site is approximately 6-8 ha per day,

which is like the estimated capacity by WeLASER around 3.5-9.6 ha per day. However, there are more lasers used on the model of Carbon Robotics so given the same capacity, the energy consumption of Carbon Robotics is predicted to be higher.

- CO₂ lasers (of Carbon Robotics) use glass tubes and require external optics and adjustment, which can easily be damaged on the field and subsequently require frequent replacement. Including the higher cost for energy consumption, the final cost of a CO₂ laser is generally higher than that of a fibre laser.
- The main challenge of a fibre laser is related to its precise treatment, which in turn requires the laser recognition systems to be functional in a dynamic condition with consideration for vibration on the field. Otherwise, the laser system might incorrectly shoot weeds and even damage crop plants.
- The cost of a fibre laser is substantially higher than for CO₂ lasers. However, the price of optics can drastically decrease if produced in mass. It is estimated that with 1000 fibre laser systems produced, the price of a fibre laser can be reduced by half (according to FUT).

In conclusion, WeLASER has several strengths compared to its (only market-available) direct competitor, Carbon Robotics. WeLASER is supposedly a solution that is more precise and more energy-effective compared to Carbon Robotics. However, Carbon Robotics is already commercialised and reaches a high volume of production to achieve economies of scale. As Carbon Robotics is enjoying the monopoly of being the only provider of laser-weeding solutions, it can be challenging for a new player such as WeLASER to penetrate the market.

It is noteworthy that the market response towards the introduction of Carbon Robotics was immensely positive. Cadogan (2023) reported that even with the price tag of more than \$1 million, Laser Weeder (the laser-weeding implement produced by Carbon Robotics) has still sold out its 2021 and 2022 models in the North American market (the US and Canada). Carbon Robotics plans to expand their markets to the EU soon. In the North American context, Farmers who purchase Laser Weeder are expected to reach breakeven after 2-3 years on 200 acres (or 81 ha) of farmland. Based on the comparison above, if WeLASER can adapt the recognition system to work in a moving vehicle efficiently, the potential of WeLASER can even surpass the current success of Carbon Robotics. However, it should be noticed that there are other projects and SMEs working on laser-weeding (i.e., Pixelfarming, Escarda, Weedbot), who could be the direct competitors of WeLASER in the coming years.



Table 7.10. Some innovative weed control applications in the current market.

#	Category ^a	Machine (company)	Country	Main features	Productivity	Price ^b	Development phase
1	C	AVO (ecoRobotix)	Switzerland	Using machine learning, the robot detects, and selectively sprays the weeds with a micro-dose of herbicide.	Up to 10 ha/day	€105000	Marketed
2	C/M	Robotti (Agrointelli)	Germany	Mechanical weeding and band-spraying/spraying. Supported by a reliable and powerful diesel and hydraulic system. Using Lidar scanners, emergency stops, and cameras for live monitoring.	0-8 km/h	€187,000	Marketed
3	M	BIPBIP (CTIFL)	France	Intra-row weeding. Hoeing tool-block independent from the carrier and automatically guided by imaging telemetry, covering a single crop row.	NA	NA	NA
4	M	Dino (Naio technology)	France	Inter-row weeding, autonomously navigate, remote mission supervision, electric batteries.	4 km/h, 4 ha/day	€220,000	Marketed
5	M	FD20 (FarmDroid)	Denmark	High precision RTK-GTS, seeding system, weeding system for inter-row and intra-row weeding, CO2-neural operation using solar power.	Up to 6.5 ha/day	\$50k - 56k	Marketed
6	M	La Chèvre (Nexus Robotics Inc)	Canada	Removing weeds near vegetable crops without damaging the crop.	95% weed removal	Sale US \$500,000 or leasing for US \$50,000 per growing season	Marketed

7	M	Robot One (Pixelfarming robotics)	The Netherlands	Using robotic arms or laser to kill weeds autonomously, based on vision system and adjustable for specific crop treatment.	Up to 1 ha/h	€150,000 - €185,000	Available in 2024 in EU.
8	M	Romi Rover (ROMI organisation)	France	Mechanical weeding for organic micro-farms. Semi-autonomous – can operate autonomously on fixed rear tracks, but require manual support to do a U-turn.	600m ² /day (precision weeding inter-row and intra-row), 7,200 m ² /day (classical weeding, inter-row)	€5,000- €10,000	Testing
9	M	Digital farmhand (AGERRIS)	Australia	Chip out weeds along the vegetable beds with robotic arms. Using solar-electric energy and can run in autonomous mode. Battery life up to 15 hours with solar panels.	Speed: 6km/h. Up to 3ha/day.	\$12500	Marketed
10	M	Titan FT 35 (FarmWise)	The United States	Intercrop and inter-row mechanical weeding	10-15 acres/day	As a service, under €445/US \$500 per acre	Marketed
11	M	Weed Whacker robot (Odd.bot)	The Netherlands	Autonomous mechanical in-row weeding for high-density crops (stamper/pusher, puller, pucker) using AI and machine learning with Delta arm robots.	NA	Sale US \$500,000 or leasing for US \$50,000 per growing season	Marketed
12	P	HarryV1 (Small robot company)	United Kingdom	Electrical weed control using ZAP	NA	NA	Testing, deployment in 2023



13	P	Annihilator (The Weed Zapper)	The United States	Using electric shock to kill weeds	8ha/h	\$42,000-\$72,500	Marketed
14	P	JATI (SPL)	Austria	Using camera detection to kill weeds by laser beams. Most effective at the four-leaf stage of weeds.	NA	NA	Demonstration
15	P	Lumina (Weedbot)	Latvia	Using laser beams to kill weeds autonomously with a sensor system to detect weed with precision up to 2mm. Able to cover 3-15 ridges. Powered by PTO generator.	0.3km/h	€ 350,000	Available in EU from 2024.
16	P	Escarda (Escarda Technologies)	Germany	Kill weeds by using a laser system thanks to data acquisition from cameras and AI image analysis.	NA	NA	Testing
17	P	Carbon Robotics	The United States	Kill weeds by using a laser system thanks to data acquisition from cameras and AI image analysis.	0.8ha/h	>\$1mil	Marketed

^a Weed control approach: M = Mechanical control, C = Chemical control, P = Physical control. NA = Not Available. ^b Prices updated based on the market data of futurefarming.com. Currency: € = EURO, \$ = US dollar. *The list of companies was self-compiled with extraction from Roland et al. (2021).*

Table 7.11. Laser-weeding solutions as competitors of WeLASER

	<u>WeLASER</u>	Autonomous laserweeder demo unit ^a (Carbon Robotics)	Laserweeder Implement ^a (Carbon Robotics)	Robot One (Pixelfarming)	Hyperweeding ^b	Escarda	Lumina (Weedbot)
Country/Region	EU	US	US	Netherlands	UK	Germany	Latvia
Type of laser	4 Fibre laser (1994-1998nm)	10 CO ₂ laser 10000nm	30 CO ₂ laser 10000nm	5 CO ₂ laser	1 fibre laser 810-nm	NA	NA
Precision shoot	3mm	3mm	3mm	2mm	0.62 mm	NA	2mm
Kill rate	~65%	NA	99% kill rate	NA	99.2%	NA	NA
Speed	0.7-2km/h	8km/h	1.6km/h	3.5km/h	0.36km/h (0.1m/s)	NA	0.6-1.5km/h
Capacity	3.5-9.6ha/day	6-8ha/day	0.8ha/h	1ha/h	NA	NA	NA
Power source	Diesel	Diesel- PTO generator	Diesel- PTO generator	Battery (13kWh)	NA	NA	Diesel- PTO generator
Weight	1,700 kg	4,300 kg	NA	2,000 kg	NA	NA	NA
Mode of transport	Autonomous vehicle	Autonomous vehicle	Front mounted on (common row) tractor	Autonomous vehicle	Mounted on rear of tractor	Pulled by a tractor (future: robot fleet)	Mounted on rear of tractor
Weeding power	250-500 W	150 W	150W	100 W	90 W	NA	NA
Price	€ 450k(estimated)	Demo only	>\$1mil ^c	€205-240k	NA	NA	€ 350,000
Development phase	Prototype	Fully developed	Available in North America	Available in 2024 in EU	Field test	Field test	Available in 2024 in EU
Track width	2m	~2 m (80 inches)	Adjustable crop row width:1.5-2m (60-80 inches).	Adjustable track width 3.5m+0.5-0.75m (vertically) or 2.2m-0.375,0.5,0.75m	NA	NA	Modular, 3-15 ridges

Source: ^a [Carbon Robotics website](#), ^b derived from Wang, Leal-Naranjo, Ceccarelli, & Blackmore (2022).^cSource: <https://www.irishexaminer.com/farming/arid-41201275.html>,^dSource: <https://www.fwi.co.uk/machinery/pixelfarming-robotics-to-target-uk-with-autonomous-weeder> (price available for only the robotic arm version, not the laser version).

7.3. Business Model Canvas

In this section, we described the business model for a future spin-off using the machinery built in the WeLASER project. The spin-off is comprehensively described using the well-structured framework of the Business Model Canvas, comprising nine modules namely (1) value propositions, (2) customer segment, (3) customer relationship, (4) distribution channels, (5) key activities, (6) key resources, (7) key partners, (8) cost structures, and (9) revenue streams (Osterwalder, Pigneur, Oliveira, & Ferreira, 2011).

The following sub-sections offer an in-depth exploration of each of these business elements, drawing insights from market intelligence derived from our market studies, the valuable perspectives of our project partners, and the empirical performance data of WeLASER, garnered through both laboratory conditions and rigorous field tests.

7.3.1. Value propositions

Based on the SWOT analysis, we have discerned five pivotal value propositions that underscore the strengths of WeLASER. These value propositions are as follows:

1. **Labour Reduction:** The escalating shortage of agricultural labour across Europe, coupled with the consequent rise in low-skilled labour costs, accentuates the appreciation for autonomous systems like WeLASER among farmers. By automating weed control processes, WeLASER addresses this labour challenge effectively.
2. **Environmental Sustainability:** Stakeholders participating in the focus group discussions overwhelmingly perceive WeLASER's primary advantage to be its contribution to environmental sustainability. The precision of WeLASER's laser treatment minimises its impact on living organisms and the surrounding ecosystem, resulting in reduced soil disturbance that safeguards biodiversity. Additionally, WeLASER's approach eliminates the need for herbicide use in weed control, thereby reducing dependence on phytosanitary products and curbing the emergence of herbicide-resistant weeds. The reduced weight of WeLASER compared to conventional mechanical weeders also mitigates the risk of soil compaction.
3. **Precision:** WeLASER's incorporation of a recognition system enables it to target in-row weeds with precision while avoiding damage to crops. Stakeholders in the discussions emphasised that WeLASER's recognition system and vehicle components empower it to identify and eliminate weeds flexibly and accurately, reducing its reliance on uniform crop rows. This feature is especially valuable in cases of intercropping where crop row structures may vary among crops.
4. **Efficient Agricultural Production:** WeLASER is viewed as a promisingly efficient method of agricultural production. Leveraging remote control and supervision systems, a single operator can manage multiple robots working concurrently in the field. The theoretical

capability of WeLASER to operate 24/7 maximises resource utilisation and offers great flexibility to farmers, alleviating concerns related to weed control.

5. **Positive Impact on Food Safety:** WeLASER holds the potential to enhance food safety significantly. This method avoids the use of chemical residues in food products, assuring consumption of cleaner and safer produce. Furthermore, the elimination of herbicides in weed control negates the necessity for withdrawal periods, streamlining the production process and ensuring food safety compliance.

7.3.2. Customer segments

Considering the lower environmental impact and the absence of chemical pesticides, organic farmers emerge as a prominent target customer segment for WeLASER. Market studies have consistently indicated that organic farmers are more inclined to favour and adopt WeLASER technology compared to their conventional counterparts (See

Market research). In this section, we delve into the potential of the organic farming sector in Europe, aiming to project the market size for WeLASER within this niche.

Within Europe, there exists a substantial organic agricultural landscape, spanning approximately 17.8 million hectares of land. Notably, a significant portion of this land, specifically at least 11.7 million hectares, is dedicated to fully converted organic farming practices. This figure includes approximately 10.6 million hectares within the European Union, excluding Austria, Germany, Portugal, the Russian Federation, and Switzerland due to data unavailability from Eurostat (Willer, Schlatter, & Trávníček, 2023). According to the Green Deal target, all the Member States in the EU should have at least 25% farmland dedicated to organic farming until 2030 (Willer et al., 2023). However, until 2021, only Austria has achieved this goal whereas other countries still need to substantially expand their organic farmland to reach the target (See Fig. 7.7). In general, the upward trend in organic farmland area in the EU indicates the potential of adopting eco-friendly weed control approaches such as WeLASER.



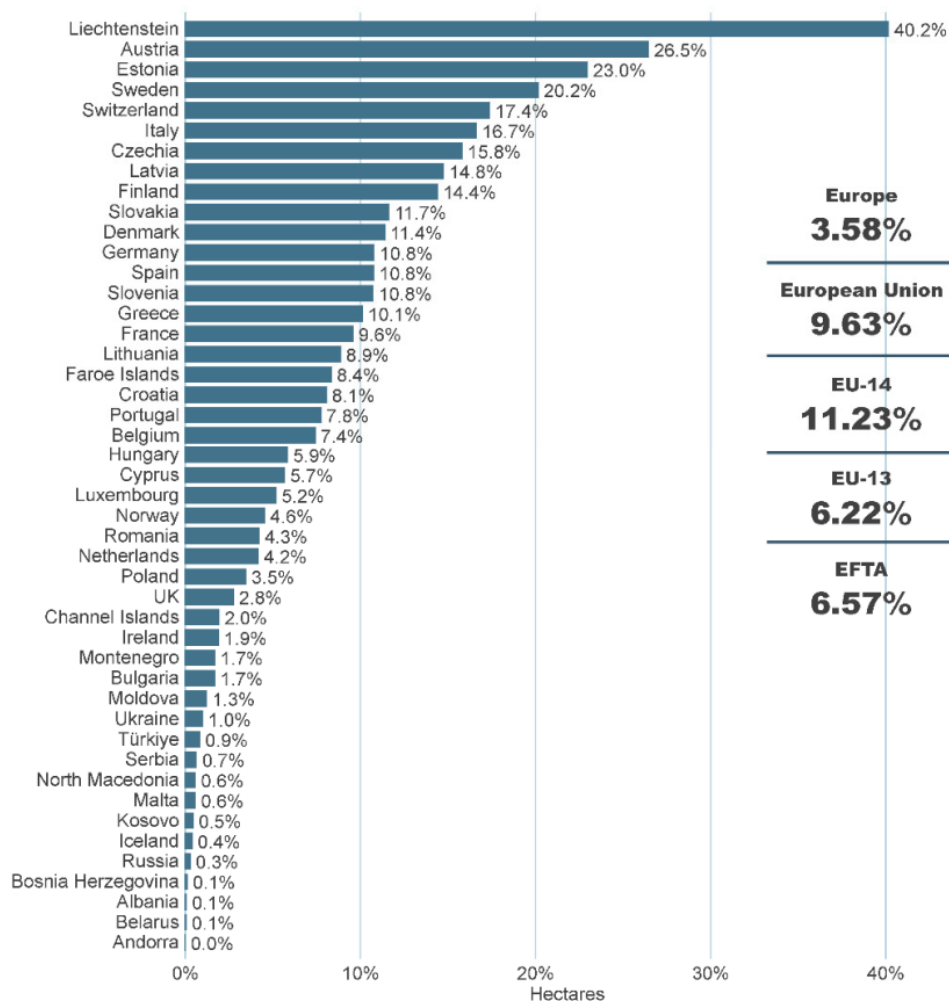


Fig. 7.7. Organic farmland in the EU by country in 2021. Source: Willer, Schlatter, & Trávníček (2023).

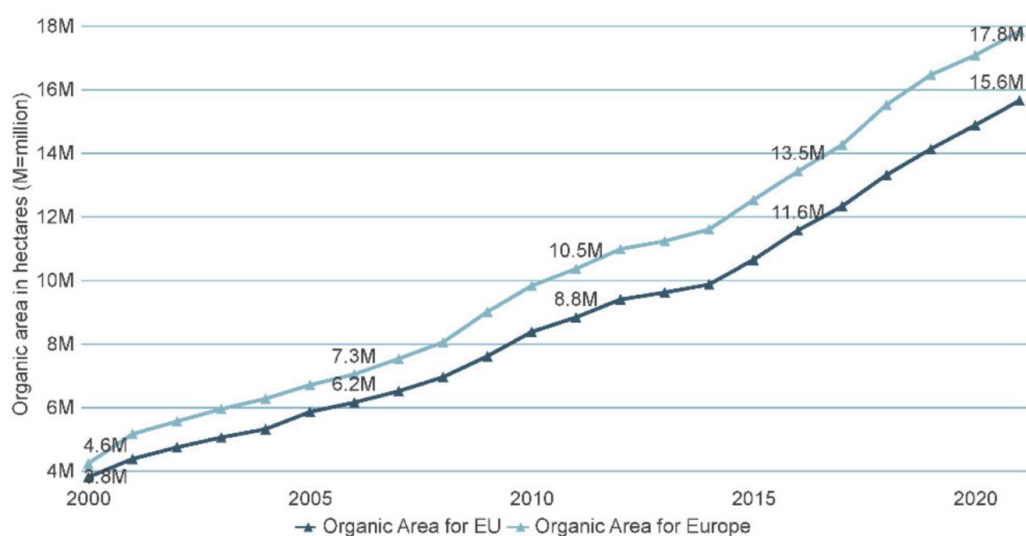


Fig. 7.8. Europe and EU: Development of organic agricultural land 200-2021. Source: Willer, Schlatter, & Trávníček (2023).

7.3.3. Distribution channels

To facilitate the spin-off of WeLASER, we are implementing a strategic approach that focuses on delivering technical and sales support through the creation of a robust dealer network, following a contractor-based model. This dealership distribution strategy enables the spin-off to reduce expenses related to storage, as production will align with customer demand (based on orders), thereby minimising logistics costs. Additionally, this approach shifts the responsibility for sales and direct customer service to the network of dealers, allowing the spin-off to operate with a leaner and more efficient business model.

The potential dealers, equipped with logistical capabilities and expertise aligned with our service requirements, are integral to the success of this endeavour. In Table 7.12 below, we outline a selection of potential dealers spanning across the European Union that are currently distributing precision agriculture machinery.

Table 7.12. Distributors.

Company name	Country of operation	Contact (A=Address, T=Telephone, F=Fax, E= Email, W=Website)
LATITUDE GPS	France	A: 13 rue des drapiers, 27110 Venon T: (+33) 02 32 40 03 26 W: https://www.latitudegps.com/
GEOKONZEPT	Germany	A: Wittenfelder Strasse 28. 85111 Adelschlag . T: +49 (0) 8424 89890. F: +49 (0) 8424 898980. E: geo@geo-konzept.de W: https://geo-konzept.de/
AGROMETIUS	The Netherlands, Belgium, Germany	A: Molensteyn 48, 3454 PT de Meern T: +31 (0)88 818 0 818 E: info@vantage-agrometius.nl Website: https://www.vantage-agrometius.nl/
FARMERSFUTURE R&B GMBH	Austria	A: Obere Hauptstraße 65, 2291 Lassee T: +43 699 135 190 25 W: https://farmersfuture.at/
YDING SMEDIE & MASKINER A/S	Denmark	A: Egeskovvej 10, 8700 Horsens T: +45 7578 2230 E: info@ysm.dk W: http://www.ysm.dk/
STECOMAT SARL	France	A: ZAC la Roubiague, 47390 Layrac T: +33 0553 980110 W: https://stecomat.com/
AGRAVIS TECHNIK	Germany	A: Plathnerstraße 4a, 30175 Hannover T: +49 173 756 93 57 or +49 172 271 74 22 W: https://www.agravis.de/en/technik/
ORGANIC AGRAR MILLER GMBH	Germany	A: Hohenreuter Str. 108, 87769 Oberrieden T: +49 (0) 8265 7334 010 E: info@organic-agrar.de W: https://organic-agrar.de/
ARVATEC SRL	Italy	A: Viale dei Kennedy 87/a, 20027 Rescaldina (MI) T: +33 0331 464840 E: info@arvatec.it

		W: https://www.arvatec.it/
IAM AGRICULTURAL MACHINERY	Ireland, North Ireland	A: Hebron Industrial Estate Kilkenny, Ireland, R95R2TA T: +353 56 7765826 E: info@iam.ie W: https://iam.ie/
AUGA GROUP	Lithuania	A: Konstitucijos pr. 21C, Quadrum North 08130 Vilnius T: +370 5 233 5340 E: t.ceponkus@auga.lt W: https://auga.lt/
K.A. HAVELAAR & ZN BV	The Netherlands	A: Spectrumlaan 11, 2665 NM BLEISWIJK T: 079 593 1307 E: info@havelaar.biz W: https://haknl.com/?lang=en
FARMSYSTEMS	Poland	A: ul. Szebesty 25 40-749 Katowice T: +48 572 243 848 or +48 693 935 333 E: kontakt@farmsystems.pl W: https://farmsystems.pl/
AG GROUP	Spain	A: Ctra. Albelda, S/N 22550 Tamarite de Litera, HU, ES T: +34 974 422 807 E: info@ag-group.es Link: https://www.ag-group.es/sobre-nosotros/
OPICO LTD	UK	A: Cherry Holt Road, Bourne, Lincolnshire, United Kingdom, PE10 9LA T: +01778 421111 E: ask@opico.co.uk W: https://www.opico.co.uk/
CULTUM	Finland	A: Nokkalantie 10 B 14, Loimaa 32210, Finland T: +358 40 563 9496 E: matti@cultum.fi W: http://www.cultum.fi/
EVOFARMING	Hungary	A: 6000 Kecskemét, Klapka Street 9-11. fst. 18/a T: +36 70 479 5100 E: info@evofarming.hu W: https://evofarming.hu/

7.3.4. Customer relationship

The business relationship between WeLASER spin-off and farmers will pass through a dealer network, which includes to direct customer services for technical supports and complaints. The dealer network will provide basic technical support to farmers and act as a middleman between farmers and the WeLASER spin-off in case of more complex technical issues need to be solved. Since the dealer network acts as the frontline with direct interaction with farmers, it is essential to establish good dealer agreements with general terms and conditions. The following joint obligations should be discussed in advance before signing the dealership:

- The WeLASER spin-off manager and every dealer will designate **local contacts** to be the focal points for the parties' general relationship, forecasts, trade area and technical or

process issues. The local contacts will be responsible for managing the relationship between all parties.

- These local contacts within the dealer network will submit a **monthly report/forecast** to the spin-off manager for the purpose of reviewing and assessing dealer's performance, future market action plans, sales commitments amount, volume goals, etc.
- Local contacts should proactively offer **prospective visits** to interested farmers. Based on plot size, they can recommend optimal, personalised business formulas adapted to the farmers' needs and abilities. They should be trained and qualified to elaborate on the technical aspects of the WeLASER solution as well.
- The dealers are required to participate in WeLASER's annual and quarterly market action planning program and meet the dealer's sales commitments as agreed under such market action plans.
- The local contacts are encouraged to form local self-supporting groups formed by farmers who are early adopters of WeLASER (or "**WeLASER-alliance**" group). The local self-supporting groups can be trained to tackle minor maintenance, share experience with other farmers, and address basic inquiries regarding WeLASER operations. As the interest in precision farming is rising within the agriculture community, this "technological culture" and innovative mind-set will increase opportunities for the dissemination of the WeLASER technology. In exchange, the farmers in the "WeLASER-alliance" group get discount in maintenance and other financial supports from WeLASER (customised in advance based on each case).

7.3.5. Key activities

To create the value proposition, service the customer segments and deliver the product to the customer, the following activities are performed by the WeLASER spin-off:

- **Production:** Subsystem integration of the WeLASER equipment will take place within the spin-off facilities. Production of the building blocks is performed by SME partners of this project proposal with whom a good collaboration has been established already. The selection of production processes, right production capacity, production planning, quality and cost control, maintenance and replacement of machines will be managed by spin-off. More details of production can be found in D2.1, D3.1, D4.1 and D5.3.
- **Research and development (R&D):** WeLASER spin-off will focus on (i) research and development of new products (perception systems, weeding tools, vehicles, etc.); (ii) optimisation of existing products; (iii) quality checking; and (iv) tracking of new trends and innovations capable of being used in our products.
- **Marketing and sales:** The project consortium's network as well as the collaboration with partnering dealers will allow a more rapid spread of the company's existence. The marketing



manager is responsible for (i) defining a marketing strategy for the company; (ii) market research; (iii) sales support and customer services; (iv) communications and event organisation (seminars, product launches, exhibitions, etc.). In this regard, quantitative and qualitative market research studies were detailed in Section 2; the record of communications and event organisation during the project was detailed by COAG.

7.3.6. Key resources

To perform the Key Activities mentioned above, following inputs can be used:

- **Physical resources:** There is a need for a building with subsystem integration facilities such as relevant components, computers, software provided by the partners (CSIC, LZH, UNIBO). UNIBO is responsible for maintaining and updating the cloud systems for field data collection. Meanwhile, subsystems such as laser sources and vehicles can be produced at the partner SMEs (FUT and AGC). As production will be on demand, a storage facility is only necessary for WeLASER machines that are used for renting service. Shipment and logistics will be outsourced to a carrier company when needed.
- **Intellectual resources:** several non-physical intangible resources have been obtained during WeLASER namely IP (patents, copy right, trademark), partnerships within the project partners, potential customers identified during the stakeholder events and trade fairs, high potential professionals derived from the education activity (i.e., summer schools and course materials), knowledge derived from the R&D process.
- **Financial resources:** Profitability analysis was performed and reported in Section 4, which provides a more accurate estimation of the necessary investments to create the WeLASER spin-off. Beyond the project, additional financial means can be searched, such as self-financing of the consortium partners for the first production phases, by use of public resources (e.g., [Invest EU](#), [EAFRD](#)) or private financial resources i.e., funds from private investors, venture capital, business angels, investment funds, etc. Some examples of venture capital for agricultural sectors can be found [here](#).

7.3.7. Key partners

On one hand, the Key Partners are those supplying equipment or services:

- FUTONICS: power laser,
- AGC: vehicles,
- CSIC: autonomous robot controller (license agreement),
- LZH: laser weed intervention mechanism (license agreement),
- UNIBO: IoT tech, communication and data management (license agreement).

On the other hand, our dealer network, agronomic consultants, and contractors serve as Key

Partners instrumental in reaching our target customer segments and delivering subsequent services to farmers. It is noteworthy that the engagement with these Key Partners was initiated as part of our multi-actor approach strategy, as meticulously reported in Deliverable 1.3.

7.3.8. Cost structure

Cost structure was presented in more detail in Section 5: Financial plan in which the Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated.

7.3.9. Revenue stream

In this section, we focus on the revenue streams that WeLASER will acquire in the EU market and later the North America market. In the EU, small-sized farmers (defined as those managing less than 50 hectares of land in this report) often operate within constrained investment budgets. However, it's crucial to recognise that the European agricultural landscape primarily consists of these small-scale farmers, making them the largest customer segment for WeLASER. To cater to their resource limitations, our approach involves offering rental services or cooperative solutions, addressing their needs effectively. Specialised companies, including the WeLASER spin-off, will own the equipment and extend it as a service to small farmers or cooperatives, ensuring competitive renting prices.

On the other hand, large-sized farms, defined as those with 50 hectares or more, benefit from the equipment's intensive utilisation, leading to a higher return on investment. Consequently, these farms are more inclined to purchase WeLASER outright. It's worth noting that European organic farms often tend to fall into this larger size category (Willer et al., 2023).

In essence, the revenue model for the WeLASER spin-off hinges on two primary streams:

- Transaction-Based Asset Sales: This stream caters to customers, typically large-scale farmers, who prefer making a one-time payment to acquire the equipment.
- Transaction-Based Revenue from Lending/Renting/Leasing: Tailored for customers, primarily small-scale farmers, who opt to pay a fee for temporary access to the equipment for a predefined period.

It's important to emphasise that service and after-sales support will be diligently provided by the WeLASER team through our established dealer network. Our pricing strategy, optimised to align with the best-worst scenarios, has been meticulously estimated in Section 5: Financial Plan.

7.4. Marketing plan

In this section, the marketing plan of WeLASER and the commercialisation roadmap are detailed.

7.4.1. 4P's marketing plan

The marketing plan of WeLASER is structured based on 4P's elements of marketing mix namely: Products, Pricing, Place, Promotion (Morozova, Litvinova, Rodina, & Prosvirkin, 2015).



7.4.2. Products

The description of the products can be found in the technical reports of the project such as Deliverable 2.1: Laser-based weeding system: Design, integration and TRL assessment, Deliverable 3.1: Weed-meristem perception system: Design, integration and TRL assessment, Deliverable 4.1: Autonomous vehicle (Platform, smart central controller, IoT and cloud computing): Design, integration and TRL assessment and Deliverable 5.3: Equipment integration, testing, evaluation and impact on crops and soil.

7.4.3. Pricing

In assessing the competitive landscape, we have observed a price range among competitors that spans from €350,000 for Weed bot to €1,000,000 for Carbon Robotics (Refer to Table 7.11). To position WeLASER effectively in the market and offer a compelling value proposition, we have determined a price range for the final version of WeLASER to be between €250,000 and €300,000. This strategic pricing range places WeLASER in a competitive position relative to other solutions.

Section 5, which delves into our Financial Analysis, will demonstrate that this chosen price range not only aligns with market competitiveness but also offers organic farmers an economically viable investment option. Specifically, if WeLASER achieves a work rate within the range of 6 to 9 hectares per day, organic farmers can anticipate reaching the breakeven point on their investment within a five-year timeframe.

7.4.4. Place

As previously detailed in Section 1, our initial targets for WeLASER's commercialisation phase are the North European countries. In line with this strategic focus, it is advisable for the WeLASER spin-off to establish its manufacturing facility near these target countries. This localisation effort specifically points to the Netherlands or North Germany, a move designed to significantly mitigate logistical costs associated with product distribution to customers.

Furthermore, a pivotal element in our approach is the utilisation of the extensive dealer networks already established within our target countries. As highlighted in Table 7.12, a comprehensive list of potential dealers is available. Leveraging these networks is paramount as they facilitate direct engagement with prospective customers and provide essential assistance as and when needed.

7.4.5. Promotion

To effectively promote WeLASER products, we have identified a range of channels to consider, each tailored to reach our target audience. These channels encompass:

1. **Social Media:** Platforms such as Facebook, YouTube, and especially LinkedIn, will serve as essential tools for engaging with our audience. These platforms allow us to showcase WeLASER's capabilities, share informative content, and connect with potential users within the agricultural community.

2. **Agriculture-Oriented Journals and Magazines:** We recognise the importance of industry-specific publications in disseminating information. We intend to utilise agriculture-oriented journals and magazines as platforms for conveying the strengths and advantages of WeLASER, as highlighted in our SWOT analysis within Section 1 (refer to Fig. 7.3).
3. **Agricultural Machinery Trade Fairs:** Participating in agricultural machinery trade fairs provides a direct avenue for showcasing WeLASER. These events offer the opportunity for hands-on experiences and interactions with potential users.

To complement our marketing efforts, a plan can be made to produce a comprehensive brochure that includes fact sheets about WeLASER. This collateral will prove invaluable during interaction events such as conferences, trade fairs, and innovation showcases, enabling us to effectively communicate with end-users.

Furthermore, try-out experiences can be offered to prospective users. For instance, during trade fairs, farmers can have the opportunity to monitor WeLASER in action within a field setting. WeLASER will also extend the offer for interested farmers to gain a first-hand experience with the machine, providing options such as:

1. A visit to a WeLASER demo field to witness the machine in action.
2. A visit to the field of early adopters within the WeLASER alliance group, offering insights into real-world usage.
3. Booking a demo at their own farm field, allowing farmers to observe WeLASER in action within their specific context (logistic costs for such demos can be negotiated upon request).

These initiatives are aimed at fostering engagement, building trust, and facilitating informed decisions among potential users of WeLASER.

7.4.6. Commercialisation roadmap

The chronological progression of essential steps, leading to WeLASER's readiness for the market, is outlined in Table 7.13. Throughout the course of the project, WeLASER successfully completed a series of critical milestones including proof of concept, prototyping, technological performance demonstrations, field trials, and validation. In Year 1 after the end of the WeLASER, another follow-up project should continue to address homologation issues, meet regulatory requirements, and optimising the configuration of the system to reach the requirement of cost-effectiveness. It is crucial to highlight that the aspects encompassed within the proof of concept and the design and development of the prototype are aligned with European standards and measurements. This strategic consideration ensures seamless approvals and compliance with regulatory homologation requirements.



Table 7.13. Steps to get the system ready for the market

Steps	WeLASER			Year 1		Year 2		Year 3	
Proof of concept									
Prototyping									
Demonstration/field trials									
Validation									
Homologation issues, regulatory requirements									
Assessing cost effectiveness									
Manufacturing									
WeLASER units launch in the EU market									

The commercial phases, as integral components of the project proposal, were partially conducted during the final period of the WeLASER project. The prototype of WeLASER needs public demonstrations aiming at introducing the robotic platform through diverse channels. In this regard, WeLASER partners, in accordance with the plans outlined in WP6, have actively engaged in technical exhibitions and agricultural fairs. These platforms serve as invaluable opportunities for companies and farmers, who constitute key stakeholders, to gain first-hand insights into how the WeLASER system works. Additionally, these engagements facilitated the collection of crucial feedback and the establishment of initial commercial relationships. In further alignment with this objective, field days were scheduled to provide the public with a hands-on understanding of the technology's most relevant features and its practical functionality under real field conditions. These promotional activities should be continued after the course of the WeLASER project. Especially, commencing from year 2 following the conclusion of the WeLASER project and prior to the first sale, field demonstrations should be conducted for (groups of) farmers of interest. These efforts are designed to increase awareness and cultivate trust among end-users.

7.5. Financial plan

The detailed financial plan is only accessible for the consortium members, project officers and external reviewers

7.6. Exploitation plans for individual subsystems

In this section, we discuss the exploitation plans for the individual subsystems of WeLASER. During the project, we identified five main subsystems namely, weed-meristem recognition systems, laser sources autonomous vehicles, smart navigation management, IoT devices, and the cloud system.

7.6.1. Weed Meristem Recognition system

Section	Detail
Characterisation	<p>Configuration of the weed-meristem recognition system built in the WeLASER project.</p> <ul style="list-style-type: none"> - On the hardware side, there is a 3D camera and a computer specialised in AI, which is especially designed for mobile applications including low power requirement coupled with high AI computing power. - On the software side, an object detection network, a deep learning tracking network and a network for target point localisation are connected by means of the NVIDIA Deepstream SDK. <p>Note: For further commercialisation, the solution would need to be detached from this framework or further investigated to see if this is possible when using Deepstream is needed. Furthermore, it is necessary to include programming image processing methods and a job manager.</p>
Value propositions	<p>As a component of WeLASER:</p> <ul style="list-style-type: none"> - It can distinguish the crops selected in WeLASER from weeds, track them and give target locations in real world coordinates to the laser system. <p>As an independent system:</p> <ul style="list-style-type: none"> - The target coordinates can similarly be provided to other methods of weed control, e.g., mechanical methods or spot spraying. - Other crops can be detected with additional training. - Further differentiation of weeds can be made. This also requires additional training.
Potential customers	<p>End-user 1: Farmers</p> <p>Benefits for end-user 1:</p> <ul style="list-style-type: none"> - As a stand-alone system, the perception system can be used to determine the condition (weed infestation) of the farmland. Likewise, position data can be provided to facilitate subsequent (manual) treatment. <p>End-user 2: Machinery developers</p> <p>Benefits for end-user 2:</p> <ul style="list-style-type: none"> - As an input component for weed treatment methods - As an independent evaluation tool
Commercialisation plan	<p>If there is a concrete demand from companies, Laser Zentrum Hannover (LZH) can be the one who develops and commercialises the recognition systems. LZH accepts industrial orders in other areas of the company. However, since there is still a need for additional research, joint research projects would be prioritised.</p>
Intellectual	<p>Some of the training data is confidential because it comes from other LZH</p>

property	research projects. Detailed patent issues are currently being clarified.
Scientific dissemination	One or two papers explaining how to build the Alare foreseen. At least, the unlabelled image data from WeLASER will be available in dataset publications. Whether labelled images will be published as well is currently under discussion.
Risk	Low market demand. In this regard, correctness and reliability of the detections must be communicated. Also, benefits for the end-users (with/without laser tool) must be communicated.


7.6.2. Laser source

Section	Details
Characterisation of the subsystem	<p>Configuration of the laser sources built in the WeLASER project.</p> <ul style="list-style-type: none"> - 2µm Fibre Laser with continuous output powers between 200W and 500W and pulsed output powers up to 800W. Output via optical high-power connector. - Scanner with 14mm Aperture and integrated high-power mirrors for 2µm wavelength and protection window. - Scanner-Box containing Collimator, Beam Splitter and aiming beam. - Power supply for 48V operation - Chiller for 48V operation.
Value propositions	<p>As a component of WeLASER:</p> <ul style="list-style-type: none"> - The laser above mentioned can destroy weed plants in 5 to 10 milli seconds time if a proper weed detection system is used. <p>As an independent system:</p> <ul style="list-style-type: none"> - The Scanner and Scanner-Box above mentioned were developed outside the WeLASER project. - Power supply above mentioned. - Chiller above mentioned. <p>No substantial modification is necessary</p>
Potential customers	<p>End-user: Machinery developers</p> <p>Benefits:</p> <ul style="list-style-type: none"> - Complete optical system. - Ready for integration into a robot. - All accessories are available. - Reliable system used in various industrial applications. - Technical support from experienced optic engineers.
Unique selling points	<ul style="list-style-type: none"> - Highest 2µm power on the market. - Eye save wavelength. - Lowest energy (< 2J) per plant for destruction compared to all other systems. - Optimum absorption depth (0,5mm) in a small plant volume @ 2µm wavelength

	<ul style="list-style-type: none"> - Small focus (~0,5mm) on plant in 1m distance -> high power density - Long lifetime (>20000h) - No beam reflection on plants (like UV light) destroying crops. - Highest electric on/off switching speed of 2µm lasers (~10µs). - Low price in quantities (< 40US\$/W). - High energy efficiency (>20%).
Commercialisation plan	Futonics Laser GmbH (FUT) will continue to develop and commercialise the current laser system.
R&D	For the next step, FUT will continue to pack the system into water- / air-tight housing. This can be done in 1 year.
Intellectual property	Two patents for high precision and fast detection of weed are pending.
Scientific dissemination	Not foreseen.
Risk	Low market awareness of laser-weeding and the limited production capacity to reach 1000 systems per year to achieve a lower production cost.



7.6.3. Autonomous vehicle

Section	Details																		
Characterisation	<p>Configuration of the autonomous vehicle (CAROB) built in the WeLASER project:</p>  <table border="1"> <tr> <td>Type of robot</td><td>Autonomous tracked vehicle (differential type)</td></tr> <tr> <td>Steering mechanism</td><td>Sliding steering</td></tr> <tr> <td>Propulsion system</td><td>Motor and batteries</td></tr> <tr> <td>Maximum speed</td><td>6 kph</td></tr> <tr> <td>Position accuracy</td><td>± 0.015 m</td></tr> <tr> <td>Positioning system</td><td>GNSS with Real-Time Kinematics (RTK), IMU</td></tr> <tr> <td>Dimensions</td><td>1.76 m × 1.5 m × 1.647 m (width × length × height)</td></tr> <tr> <td>Distance between tracks</td><td>0.80 m - 2.20 m (adjustable)</td></tr> <tr> <td>Minimum distance for crops</td><td>1.48 m</td></tr> </table>	Type of robot	Autonomous tracked vehicle (differential type)	Steering mechanism	Sliding steering	Propulsion system	Motor and batteries	Maximum speed	6 kph	Position accuracy	± 0.015 m	Positioning system	GNSS with Real-Time Kinematics (RTK), IMU	Dimensions	1.76 m × 1.5 m × 1.647 m (width × length × height)	Distance between tracks	0.80 m - 2.20 m (adjustable)	Minimum distance for crops	1.48 m
Type of robot	Autonomous tracked vehicle (differential type)																		
Steering mechanism	Sliding steering																		
Propulsion system	Motor and batteries																		
Maximum speed	6 kph																		
Position accuracy	± 0.015 m																		
Positioning system	GNSS with Real-Time Kinematics (RTK), IMU																		
Dimensions	1.76 m × 1.5 m × 1.647 m (width × length × height)																		
Distance between tracks	0.80 m - 2.20 m (adjustable)																		
Minimum distance for crops	1.48 m																		
Value propositions	<p>As a component of WeLASER:</p> <ul style="list-style-type: none"> - Acquisition of GNSS-RTK positioning and ensure safety with AGCbox geofencing technology. - Receive navigation commands and transmission to actuators for autonomous guidance. - Carry the laser weeding systems. <p>As an independent system:</p> <ul style="list-style-type: none"> - Ensure safety and geofencing. - Autonomous navigation - Carry different agricultural tools and sensors 																		
Customer segment	<p>End-user 1: machinery manufacturers</p> <p>Benefits for end-user 1:</p> <ul style="list-style-type: none"> - Equip their machines with safe geofencing technology. - Implement accurate positioning technology to their machines. <p>End-user 2: farmers</p> <p>Benefits for end-user 2:</p> <ul style="list-style-type: none"> - Automate labour-intensive activities. - Map their parcel, plants rows and obstacles. - Save money, time and energy to focus on more added-value activities. 																		
Unique selling points	<ul style="list-style-type: none"> - The only geofencing technology in the world that reaches the EU Product Liability Directive (PLD) and ensures that the robot will not go out of its working area. - Adaptability to many configurations and to farmers' or machinery manufacturers' needs 																		
Commercialisation plan	Agreenculture and Pellenc Group will continue to commercialise the current autonomous vehicle.																		
Intellectual property	Not applicable.																		
Scientific dissemination	Not foreseen.																		
Risk	Low market demand.																		

7.6.4. Smart Navigation Manager (SNM)

Section	Details
Characterisation	<p>Configuration of the Smart Navigation Manager (SNM) built in the WeLASER project (more details in Deliverable 4.1):</p> <p>The Smart Navigation Manager (SNM) is the system responsible for driving the autonomous robot and coordinating all other modules and systems. The SNM is mainly split into:</p> <ul style="list-style-type: none"> – Hardware: – The central Controller – Software: – the Smart Operation Manager, – the Central Manager, which also includes the HMI, and – the Communication with Subsystems.
Value propositions	<p>As a component of WeLASER:</p> <ul style="list-style-type: none"> • The Smart Operation Manager. It is allocated in the cloud and contains: <ul style="list-style-type: none"> - the Global Mission Planner and Supervisor, - the Map Builder, and - the module for managing the IoT and Cloud Computing System. • The Central Manager. It is located onboard the Mobile Platform and contains: <ul style="list-style-type: none"> - the Obstacle Detection System, - the Local Mission Planner and Supervisor, and - the Guiding System <p>As an independent system:</p> <p>The Central Manager can be adapted to the mobile platforms of any manufacturer. It would consist of:</p> <ul style="list-style-type: none"> - the Obstacle Detection System, - the Local Mission Planner and Supervisor, and - the Guiding System
Potential customers	<p>End-user 1: mobile platform manufacturers</p> <p>Benefits for end-user 1:</p> <ul style="list-style-type: none"> - Autonomous robot relying partially on GNSS (Global Navigation Satellite System) to navigate, including vision-based crop row detection to handle row-following. - Enabling navigation throughout the entire farm, including obstacle avoidance. - Enabling communication with the cloud, using FIWARE data models for scalability and adaptability to handle third-party maps and farm management systems. <p>End-user 2: farmers</p> <p>Benefits for end-user 2:</p> <ul style="list-style-type: none"> - Friendly and easy-to-use web-based HMI. - Offline map generation (without the need for extra antennas).
Commercialisation plan	<p>CSIC, as a research institution, does not directly commercialise its outcomes. Instead, it licenses its results to third parties for commercialisation.</p>
Intellectual property	<ul style="list-style-type: none"> – Copyright (Blockchain and notarial protection) of the source code “Digital Representation of Agricultural Environments to Navigate with Autonomous Robots”.

	<ul style="list-style-type: none"> – Patentability study of “A system and procedure for vision/perception of crop lines for guiding autonomous robots in agricultural tasks, especially in laser weed removal tasks” Detailed in D6.8).
Scientific dissemination	<ul style="list-style-type: none"> – Luis Emmi, Roemi Fernández, Pablo Gonzalez-de-Santos, Matteo Francia, Matteo Golfarelli, Giuliano Vitali, Hendrik Sandmann, Michael Hustedt and Merve Wollweber <ul style="list-style-type: none"> ○ Exploiting the Internet Resources for Autonomous Robots in Agriculture ○ Agriculture 2023, 13, 1005. https://www.mdpi.com/2077-0472/13/5/1005 – Jesus Herrera, Luis Emmi, and Pablo González-de-Santos <ul style="list-style-type: none"> ○ Enabling navigation for autonomous robots in early-stage crop growth ○ World FIRA 2021, Toulouse, France, 7-9 December 2021 – Luis Emmi, Jesus Herrera-Diaz and Pablo Gonzalez-de-Santos <ul style="list-style-type: none"> ○ Toward Autonomous Mobile Robot Navigation in Early-Stage Crop Growth ○ ICINCO 2022: 19th International Conference on Informatics in Control, Automation and Robotics ○ Lisbon, Portugal ○ 14-16 July 2022 ○ 11 – Luis Emmi, Rebeca Parra and Pablo Gonzalez-de-Santos <ul style="list-style-type: none"> ○ Digital representation of smart agricultural environments for robot navigation ○ HAICTA 2022: 10th International Conference on ICT in Agriculture, Food & Environment ○ Athens, Greece ○ 22-25 September 2022
Risk	Low market demand.

7.6.5. IoT devices

Three IoT devices are developed in the WeLASER project namely the E-FENCE, weather station, and CO2 Respirometer.

IoT device 1: E-FENCE

Section	Answers
Characterisation	<p>Configuration (more details in Deliverable 4.1)</p> <ul style="list-style-type: none"> - Front and rear camera nodes on the field robot (powered by the robot) - Field-edge camera nodes (powered by a battery and a photovoltaic panel) - Field bridge: 8 W lead battery and a larger photo Voltaic panel. <p>Each node includes a low-power Radio Frequency (RF) system that the bridge used to awake the filed nodes to collect measures and images and update the firmware.</p>
Value propositions	<p>As a component of WeLASER:</p> <ul style="list-style-type: none"> - The camera system (attached on WeLASER) captures field images and keeps the record of the mission on the cloud to keep track of the activity of the robots on the surface. - Field-edge camera: intrusion alert, RF awakening, snapshots, send images and alert to ensure robot safety and security. <p>As an independent system:</p> <ul style="list-style-type: none"> - An electronic fence for users of autonomous vehicles. - Surveillance of worksites. - Monitoring of crops, animals and insects
Customer segment	<p>End-user 1: Users of autonomous field robot Benefits for end-user 1: Ensure robot safety and security.</p> <p>End-user 2: Farmers and Researchers Benefits for end-user 2: Monitor crops</p>
R&D and commercialisation plan	<p>The calibration of the system still needs to be optimised and scaled. Currently, UNIBO is contacting interested manufacturers to discuss the potential of commercialisation of this subsystem.</p>
Intellectual property	<p>A patent was applied for E-FENCE by UNIBO, in which UNBIO is the only owner of the patent and will claim 50% of the right of income (if commercialised).</p>
Scientific dissemination	<p>Not foreseen.</p>
Risk	<p>Low market demand.</p>

IoT device 2: Weather station

Section	Answers
Characterisation	<p>Configuration (more details in Deliverable 4.1)</p> <ul style="list-style-type: none"> - Autonomous weather station: built-in air temperature and relative humidity, wind velocity and direction, multi-depth soil water content and temperature probe and rain characterisation sensor.
Value propositions	<p>As an independent system:</p> <ul style="list-style-type: none"> - Collect field data regarding air temperature, relative humidity, wind velocity and direction, soil water content, temperature probe, rain.
Customer segment	<p>End-user 1: Farmers and farmers' organisations Benefits for end-user 1:</p> <ul style="list-style-type: none"> - site-specific observation

	End-user 2: researchers
R&D and commercialisation plan	The system still needs to be modified to regional conditions. Currently, satellite information does not provide sufficient data (such as temperature of micro-climate) and the soil data is missing due to the lack of soil probe. Hence, to have a better forecast system, more dense and rich data are required. Depending on the requirement of end-users, R&D can take from 3 months to a few years to be ready for commercialisation. This development to achieve TRL9 requires more funding from private investors. UNIBO is scouting for companies to commercialise the current weather station.
Intellectual property	Not applicable.
Scientific dissemination	One publication (Congress in Stockholm)
Risk	Low market demand.

IoT device 3: CO₂ Respirometer (ETRometer)

Section	Answers
Characterisation	Configuration (more details in Deliverable 4.1)
Value propositions	As an independent system: <ul style="list-style-type: none"> - Estimate soil and vegetation respiration by means of the measurement of CO₂, relative humidity, and temperature.
Customer segment	End-user: Researchers, Farm advisors Benefits: Building observation network on fluxes of CO ₂ and water from surfaces.
R&D and commercialisation plan	Currently the CO ₂ respirometer is used for research purposes. The commercialisation for mass production is not foreseen.
Intellectual property	No patent.
Scientific dissemination	One publication with Open Access. Link: https://www.mdpi.com/1424-8220/23/5/2647

7.6.6. Cloud system

Section	Answers
Characterisation	Configuration: <ul style="list-style-type: none"> - The hardware/software characteristics are summarised in D4.1
Value propositions	As a component of WeLASER: <ul style="list-style-type: none"> - Provide a GUI to control the robot and to visualise/check its status online. - Collect and store data and images for posterior analysis. - Reply mission data and provide dashboards to visualise sensor data. As an independent system: <ul style="list-style-type: none"> - Collect and store data and images for precision agriculture. - Reply mission data and provide dashboards to visualise sensor data. Note: No modification is necessary to make the system independent.
Customer segment	End-user 1: Farmer Benefits for end-user 1: <ul style="list-style-type: none"> - Visualise key performance indicators on the status of a specific farm. - Computer historical trends of sensor data and key performance indicators End-user 2: Precision farming technician Benefits for end-user 2: <ul style="list-style-type: none"> - Plan the robot missions.
Unique selling points	<ul style="list-style-type: none"> - The ecosystem allows the control of robot and robot mission data. - Extraction of Key Performance Indicators (KPIs) related to robotic and sensor devices.
Commercialisation and R&D plan	UNBIO will oversee the commercialisation of this cloud system. Currently, the features related to privacy and access control must be improved. It is not important who is selling the product, but it is important to have a software house evolving and maintaining the product.
Intellectual property	Software <i>per se</i> cannot be subject of patents
Scientific dissemination	Three publications: <ul style="list-style-type: none"> - L Emmi et al. Exploiting the Internet Resources for Autonomous Robots in Agriculture. Agriculture 13 (5), 1005 - G Vitali et al. Crop management with the IoT: An interdisciplinary survey. Agronomy 11 (1), 181

	<ul style="list-style-type: none"> - M Francia et al. Data models in precision agriculture: from IoT to big data analytics. ECPA 2023 Two further submissions related to the cloud platform are foreseen.
Risk management	Insufficient functionality with regards to commercial platforms such as AGRICOLUS

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9. ANNEXES

9.1. Annex 1 – WeLASER Templates


9.1.1. POWER POINT format template for presentations






Title

- **Title 2**
 - ☐ Title 2.1
 - ☐ Title 2.2
- **Title 3**
 - ☐ Title 3.1
 - ☐ Title 3.2







9.1.2. WORD format template for deliverables








Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

DX.Y – Title

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Co-funded by the Horizon 2020 programme

DX.Y – Title

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DX.Y – Title

Acknowledgement

WeLASER is a project co-funded by the Horizon 2020 Research and Innovation Programme of the European Union under the call "Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bio-economy" and the topic "Innovative health approaches and alternatives to pesticide use" (H2020-SFS-64-2019-2020) Grant agreement N. 101000256

Disclaimer

The views and opinions expressed in this document are solely those of the project, neither of the European Commission.


Deliverable number	DX.Y
Work package Task	WP.Y
Work package leader	CSIC
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Dissemination level **	
Status - Version	VX
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Approval by	XXXXX XXXXX

* Report Deliverable Dissemination, Other


** Public, Restricted or other appropriate classification (including the Commission, Services), Restricted or a group specified by the consortium (including the Commission, Services, Confidential, Restricted, Confidential, Restricted, Confidential, Restricted)

3

9.1.3. WORD format template for the agendas and minutes of the meetings

 Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools		
AGENDA OF THE KICK-OFF MEETING AND THE GENERAL ASSEMBLY		
Vidiconference October X, 2020		
DAY 1 - October X, 2020		
10:00 – 10:15	Welcome and WeLASER project overview	Pablo GONZALEZ-DE-SANTOS (Project coordinator)
10:15 – 10:30	EC and H2020 general information	Silvia GEMINI (EC project officer)
10:30 – 11:30	Presentation of the consortium A five-minute presentation per beneficiary following the template WeLASER-Beneficiary presentation (format).pptx. Please, use a few slides with the content: 1.- Description of the organization. 2.- Main projects and products of the group and 3.- Role in WeLASER.	1-CSK: Pablo GONZALEZ-DE-SANTOS 2-FUT: Karsten SCHOLLE 3-LZH: Merve WOLLWEBER 4-UCPH: Christophe AUBE 5-AGC: Giuliano VITALI
11:30 – 11:40	Break	
11:40 – 13:00	<div style="border: 2px solid red; padding: 10px; text-align: center;"> <h1 style="color: red; margin: 0;">TEMPLATE DRAFT</h1> </div>	
	Final impact assessment perception system	Karsten SCHOLLE (FUT)
	WP4 - Autonomous vehicle for laserweeding	Merve WOLLWEBER (LZH)
	WP5 - Industrial integration and evaluation	Christophe AUBE (UCPH)
	WP6 - Knowledge spread and innovation management	Pablo GONZALEZ-DE-SANTOS (CSK)
		Giuliano VITALI (UNIBO)

9.1.4. WORD format template for newsletters



Issue-N. X₁
September 2021

Contributing authors: §

Inside this issue: §

Welcome to the second issue of the WeLASER newsletter. §

WeLASER first face-to-face meeting. §

WeLASER Second Stakeholder Event. §

AGRICULTURE delivers the first mobile platform CSK. §

WeLASER participation in EC clusters. §

Integration of the WeLASER IoT network, cloud computing tools and Smart Navigation Manager. §

Preparing WeLASER test and demo field. §

Communication and dissemination activities. §

CSK FUTONICS LZH UNIVERSITY OF COPENHAGEN

AGRICULTURE COAG

Salto de sección (Continúa)

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On April 8 and 9, 2021, WPS leader, Luis GARCIA (CSK) visited AGRICULTURE (AGC) in Toulouse, France. This was the first face-to-face meeting between two WeLASER partners. The two-day meeting was devoted to organize and plan the delivery of the first mobile platform at the coordinator facilities to start the system integration. §

AGC provided training on several platforms control, management and maintenance aspects for the commissioning of the robot in the field (base station, remote control, etc.). §

AGC provided training on several platforms control, management and maintenance aspects

Salto de sección (Continúa)

Title-1§

WeLASER newsletter is a six-monthly publication devoted to engage and keep all potential actors (farmers, agronomists, researchers, engineers, policymakers, students, business institutions and governments, investors, citizens, etc.) informed about the progress and activities of WeLASER, a project funded under the Horizon 2020 programme of the European Commission in the call "Integrated health approaches and alternatives to pesticide use (SFS-04-2019)". The project attempts to eradicate health risks and environmental adverse effects associated with the use of herbicides by using laser and ICT technologies along with autonomous navigation systems. §

In the second issue, you are being informed about the project's objectives, expected results and the activities carried out during the second semester of the project development (start 2021 to September 2021). §

Title-2§

On April 8 and 9, 2021, WPS leader, Luis GARCIA (CSK) visited AGRICULTURE (AGC) in Toulouse, France. This was the first face-to-face meeting between two WeLASER partners. The two-day meeting was devoted to organize and plan the delivery of the first mobile platform at the coordinator facilities to start the system integration. §

AGC provided training on several platforms control, management and maintenance aspects for the commissioning of the robot in the field (base station, remote control, etc.). §

AGC provided training on several platforms control, management and maintenance aspects

Report of the cluster meeting §

every year for newly funded projects. The cluster meeting main aim is to bring together thematically linked projects and relevant stakeholders to foster networking, cooperation and exploitation of results. §

In this event, twelve projects related to the H2020 Plant Health were presented and discussed to an audience of over 75 attendees. §

The WeLASER project coordinator gave a presentation on the project description, communication, dissemination and exploitation results and possible synergies with other projects. The Technical and Innovation Manager, Merve WOLLWEBER (LZH), the Dissemination manager, Pablo GONZALEZ (CSK) and WPS (Knowledge spread and innovation management) leader, Giuliano VITALI (UNIBO), also attended the meeting. §

Title-4§

UNIBO and CSK have given the first steps for integrating the WeLASER IoT network and cloud computing tools with the Smart Navigation Manager. The Cloud Computing architecture, powered by FITSIAE, allows the integration of IoT and robotic data, enabling the monitoring and supervising of weeding tasks and robot missions. The following Figure illustrates an example of a robot simulation generating mission data and a visual dashboard representing the location of the robot within the field. §

In addition, UNIBO has designed a mesh-based networking system, which is under testing, with the purpose of supplying IoT connectivity and

Project Title:
Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools

Coordinator:
Horizon Europe Research Council (CSK)

Duration:
36 months (October 1, 2020 to September 30, 2023)

Funding scheme:
EC Horizon programme - Innovation Action (Grant Agreement No. 101017734)

Project website:
WeLASER project off

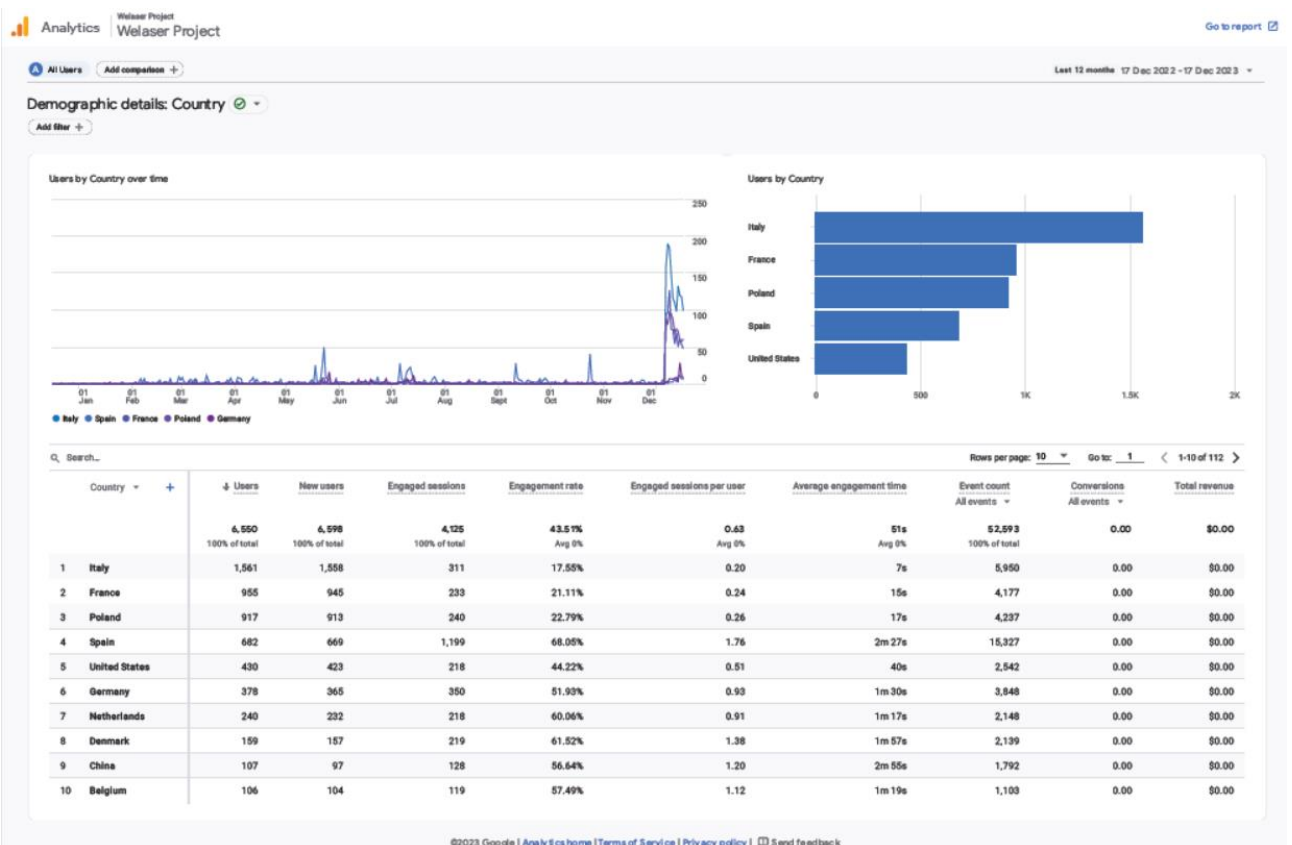
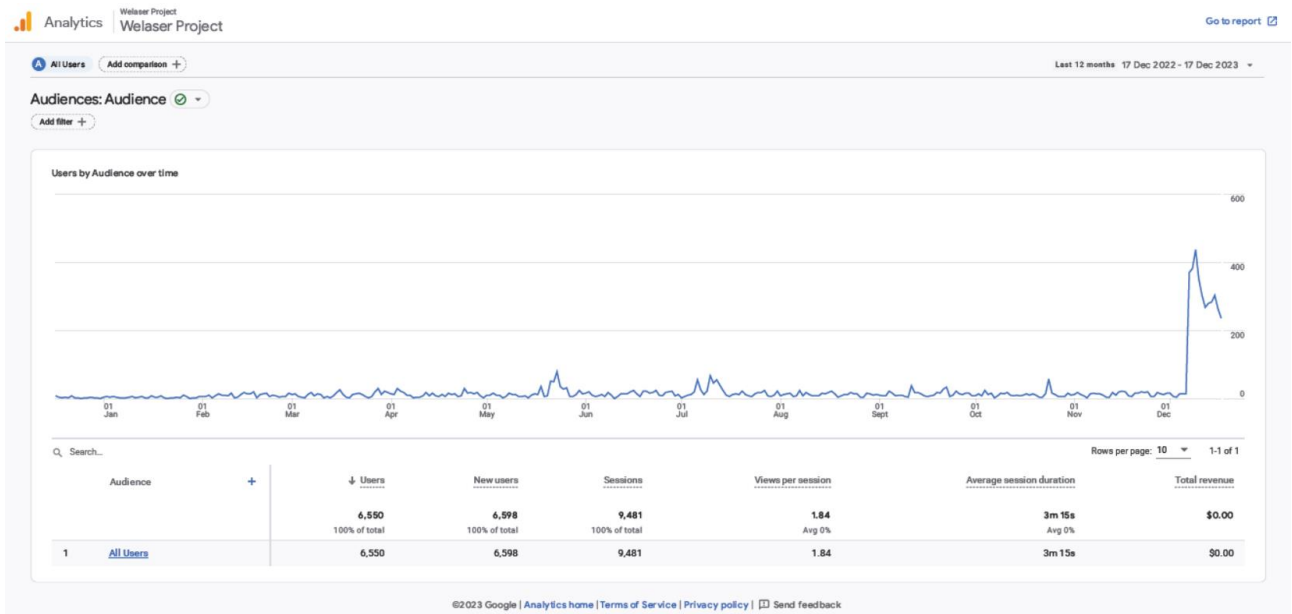
Social media and channels:

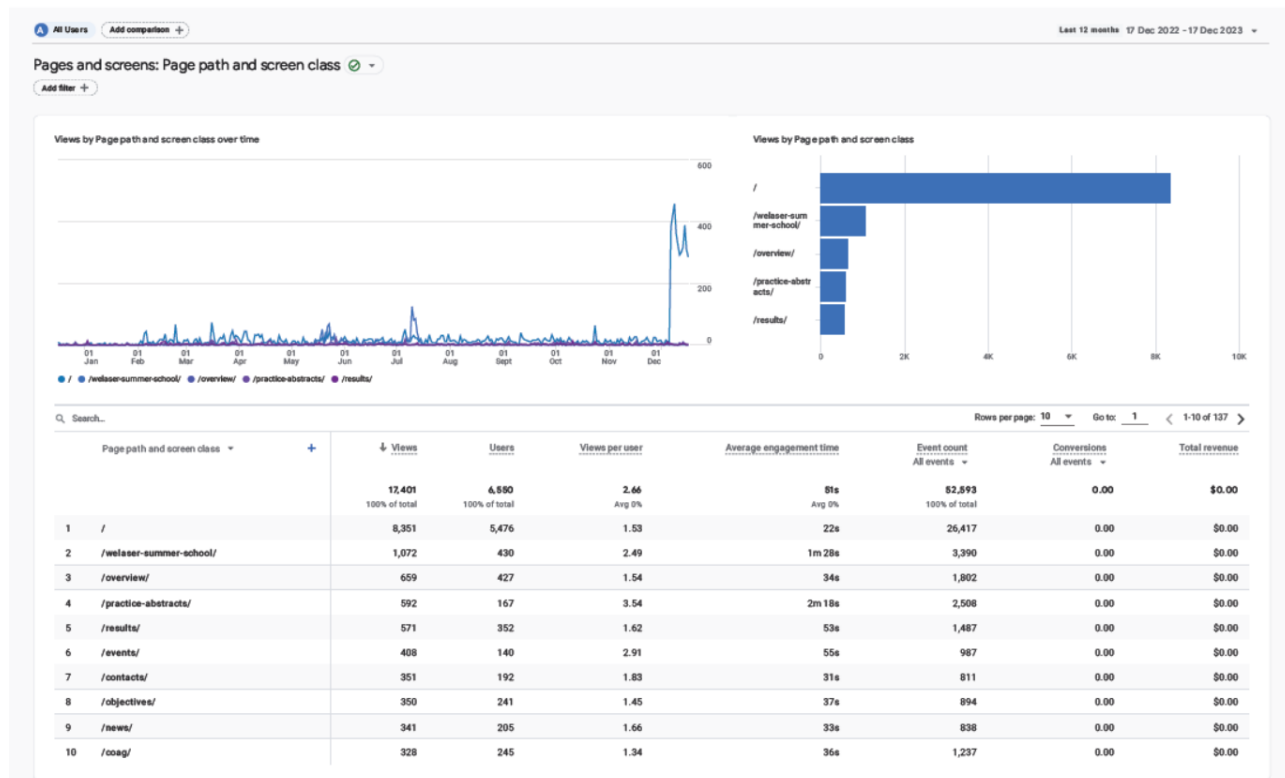
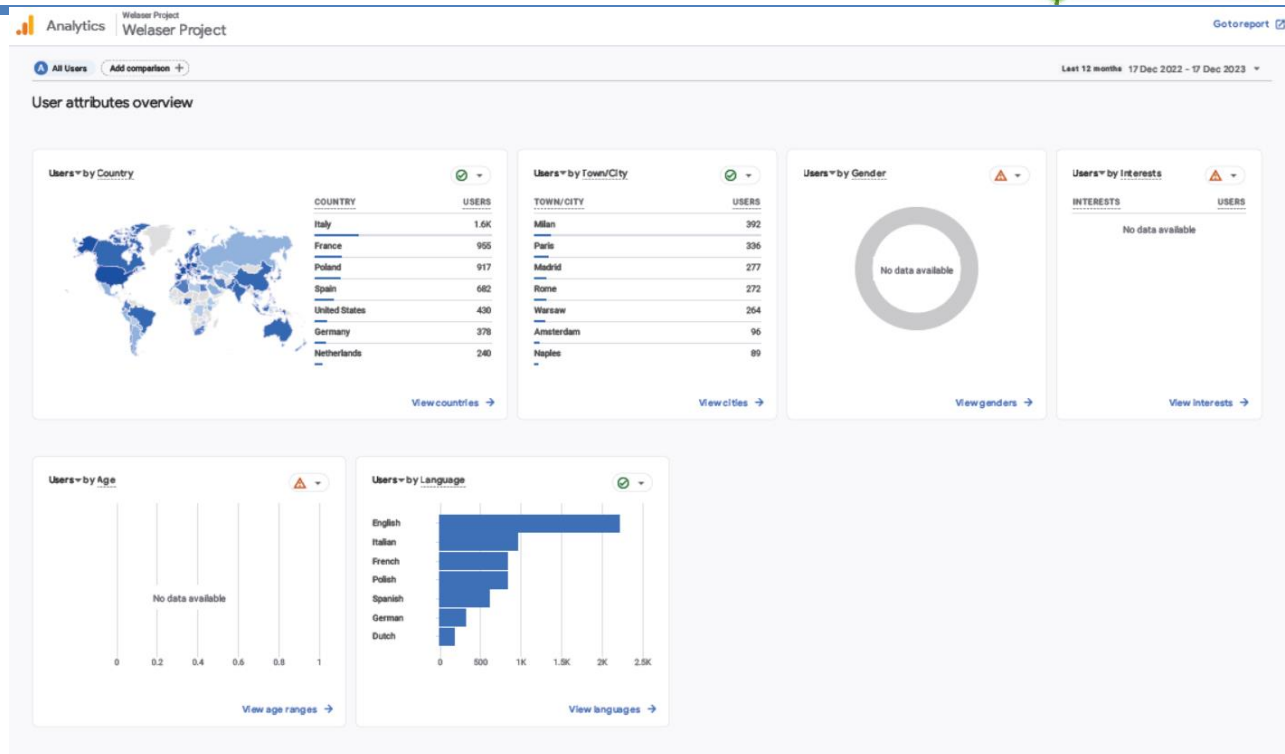
Consortium:

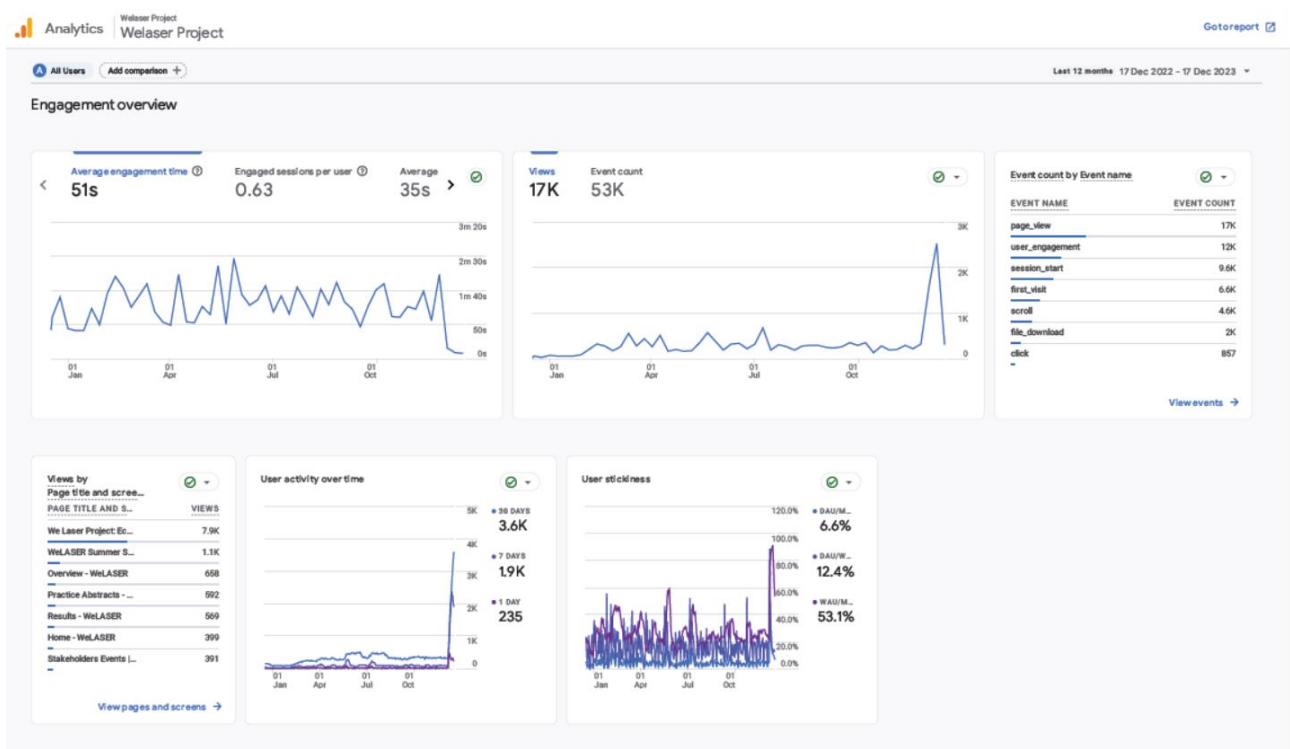
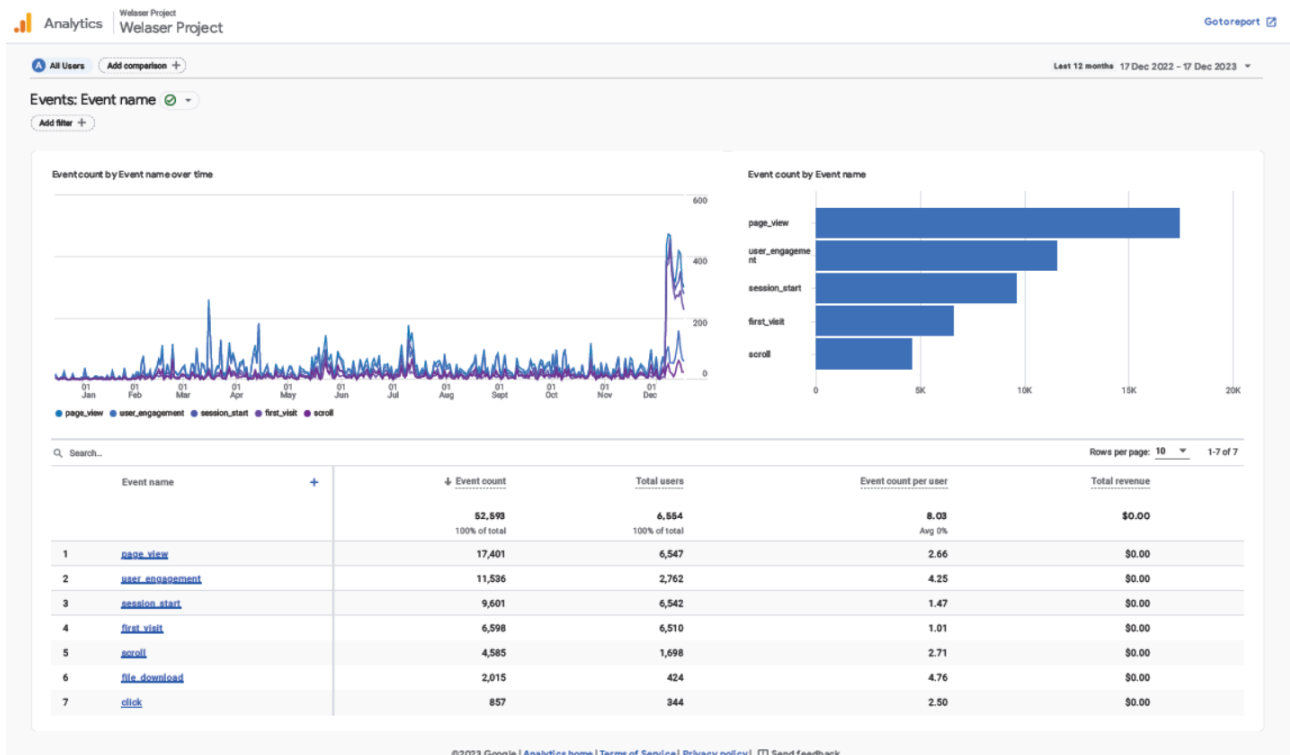
1. CSK - Spanish National Research Council, Spain
2. FUT - Fraunhofer Laser Center, Germany
3. LZH - Laser Zentrum Hannover AG, Germany
4. UCPH - University of Copenhagen, Denmark
5. AGC - Agriculture, France
6. UNIBO - University of Bologna, Italy
7. UNIBO - University of Bologna, Italy
8. FITSIAE - Institute for Energy Efficient Areas, Poland
9. UNIBO - University of Bologna, Italy
10. VSB - Vrije Universiteit Brussel, The Netherlands

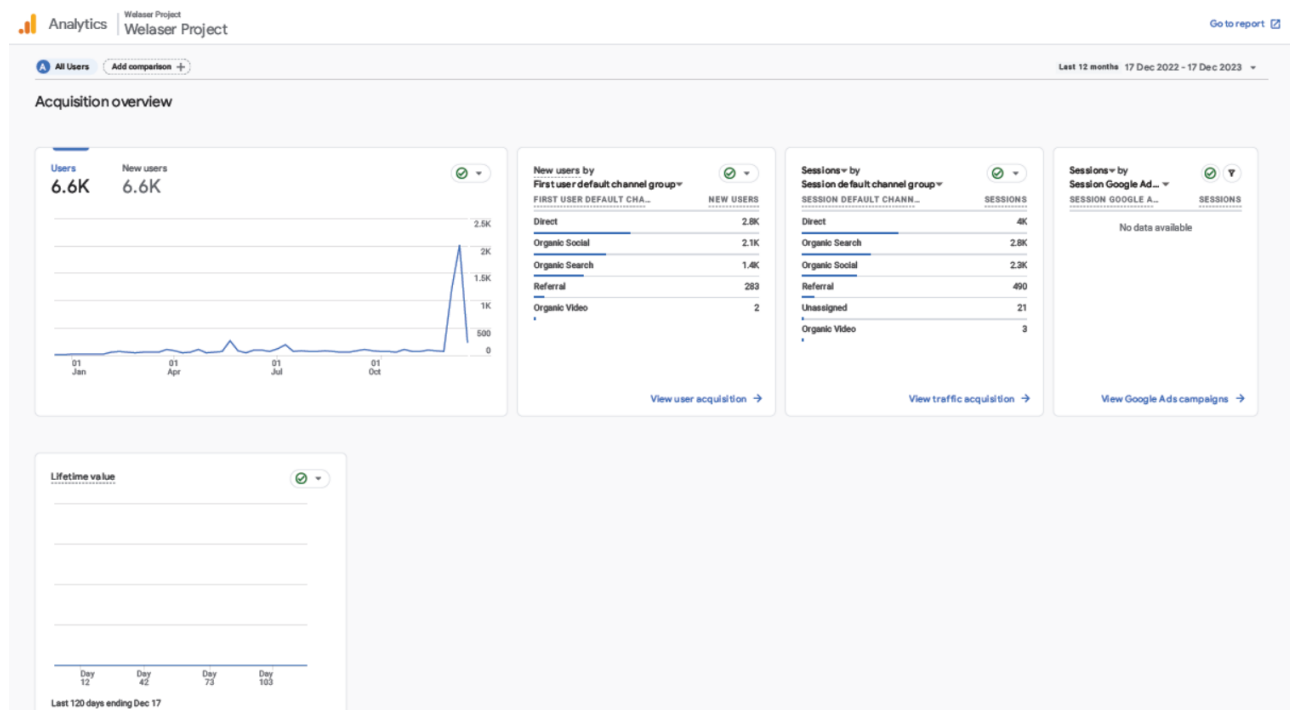
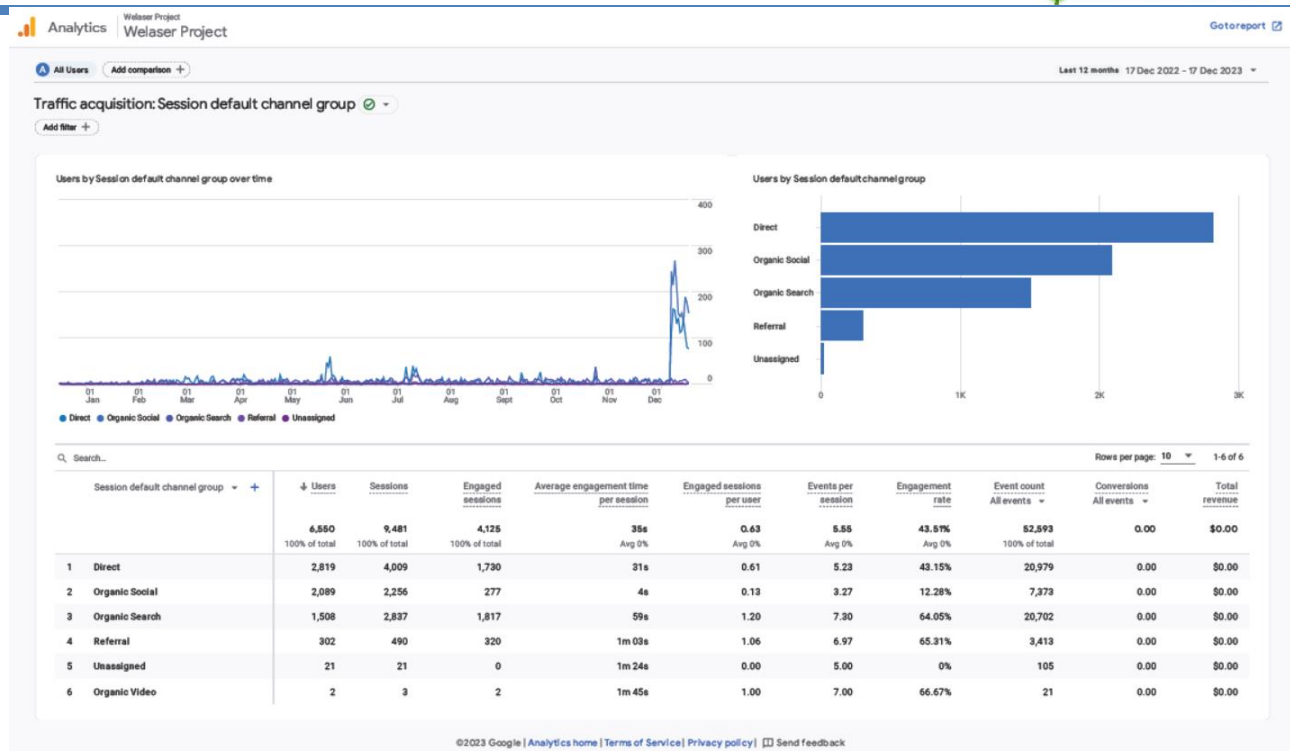
9.2. Annex 2 – WeLASER websites and social media statistics

9.2.1. Website

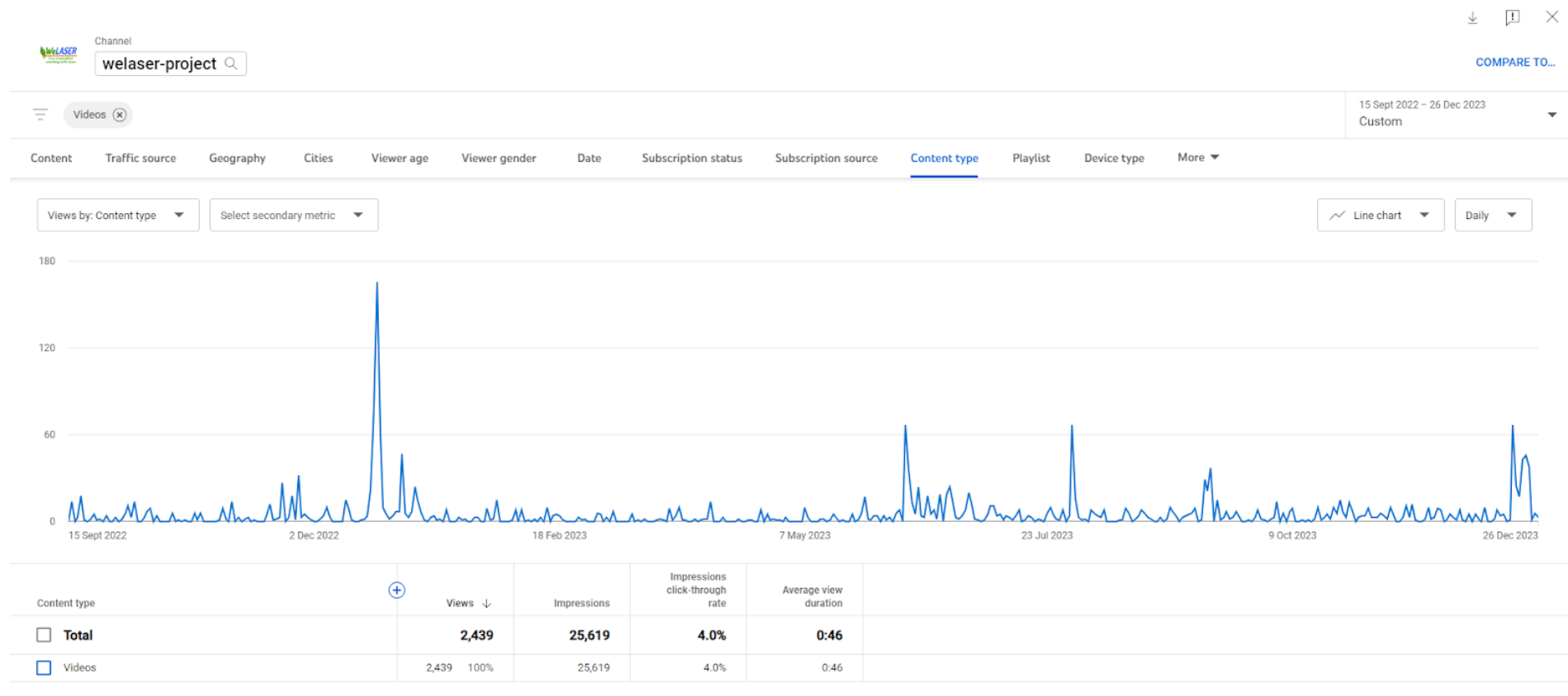


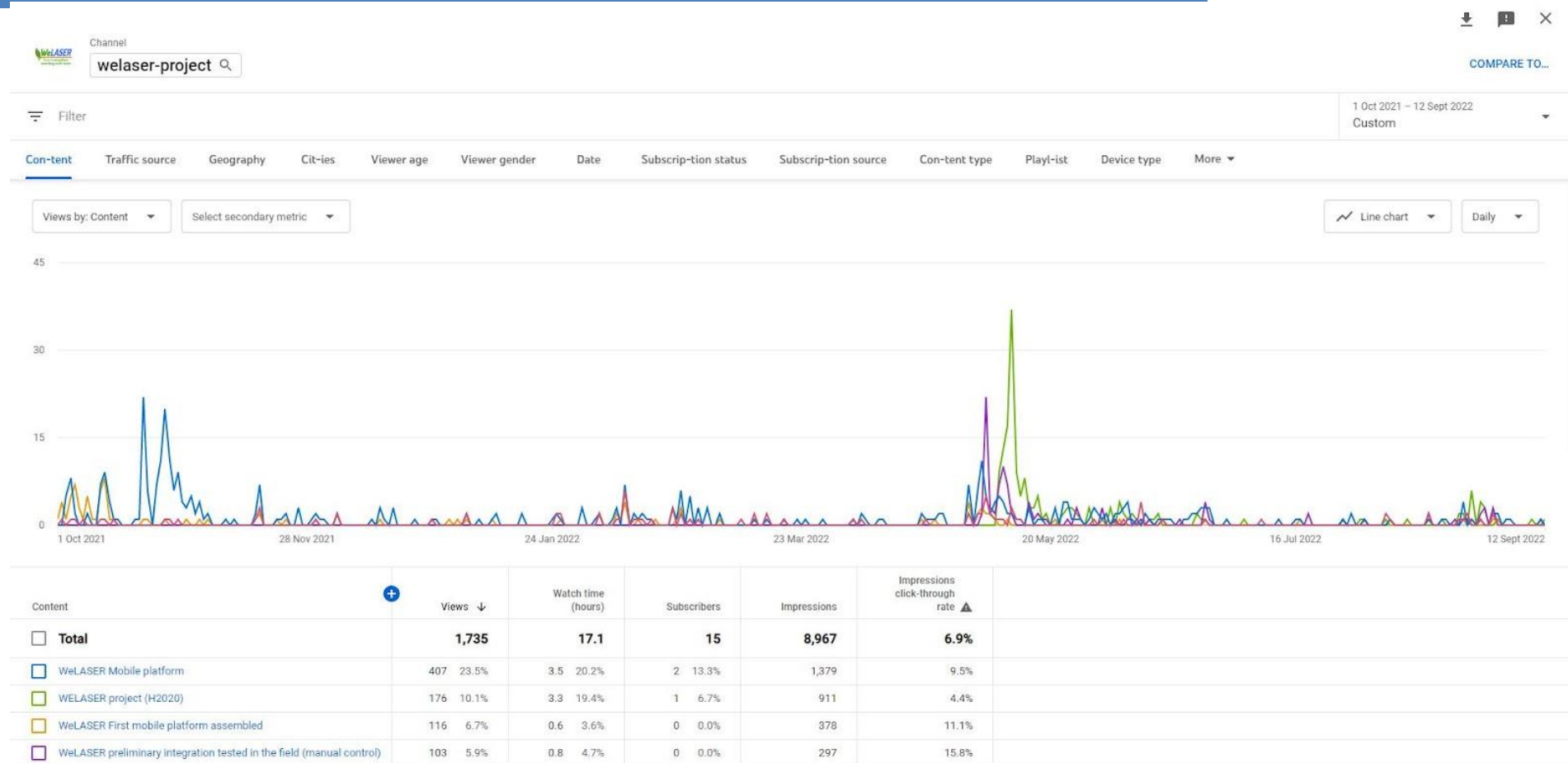


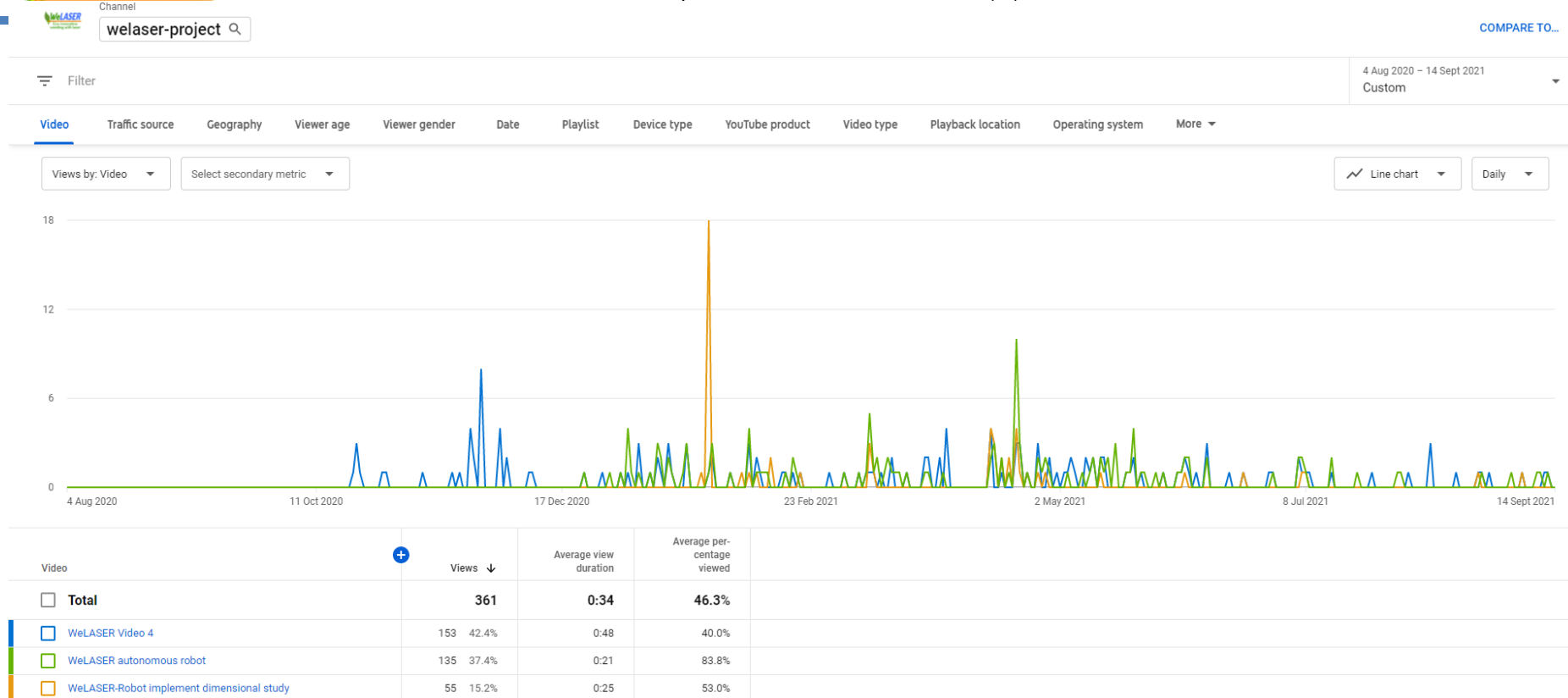




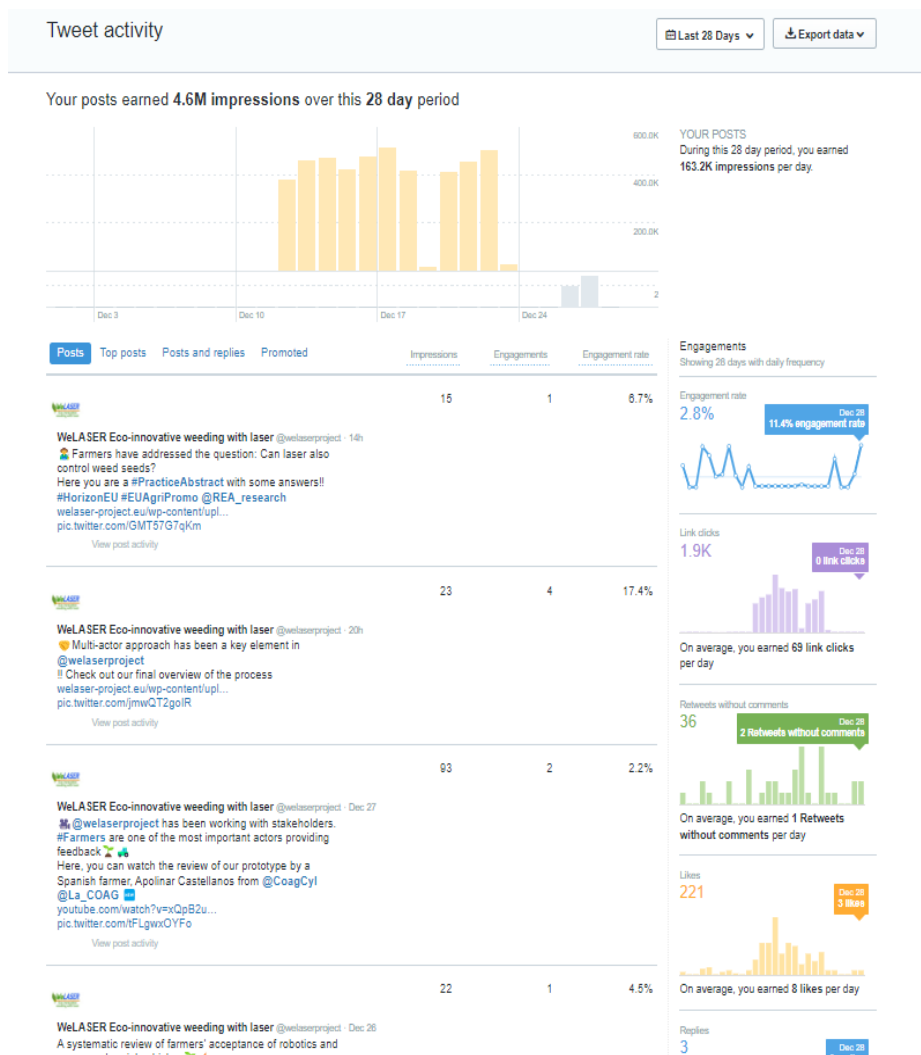
9.2.2. YouTube







9.2.3. Twitter (X)

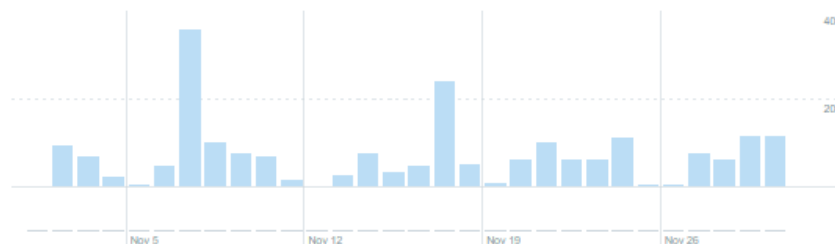


Tweet activity

November 2023

Export data

Your posts earned **2.1K impressions** over this 30 day period



YOUR POSTS
During this 30 day period, you earned **71 impressions** per day.

Posts Top posts Posts and replies Promoted Impressions Engagements Engagement rate

132 13 9.8%

WeLASER Eco-innovative weeding with laser @welaserproject · Nov 30
!!New @welaserproject publication, thanks to our partner @CARobotica_ in @AgricultureMdpi: "Enabling Autonomous Navigation on the Farm: A Mission Planner for Agricultural Tasks" 🌱
#HorizonEU #EUAgriPromo @REA_research mdpi.com/2077-0472/13/1... pic.twitter.com/aNbU7cLEWe

View post activity

31 4 12.9%

WeLASER Eco-innovative weeding with laser @welaserproject · Nov 30
🔓 Unlocking Revenue Potential of WeLASER 🔓 @REA_research #HorizonEU #EUAgriPromo #PracticeAbstract welaser-project.eu/wp-content/upl... pic.twitter.com/lZiJnLddDS

View post activity

96 8 8.3%

WeLASER Eco-innovative weeding with laser @welaserproject · Nov 29
Do you want to know who are potential buyers of @welaserproject in Europe? !!Check out this #PracticeAbstract to discover it! 📄 @REA_research #HorizonEU #EUAgriPromo welaser-project.eu/wp-content/upl... pic.twitter.com/GKuY3Nhi8q

View post activity

136 8 5.9%

WeLASER Eco-innovative weeding with laser @welaserproject · Nov 28
!! New @welaserproject publication in @FrontiersIn: "Side-effects of laser weeding: quantifying off-target risks to arthropods (Ephydraeidae) and insects (Tenebrionidae)"

Engagements

Showing 30 days with daily frequency

Engagement rate
4.8% Nov 30 2.6% engagement rate



Link clicks
14 Nov 30 1 link click



On average, you earned **0 link clicks** per day

Retweets without comments
21 Nov 30 1 Retweet without comments



On average, you earned **1 Retweets without comments** per day

Likes
34 Nov 30 1 like



On average, you earned **1 likes** per day

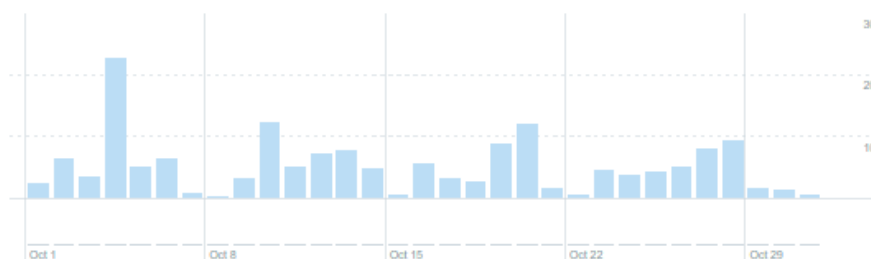
Replies
0 Nov 30 0 replies

Tweet activity

October 2023

Export data

Your posts earned 1.6K impressions over this 31 day period



YOUR POSTS
During this 31 day period, you earned 53 impressions per day.

Posts Top posts Posts and replies Promoted

Impressions Engagements Engagement rate

WeLASER Eco-innovative weeding with laser @welaserproject · Oct 27
🔥🌿 Can Canada thistle be controlled with #laser beams?
Check it out in this #PracticeAbstract
welaser-project.eu/wp-content/upl...
pic.twitter.com/WOuAJ9lyds
[View post activity](#)

138 9 6.5%

WeLASER Eco-innovative weeding with laser @welaserproject · Oct 26
🔥🌿 ¿Puede controlarse el cardo de Canadá con rayos láser?
Compruébalo en este #PracticeAbstract
welaser-project.eu/wp-content/upl...
#HorizonEU #EUAgriPromo @REA_research
pic.twitter.com/1Atl6HDOo4
[View post activity](#)

48 4 8.3%

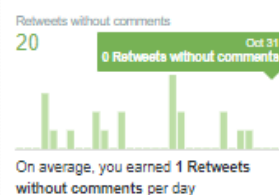
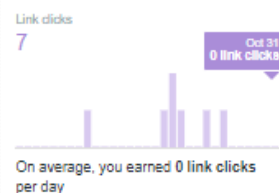
WeLASER Eco-innovative weeding with laser @welaserproject · Oct 25
🌱 Some key elements for the future alternatives in #CropProtection products
🔹 These are the main conclusions of our 5th Stakeholder Event
#PracticeAbstract
welaser-project.eu/wp-content/upl...
#HorizonEU #EUAgriPromo @REA_research
pic.twitter.com/Q4V3UOIkwC
[View post activity](#)

53 4 7.5%

WeLASER Eco-innovative weeding with laser @welaserproject · Oct 24

42 3 7.1%

Engagements
Showing 31 days with daily frequency

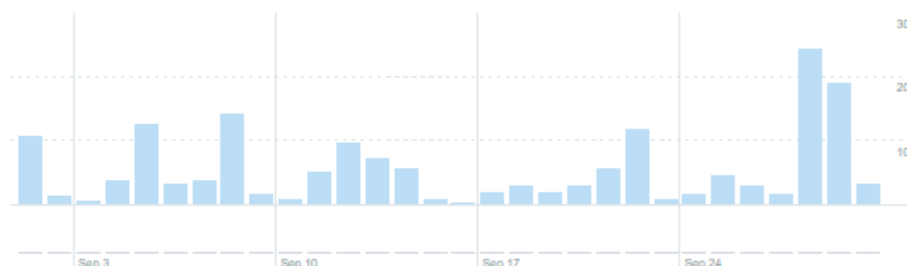


Tweet activity

September 2023

Export data

Your posts earned 1.7K impressions over this 30 day period



YOUR POSTS

During this 30 day period, you earned 56 impressions per day.

Posts Top posts Posts and replies Promoted Impressions Engagements Engagement rate

230 21 9.1%



WeLASER Eco-innovative weeding with laser @welaserproject · Sep 29

Although it looks like a rural @daftpunk concert, it is our final event we celebrated yesterday 🎉.

More details to come! pic.twitter.com/ZNiFnUxo8G

View post activity

260 28 10.8%



WeLASER Eco-innovative weeding with laser @welaserproject · Sep 28

!! Hoy celebramos nuestra demostración final en campo!! Podremos mostrar nuestro prototipo a todas las personas que se acerquen a la sede del @CARobotica_ en Arganda del Rey. Aquí el programa 📄

#HorizonEU #EUAgrriPromo pic.twitter.com/sQIOvebo8D

View post activity

35 4 11.4%



WeLASER Eco-innovative weeding with laser @welaserproject · Sep 25

! Worried about the Implications for EU production of the Regulation on the sustainable use of plant protection products? 🤖

Check out the main conclusions of our 5th Stakeholder Event 📄

welaser-project.eu/wp-content/upl...

pic.twitter.com/NoT8lIE6vl

View post activity

208 10 4.8%



WeLASER Eco-innovative weeding with laser @welaserproject · Sep 21

📄 How to apply #ArtificialIntelligence in crop detection to ensure precise navigation with fully autonomous #robotic

.....

Engagements

Showing 30 days with daily frequency

Engagement rate

3.4%

Sep 30 2.5% engagement rate



Link clicks

7

Sep 30 0 link clicks



On average, you earned 0 link clicks per day

Retweets without comments

14

Sep 30 0 Retweets without comments



On average, you earned 0 Retweets without comments per day

Likes

21

Sep 30 0 likes



On average, you earned 1 likes per day

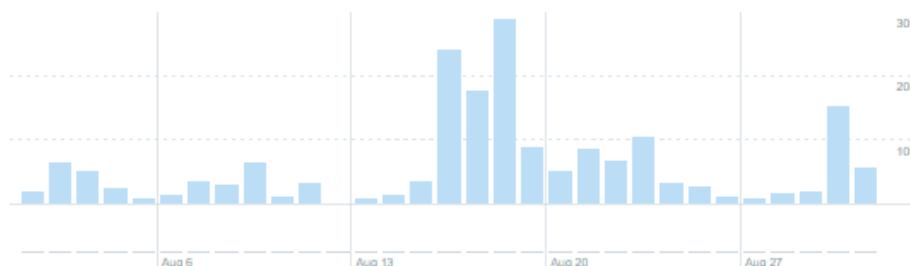
Replies

Tweet activity

August 2023

Export data

Your posts earned 1.9K impressions over this 31 day period



YOUR POSTS

During this 31 day period, you earned 60 impressions per day.

Posts

Top posts

Posts and replies

Promoted

Impressions

Engagements

Engagement rate



WeLASER Eco-innovative weeding with laser @welaserproject · Aug 30
 ⚡ @welaserproject was on display in the Netherlands for the first time, during the nLdutch Precision Days on August 25 and 26

!Discover what happened in this article in @futurefarming
 futurefarming.com/crop-solutions...
 pic.twitter.com/SiX20gKs18

View post activity

209

20

9.6%



WeLASER Eco-innovative weeding with laser @welaserproject · Aug 23
 Get ready for our FIELD DAY 3!!
 Precision Farming Days, August 24-26, 2023
 Reusel, The NetherlandsNL
 Organized by Van den Borne Projecten @jacobvdborne

@welaserproject will participate giving demos and special sessions
 welaser-project.eu/wp-content/upl...
 pic.twitter.com/40eyjmWAPo

View post activity

63

2

3.2%



WeLASER Eco-innovative weeding with laser @welaserproject · Aug 23
 Get ready for our FIELD DAY 3!!
 Precision Farming Days, August 24-26, 2023
 Reusel, The NetherlandsNL
 Organized by Van den Borne Projecten @jacobvdborne

@welaserproject will participate giving demos and special sessions
 welaser-project.eu/wp-content/upl...
 pic.twitter.com/SpsRWXlyoq

56

0

0.0%

Engagements

Showing 31 days with daily frequency

Engagement rate

4.6%

Aug 31
10.3% engagement rate

Link clicks

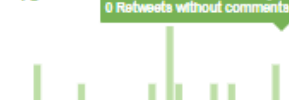
7

Aug 31
0 link clicks

On average, you earned 0 link clicks per day

Retweets without comments

13

Aug 31
0 Retweets without comments

On average, you earned 0 Retweets without comments per day

Likes

26

Aug 31
1 like

On average, you earned 1 likes per day

Replies

1

Aug 31
0 replies

Aug 2021 • 31 days

TWEET HIGHLIGHTS

Top Tweet earned 1,494 impressions

🔗 Meet our consortium, which gathers 10 Partners from 8 European countries and it's coordinated by

@CSIC (<https://twitter.com/CSIC>)

@CARobotica_ (https://twitter.com/CARobotica_)

More info: welaser-project.eu
(<https://t.co/KixIzKiDZA>)

@La_COAG (https://twitter.com/La_COAG)

@LZH_Hannover

(https://twitter.com/LZH_Hannover) @ugent

(<https://twitter.com/ugent>) @unibo

(<https://twitter.com/Unibo>)

@uni_copenhagen

(https://twitter.com/uni_copenhagen)

@IETU4 @AGC_Robotics

(https://twitter.com/AGC_Robotics)

@jacobvdborne

(<https://twitter.com/jacobvdborne>)

[pic.twitter.com/BNJT11QFRL](https://twitter.com/BNJT11QFRL)

(<https://t.co/BNJT11QFRL>)

**Top mention** earned 32 engagements

(<https://twitter.com/COAGInnova>)

COAG INNOVA

@COAGInnova

(<https://twitter.com/COAGInnova>) · Aug 30

(<https://twitter.com/COAGInnova/status/1432225822534995970>)

🔗 @La_COAG

(https://twitter.com/La_COAG) forma parte del proyecto @welaserproject

(<https://twitter.com/welaserproject>), que

reúne a 10 socios de 8 países europeos,

coordinados por @CSIC

(<https://twitter.com/CSIC>) @CARobotica_

(https://twitter.com/CARobotica_)

Aquí puedes ver toda la información 

welaser-project.eu (<https://t.co/6ftbVxVqFb>)

@LZH_Hannover

(https://twitter.com/LZH_Hannover) @ugent

(<https://twitter.com/ugent>) @unibo

(<https://twitter.com/Unibo>)

@uni_copenhagen

(https://twitter.com/uni_copenhagen)

@IETU4 @AGC_Robotics

(https://twitter.com/AGC_Robotics)

@jacobvdborne

(<https://twitter.com/jacobvdborne>)

[pic.twitter.com/BNJT11QFRL](https://twitter.com/BNJT11QFRL)

(<https://t.co/CapaDLcVWVn>)



AUG 2021 SUMMARY

Tweets	5	Tweet impres	2,889
Profile visits	1,030	Mentions	4
New followers	10		

Jul 2021 • 31 days

TWEET HIGHLIGHTS

Top Follower followed by 70 people

(<https://twitter.com/psdnepalngo>)



(<https://twitter.com/psdnepalngo>)

PSD-Nepal

(<https://twitter.com/psdnepalngo>)

Progressive Sustainable Developers Nepal (PSD-Nepal) is a social organization established to work in the sectors like agriculture, health and environment

View profile (<https://twitter.com/psdnepalngo/>)

Top mention earned 12 engagements

(<https://twitter.com/BIOSCHAMP>)

BIOSCHAMP H2020 project

@BIOSCHAMP

(<https://twitter.com/BIOSCHAMP>) · Jul 6

(<https://twitter.com/BIOSCHAMP/status/1412297808162471939>)

🔗 BIOSCHAMP aims to improve the

#MushroomSector

(<https://twitter.com/hashtag/MushroomSector?src=hash>) profitability while reducing the

need for #pesticides

(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

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(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

(<https://twitter.com/hashtag/pesticides?src=hash>) by 90%.

JUL 2021 SUMMARY

Tweet impressions	237	Profile visits	421
Mentions	3	New followers	-1

💡 Learn more about them 

bioschamp.eu/archivos/1177

(<https://t.co/G7RqQH5sB1>)

WELASER EU-Innovative Weeding... (http://twitter.com/welaserproject)

Jun 2021 • 30 days

TWEET HIGHLIGHTS

Top Tweet earned 138 impressions

On 25/05/2021, the 2nd @welaserproject (https://twitter.com/welaserproject) Stakeholder Event (welaser-project.eu/events/ (https://t.co/roP5xqnDnz)) was held getting together over 40 participants. Attendees discussed the successful application of agricultural robots using laser techniques for weeding #innovation (https://twitter.com/hashtag/innovation?src=hash) @EU_H2020 (https://twitter.com/EU_H2020) pic.twitter.com/kaNiSTRHR8 (https://t.co/kaNiSTRHR8)



(https://twitter.com/welaserproject/status/1401838552116310018) (https://twitter.com/welaserproject/status/1401838552116310018)

1 2

View all Tweet activity (/user/welaserproject/tweets)

View Tweet activity

Top mention earned 6 engagements

On 25/05/2021, the 2nd @welaserproject (https://twitter.com/welaserproject) Stakeholder Event (welaser-project.eu/events/ (https://t.co/roP5xqnDnz)) was held getting together over 40 participants. Attendees discussed the successful application of agricultural robots using laser techniques for weeding #innovation (https://twitter.com/hashtag/innovation?src=hash) @EU_H2020 (https://twitter.com/EU_H2020) pic.twitter.com/kaNiSTRHR8 (https://t.co/kaNiSTRHR8)



(https://twitter.com/welaserproject/status/1401838552116310018) (https://twitter.com/welaserproject/status/1401838552116310018)

1 2

View all Tweet activity (/user/welaserproject/tweets)

View Tweet activity

May 2021 • 31 days

TWEET HIGHLIGHTS

Top Follower followed by 3 people

(https://twitter.com/0x616469747961)



(https://twitter.com/0x616469747961)

aditya

(https://twitter.com/0x616469747961) (https://twitter.com/0x616469747961) FOLLOWS YOU View profile (https://twitter.com/0x616469747961/)

Top mention earned 22 engagements

(https://twitter.com/COAGInnova) **COAG INNOVA** @COAGInnova (https://twitter.com/COAGInnova) - May 25 (https://twitter.com/COAGInnova/status/1397209209075343365) Today we attend the 2nd @welaserproject (https://twitter.com/welaserproject) Stakeholder Event A multiactor discussion is held on security and safety issues, and barriers and economic opportunities of the laser-based weeding system pic.twitter.com/NJ0sQmVfU2 (https://t.co/NJ0sQmVfU2)



JUN 2021 SUMMARY

Tweets	1	Tweet impres	235
Profile visits	101	Mentions	1
New followers	0		

MAY 2021 SUMMARY

Tweet impressions	123	Profile visits	175
Mentions	2	New followers	2

Apr 2021 • 30 days

TWEET HIGHLIGHTS

Top Tweet earned 189 impressions

Newsletter N. 1 of the **@welaser** (<https://twitter.com/welaser>)-project is released in English, German, Italian and Spanish. It's available on [welaser-project.eu/newsletter/](https://project.eu/newsletter/) (<https://t.co/r94s0ymybp>). **@EU_2020** (https://twitter.com/eu_2020) **#precisionfarming** (<https://twitter.com/hashtag/precisionfarming?src=hash>) **#Robotics** (<https://twitter.com/hashtag/Robotics?src=hash>) [pic.twitter.com/1xSkC3jdmw](https://t.co/1xSkC3jdmw) (<https://t.co/1xSkC3jdmw>)

Inside this issue

Welcome to the first issue of the WeLASER newsletter.....2
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Mission 1.....4
WeLASER website, social networks and channels.....5
Fulonica delivers a 2-jaw laser at the University of Copenhagen for performing the first tests.....5
Communication and dissemination activities.....6



(<https://twitter.com/welaserproject/status/1379367148271902721>)
2

View all Tweet activity (/user/welaserproject/tweets)

View Tweet activity

Top Follower

Mar 2021 • 31 days

TWEET HIGHLIGHTS

Top Follower followed by 387 people(https://twitter.com/kriecck_josh)(https://twitter.com/kriecck_josh)**Josh Kriecck**(https://twitter.com/kriecck_josh) FOLLOW

YOU

View profile (https://twitter.com/kriecck_josh/)**Top mention** earned 83 engagements**FIRA**(https://twitter.com/FIRA_team)

Apr 10

(https://twitter.com/FIRA_team/status/1380815317249748996)

Killing weeds in a sustainable way using a autonomous robot with laser vision 🌱

@welaserproject(<https://twitter.com/welaserproject>)**@InnoOrigins**(<https://twitter.com/InnoOrigins>)

🔗 [innovationorigins.com/killing-weeds-...](https://t.co/EF83zhFq07) (<https://t.co/EF83zhFq07>)

#robot (<https://twitter.com/hashtag/robot?src=hash>) **#agriculture** (<https://twitter.com/hashtag/agriculture?src=hash>) **#agtech** (<https://twitter.com/hashtag/agtech?src=hash>) **#weeding** (<https://twitter.com/hashtag/weeding?src=hash>) [pic.twitter.com/NUR20PHdSG](https://t.co/NUR20PHdSG) (<https://t.co/NUR20PHdSG>)



APR 2021 SUMMARY

Tweets

2

Tweet impres

505

Profile visits

579

Mentions

4

New followers

10

Top mention earned 4 engagements**LaserZentrumHannover**(https://twitter.com/LZH_Hannover)

Mar 25

(https://twitter.com/LZH_Hannover/status/1375050733532426241)Im **@welaserproject**(<https://twitter.com/welaserproject>) arbeitenwir mit 9 Partnern daran, **#Laser**(<https://twitter.com/hashtag/Laser?src=hash>)mit **#KI** (<https://twitter.com/hashtag/KI?src=hash>) und **#IoT**(<https://twitter.com/hashtag/IoT?src=hash>)

zu kombinieren, als Alternative zur

chemischen Unkrautbekämpfung. Testen

werden wir den Prototyp im Ackerbau.

#Laserjäten(<https://twitter.com/hashtag/Laserj%C3%A4ten?src=hash>)**@EU_H2020**(https://twitter.com/EU_H2020) **#H2020**(<https://twitter.com/hashtag/H2020?src=hash>)**#Cloud**(<https://twitter.com/hashtag/Cloud?src=hash>)**#Nachhaltigkeit**(<https://twitter.com/hashtag/Nachhaltigkeit?src=hash>)[pic.twitter.com/Zc528W7JPr](https://t.co/Zc528W7JPr)(<https://t.co/Zc528W7JPr>)

MAR 2021 SUMMARY

Tweet impressions

100

Profile visits

176

Mentions

2

New followers

2

Feb 2021 • 28 days

TWEET HIGHLIGHTS

Top Follower followed by 1,455 people
(<https://twitter.com/RoboCity2030>)

Top mention earned 1 engagements
(<https://twitter.com/DigitalAgriUCO>)
Máster DIGITAL AGRI

FEB 2021 SUMMARY

Tweet impressions
128

Profile visits
44

Jan 2021 • 31 days

TWEET HIGHLIGHTS

Top Follower followed by 1,745 people
(<https://twitter.com/DigitalAgriUCO>)



(<https://twitter.com/DigitalAgriUCO>)

Máster DIGITAL AGRI

(<https://twitter.com/DigitalAgriUCO>)

#Máster (<https://twitter.com/hashtag/M%C3%A1ster?src=hash>) en **#TransformaciónDigital** (<https://twitter.com/hashtag/Transformaci%C3%B3nDigital?src=hash>) del sector agroalimentario y forestal |
@ETSIAMCordoba (<https://twitter.com/ETSIAMCordoba>)
@UnivCordoba (<https://twitter.com/UnivCordoba>)
@ucoidep (<https://twitter.com/ucoidep>)

View profile (<https://twitter.com/DigitalAgriUCO/>)

Top mention earned 34 engagements



(<https://twitter.com/DigitalAgriFood>)
Digital AgriFood

@DigitalAgriFood
(<https://twitter.com/DigitalAgriFood>) - Jan 27
(<https://twitter.com/DigitalAgriFood/status/1354371319450624004>)

🤖🌱🌱 Un proyecto coordinado por el **@CSIC** (<https://twitter.com/CSIC>) desarrolla un **#robot**

(<https://twitter.com/hashtag/robot?src=hash>) autónomo que utilizará el **#láser**

(<https://twitter.com/hashtag/l%C3%A1ser?src=hash>) y la inteligencia artificial para eliminar las **#malashierbas**

(<https://twitter.com/hashtag/malashierbas?src=hash>) de los cultivos de forma sostenible 🌱

JAN 2021 SUMMARY

Tweet impressions
89

Profile visits
57

Mentions
3

New followers
2

Dec 2020 • 31 days

TWEET HIGHLIGHTS

Top Follower followed by 916 people
(<https://twitter.com/custolopez>)



(<https://twitter.com/custolopez>)

Custodio López Cruz

(<https://twitter.com/custolopez>)
FOLLOWS YOU
Agricultura Sostenible. En el campo tengo mis raíces.

View profile (<https://twitter.com/custolopez/>)

Top mention earned 91 engagements



(<https://twitter.com/alvaroareta>)
Alvaro Areta

@alvaroareta (<https://twitter.com/alvaroareta>) -
Dec 1
(<https://twitter.com/alvaroareta/status/1333672465252413441>)

🌱 Nace **@welaserproject** (<https://twitter.com/welaserproject>), la solución tecnológica que pretende acabar con los tratamientos químicos en la eliminación de malas hierbas.

🌱 Agricultores y 7 centros de I+D juntos para contribuir desde la ciencia a un sector agrario más sostenible **#innovación** (<https://twitter.com/hashtag/innovaci%C3%B3n?src=hash>)

DEC 2020 SUMMARY

Tweet impressions
216

Profile visits
195

Mentions
4

New followers
3

Nov 2020 • 30 days

TWEET HIGHLIGHTS

Top Tweet earned 192 impressions

On 26/11/2020, the 1st **@welaserproject** (<https://twitter.com/welaserproject>) Stakeholder Event was held getting together over 60 participants -partners, REA officers, farmers, institutions, NGOs, and policymakers. The event conclusions will drive the development of the laser-based weeding system **#innovation** (<https://twitter.com/hashtag/innovation?src=hash>) **@EU_H2020** (https://twitter.com/EU_H2020)
(<https://twitter.com/Nr58Ac2aQ>)

Top mention earned 127 engagements



(https://twitter.com/La_COAG)
COAG

@La_COAG (https://twitter.com/La_COAG) -
Nov 26
(https://twitter.com/La_COAG/status/1331894157791649792)

👉 **#EstáPasando** (<https://twitter.com/hashtag/Est%C3%A1Pasando?src=hash>) Nuestro responsable de jóvenes **@marcosgarceslz** (<https://twitter.com/marcosgarceslz>) siguiendo de forma online la presentación del proyecto de innovación

NOV 2020 SUMMARY

Tweets
1

Tweet impres
425

Profile visits
129

Mentions
9

New followers
12

Oct 2020 • 31 days

TWEET HIGHLIGHTS

Top Tweet earned 292 impressions

On October 1st, 2020, @welaserproject (<https://twitter.com/welaserproject>), an innovation action funded by @EU_H2020 (https://twitter.com/EU_H2020), started its activities for weeding with laser technologies and contributing to the eradication of herbicides. The kickoff meeting was held on October 13th #precisionfarming (<https://twitter.com/hashtag/precisionfarming?src=hash>) #Robotics (<https://twitter.com/hashtag/Robotics?src=hash>) pic.twitter.com/VlwOTMDFWI (<https://t.co/VlwOTMDFWI>)



(<https://twitter.com/welaserproject/status/1321769670127636485>)
 4 2

View all Tweet activity (/user/welaserproject/tweets)

View Tweet activity

Top mention earned 18 engagements

On October 1st, 2020, @welaserproject (<https://twitter.com/welaserproject>), an innovation action funded by @EU_H2020 (https://twitter.com/EU_H2020), started its activities for weeding with laser technologies and contributing to the eradication of herbicides. The kickoff meeting was held on October 13th #precisionfarming (<https://twitter.com/hashtag/precisionfarming?src=hash>) #Robotics (<https://twitter.com/hashtag/Robotics?src=hash>) pic.twitter.com/VlwOTMDFWI (<https://t.co/VlwOTMDFWI>)



(<https://twitter.com/welaserproject/status/1321769670127636485>)
 4 2

View all Tweet activity (/user/welaserproject/tweets)

View Tweet activity

OCT 2020 SUMMARY

Tweets	1	Tweet impres	294
Profile visits	32	Mentions	2
New followers	3		

Sep 2020 • 30 days

TWEET HIGHLIGHTS

Top Follower followed by 2,518 people

(<https://twitter.com/alvaroareta>)



(<https://twitter.com/alvaroareta>)

Alvaro Areta

(<https://twitter.com/alvaroareta>)
 Dr. Ingeniero Agrónomo. Técnico en la Coordinadora de Organizaciones de Agricultores y Ganaderos (COAG).

View profile (<https://twitter.com/alvaroareta/>)

Top mention earned 2 engagements

(<https://twitter.com/CoopsAgroES>)
Cooperativas Agro-alimentarias de España
 @CoopsAgroES (<https://twitter.com/CoopsAgroES>) · Sep 30
 (<https://twitter.com/CoopsAgroES/status/1311238084089049091>)
 @REA_research (https://twitter.com/REA_research)
 @EU_H2020 (https://twitter.com/EU_H2020)
 @EUAgri (<https://twitter.com/EUAgri>)
 @EU_MARE (https://twitter.com/EU_MARE)
 @EU_ENV (https://twitter.com/EU_ENV)
 @welaserproject (<https://twitter.com/welaserproject>)
 @ProhensJaime (<https://twitter.com/ProhensJaime>) Y
 @CoopsAgroES (<https://twitter.com/CoopsAgroES>) participa en dos proyectos #COOPID (<https://twitter.com/hashtag/COOPID?src=hash>) y #MEF4CAP (<https://twitter.com/hashtag/MEF4CAP?src=hash>) @jncorb (<https://twitter.com/jncorb>)

1

View Tweet

(<https://twitter.com/CoopsAgroES/status/1311238084089049091>)

SEP 2020 SUMMARY

Tweet impressions	5	Profile visits	8
Mentions	1	New followers	2

9.2.4. Facebook

Publicaciones Facebook





WeLASER-project

Publicado por Rubén Villanueva ·
21 de septiembre a las 08:34

Stakeholders are really important in @welasproject. This #PracticeAbstract is an example of their contribution: "Stakeholders help defining the WeLASER system specifications" !!

Download it here

<https://welaser-project.eu/download/welaser-pa-2-english/>

Ver traducción



WeLASER Practice Abstract N

Eco-innovative wedding with laser

Stakeholders help defining the WeLASER system specifications

Opportunities

The First WeLASER Stakeholder Event was held on 26/11/2020 gathering over participants including farmers, research and agriculture institutions, civil society NGOs, policymakers, the REA project officers and the project partners. The eve was an opportunity to involve the stakeholders in the project and in the definition the system characteristics.

Preliminary system characteristics

Rendimiento de tu publicación

402 Personas alcanzadas

9 Me gusta, comentarios y contenido compartido

9 Clics en publicaciones

3 Visualizaciones de fotos	0 Clics en el enlace	6 Clics de otro tipo
----------------------------	----------------------	----------------------

Ver más detalles

COMENTARIOS NEGATIVOS

0 Ocultar todas las publicaciones

0 Ocultar publicación

0 Reportar como spam


Ya no me gusta esta página

9 Me gusta, comentarios y contenido compartido

DISTRIBUCION DE CONTENIDO DE MARCA

402	402	0
-----	-----	---

Ver desglose



Welaser-project


Publicado por Rubén Villanueva ·
9 de septiembre a las 14:29 ·

#Welaser already published 12 [PracticeAbstracts](#)

Curious about them? Read more here

<https://welaser-project.eu/practice-abstracts/>

Ver traducción




WELASER Practice Abstract N.





Go-innovative weeding with laser


Laser weeding in organic production

weeding vs. mechanical weeding

Weeding with a laser makes good sense in organic production because laser-weeding is based on electricity produced from windmills, hydropower or other non-fossil-fuels and sources and thereby contributed to an environmentally friendly production. The laser beam is only directed against the growth point of the small emerging weed plants, which is a very small spot between the first leaves. Therefore, laser-weeding interferes as little as possible with the environment in contrast to mechanical weed control, which so harms beneficial organisms in the soil and on the soil surface.



 1
  Me gusta
  Comentar
  Compartir



Comentar como Welaser...

Presiona 'Enter' para publicar.

Rendimiento de tu publicación

12 Personas alcanzadas	1 Me gusta, comentarios y contenido compartido
2 Clics en publicaciones	0 Visualizaciones de fotos
2 Clics en el enlace	0 Clics de otro tipo

Ver más detalles

COMENTARIOS NEGATIVOS

0 Ocultar todas las publicaciones	0 Ocultar publicación
0 Reportar como spam	Ya no me gusta esta página

1 Me gusta, comentarios y contenido compartido

DISTRIBUCIÓN DE CONTENIDO DE MARCA

Ver desglose

12 Alcance total	12 Alcance orgánico	0 Alcance pagado
16 Impresiones totales	16 Impresiones orgánicas	0 Impresiones pagadas



WeLASER-project
Publicado por Pablo Gonzalez ·
10 de noviembre de 2020 ·

18 Personas alcanzadas

1 Me gusta, comentarios y contenido compartido

2 Clics en publicaciones

0 Visualizaciones de fotos

0 Clics en el enlace

2 Clics de otro tipo

Ver más detalles

WeLASER project kickoff meeting was held on October 13th, 2020.

Ver traducción

Sustainable Weed Management in Agriculture with Laser-Based Autonomous Tools



















Cooperación entre el sector público y privado
European Commission



WeLASER-project
Publicado por Pablo Gonzalez ·
28 de noviembre de 2020 ·


On November 26th, @welaserproject held the First WeLASER Stakeholder Event getting together in a virtual meeting the project partners, the REA project officers, and many farming industries, practitioners, agricultural institutions, research institutions, civil societies (NGO), and policymakers. The event conclusions will drive the WeLASER consortium in improving the laser-based weeding system under development.

Ver traducción



WeLASER
Eco-innovative weeding with laser

First Stakeholder Event



Rendimiento de tu publicación

21 Personas alcanzadas

2 Me gusta, comentarios y contenido compartido

3 Clics en publicaciones

1 Visualizaciones de fotos	0 Clics en el enlace	2 Clics de otro tipo
----------------------------	----------------------	----------------------

Ver más detalles

COMENTARIOS NEGATIVOS

0 Ocultar todas las publicaciones	0 Ocultar publicación
0 Reportar como spam	Ya no me gusta esta página

2 Me gusta, comentarios y contenido compartido

DISTRIBUCION DE CONTENIDO DE MARCA

21 Alcance total	21 Alcance orgánico	0 Alcance pagado
32 Impresiones	32 Impresiones	0 Impresiones



WeLaser-project

Publicado por Pablo Gonzalez · 6 de abril ·

Newsletter N. 1 of the @WeLaser-project is released in English, German, Italian and Spanish. It's available on <https://welasar-project.eu/newsletter/>.

Ver traducción



WeLaser

apical welding with laser

Newsletter

Issue N.1

March 2020

Submitting authors: CSBG, COAG, UNIBO, L2H



Se this issue:

- ome to the first issue of the WeLaser newsletter
- ducing WeLaser
- ASER First Stakeholder Event
- stone 1
- ASER website, social networks and email
- rics delivers a 2 µm laser at the entry of Copenhagen for performing jet tests

Readiness of tu publication

25 Personas alcanzadas

0 Me gusta, comentarios y contenido compartido

1 Clips en publicaciones

0 Visualizaciones de fotos

1 Clics en el enlace

0 Clics de otro tipo

Ver más detalles

COMENTARIOS NEGATIVOS

0 Ocultar todas las publicaciones

0 Ocultar publicación

0 Reportar como spam

Ya no me gusta esta página

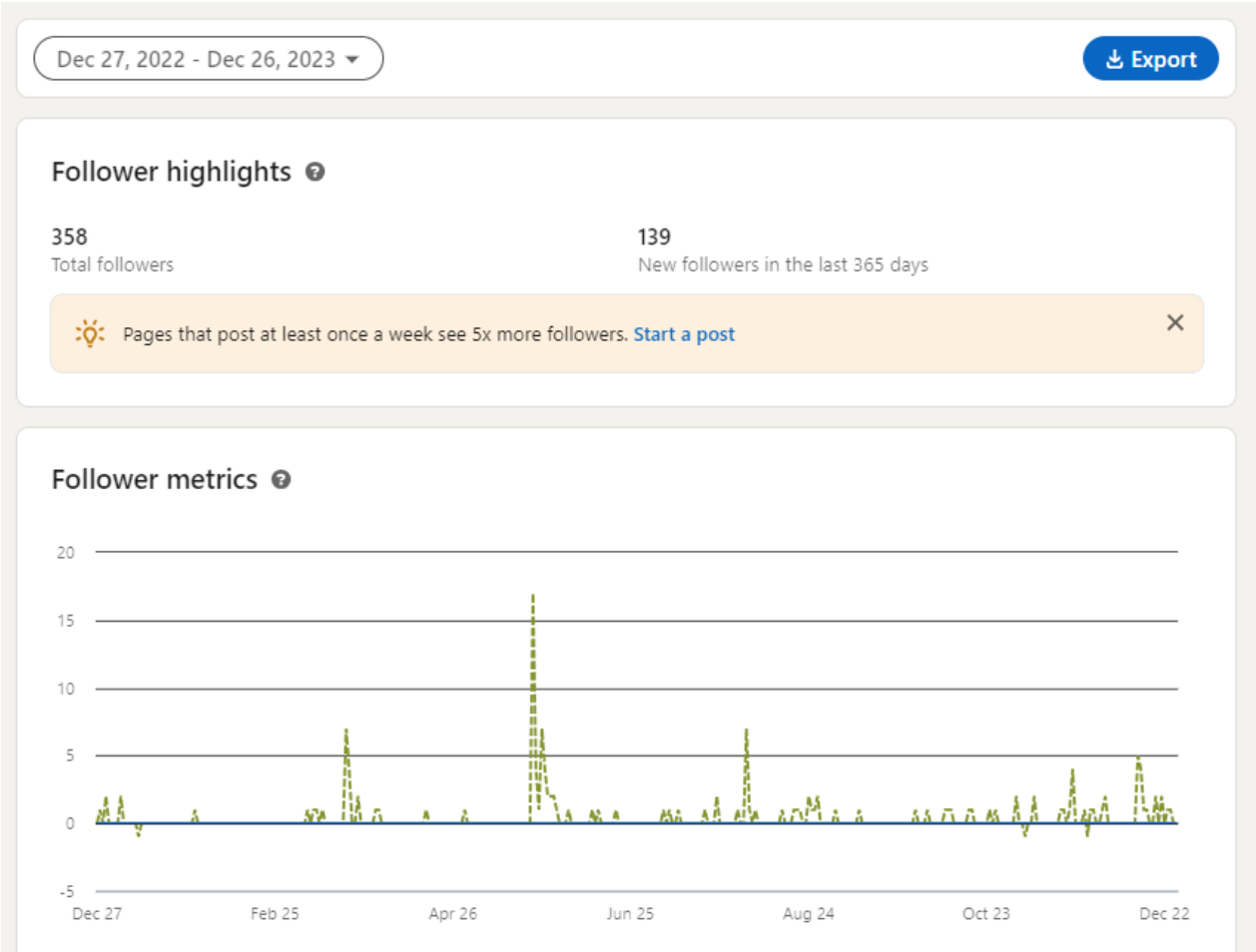
0 Me gusta, comentarios y contenido compartido

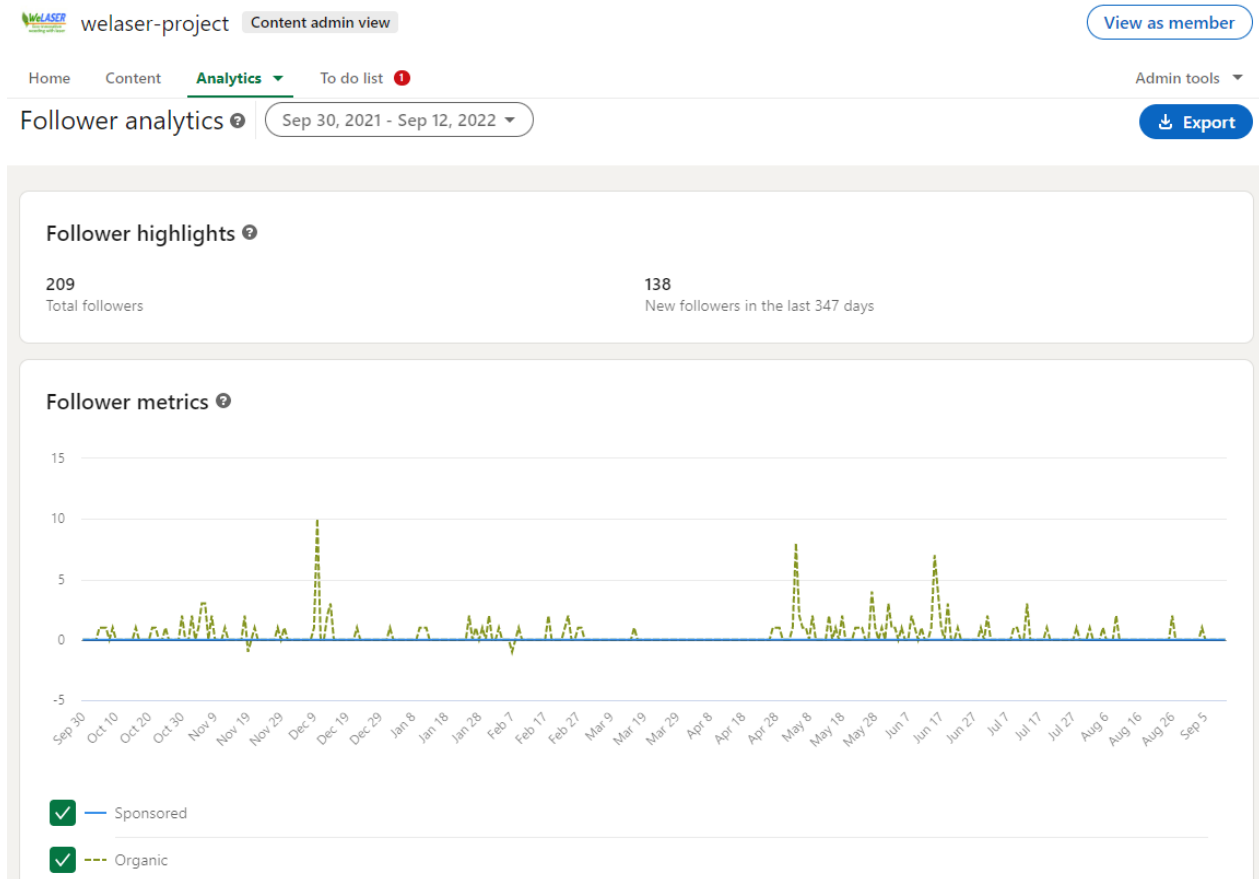
DISTRIBUCION DE CONTENIDO DE MARCA

Ver desglose

25	25	0
Alcance total	Alcance orgánico	Alcance pagado
34	34	0
Impresiones totales	Impresiones orgánicas	Impresiones pagadas

9.2.5. LinkedIn





Dec 27, 2022 - Dec 26, 2023 ▾

📄 Export

Visitor highlights ⓘ

698

Page views

237

Unique visitors

39

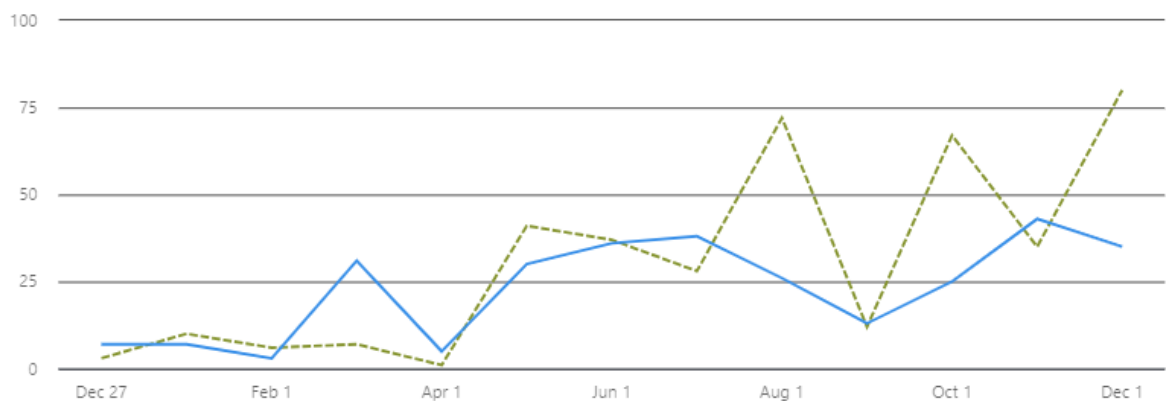
Custom button clicks

Visitor metrics ⓘ

Page views ▾

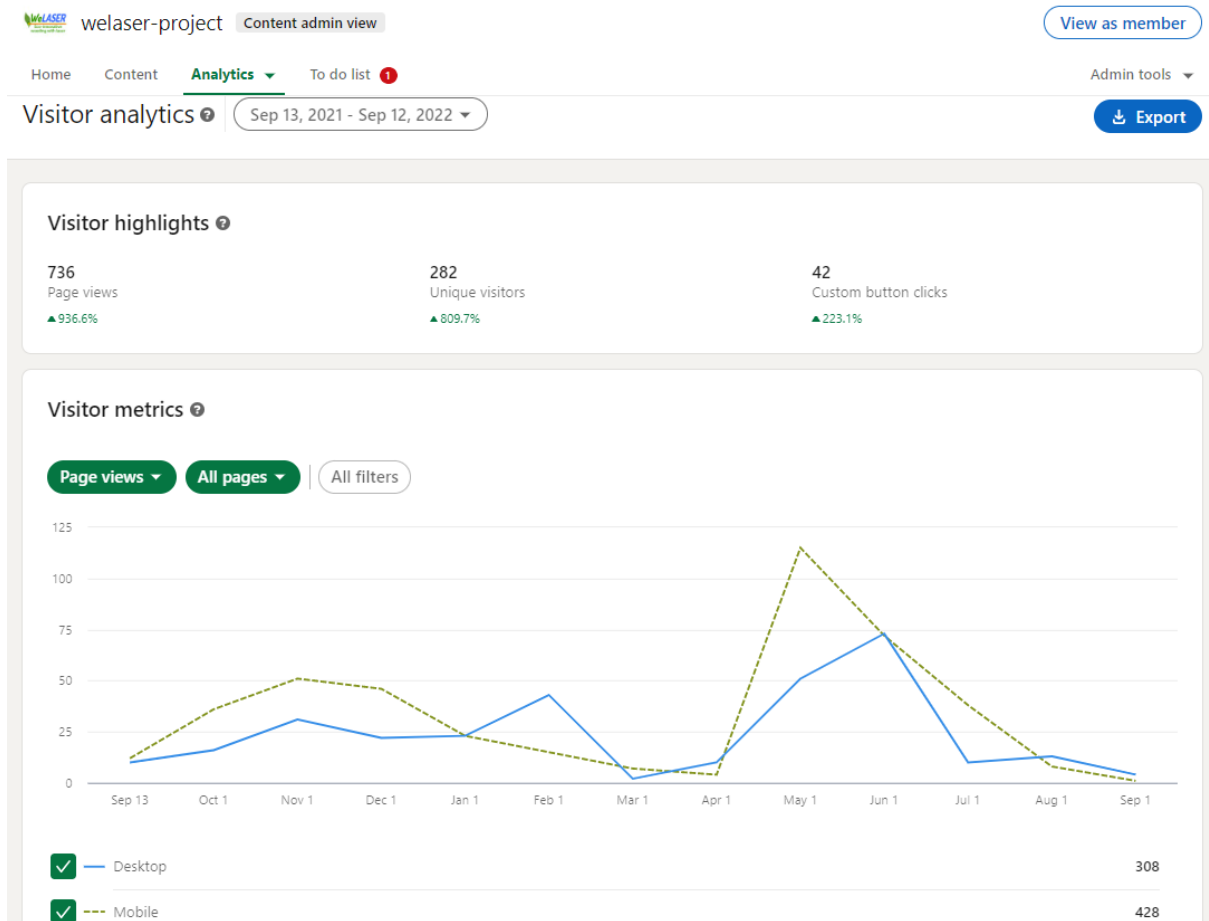
All pages ▾

All filters



✓	Desktop	299
✓	Mobile	399





Dec 27, 2022 - Dec 26, 2023 ▾

↓ Export

Highlights

Data for 12/27/2022 - 12/26/2023

690

Reactions

2

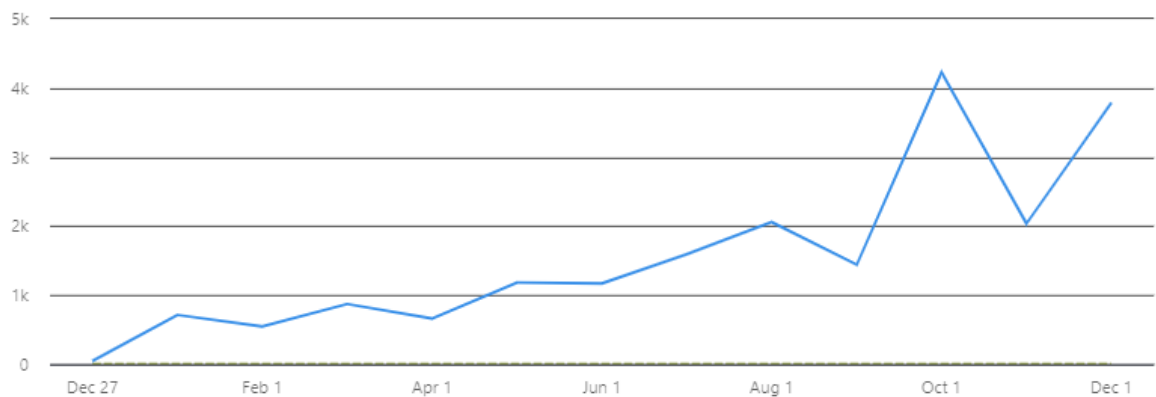
Comments

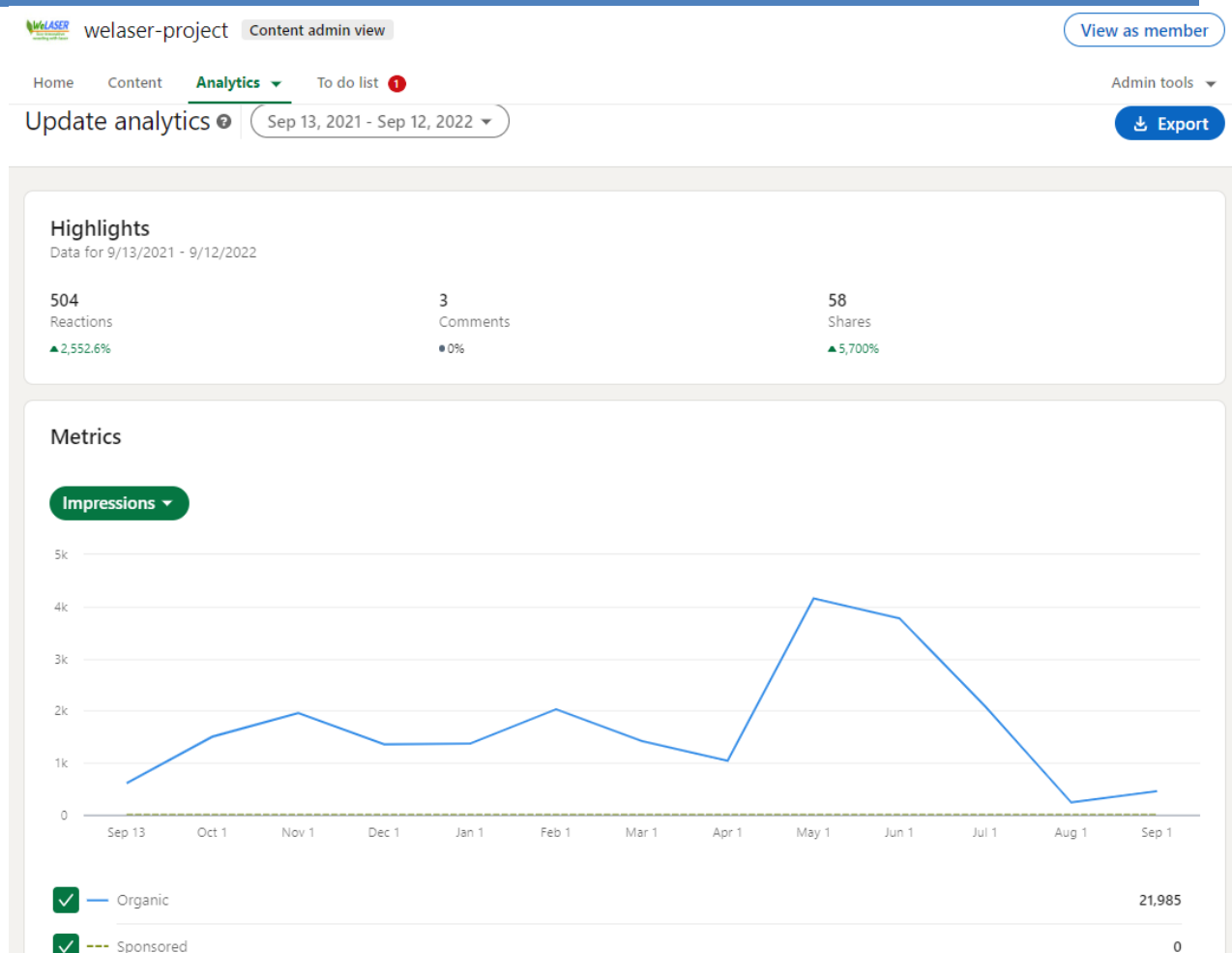
55

Reposts

Metrics

Impressions ▾





9.3. Annex 3 – WeLASER Clipping (Final Press Release)

To increase the impact and enhance the communication of the final results a special effort was made at the end of the WeLASER project. A final press release was launched for the whole EU in English, but also in several languages (French, Spanish, Polish, Italian, Dutch, German and Danish) for the national media of the countries of WeLASER partners. Also, a final press dossier was prepared with more comprehensive and detailed information, and a video also supported the action, for online media and social networks. This communication action reached an EU of 10.9 million impacts. Access to the clipping (EU and national level) is available through this [link](#).