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The INNOSETA Platform: a web-tool to support dissemination of innovation and research in the crop protection sector

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Summary

European farmers are increasingly facing new challenges linked to climate change, but at the same time they must guarantee high levels of production and quality to meet the growing market demands. Therefore, agriculture shall achieve a greater efficiency in quality and quantity of products taking into account environmental sustainability to comply with the European Directives. To increase agriculture sustainability, it is necessary to disseminate information on the most advanced technical solutions available for relevant agriculture stakeholders. The H2020 INNOSETA project set up an INNOvative self-sustainable thematic network on Spraying Equipment, Training and Advising to close the gap between the available novel high-end crop protection solutions and current European agriculture practices. A thorough inventory of relevant projects and articles, innovative industry products and training materials was carried out by the Project partners as input for an online, interactive, open access, multi-language platform available for all stakeholders at www.platform.innoseta.eu.

Key words: Spraying equipment, innovative sprayers, training and advising, web platform, chemical input reduction, Plant Protection Products, precision agriculture

Introduction

The modern EU agriculture and farmers must face many new challenges due to climatic changes, productivity and quality request and new regulations that foresee the drastic reduction in use of PPPs (Plant Protection Products) in order to comply with EU Green Deal (von der Leyen, 2019) and article 9 of Directive 2009/128/EC of the European Parliament. In recent years it was possible to see great improvements in PPPs developments, new spray technologies, Best Management Practices (BPM), advances in electronics connected to a reduction of its costs and in the adoption of PA (Precision Agriculture). The latter is a farming management concept which avails itself of technologies and practices allowing for a reduction of the use of PPPs and shifts the farming system towards a more sustainable production which strongly depends on the knowledge held by stakeholders: farmers, advisors, contractors (Pathak *et al*., 2019). Thanks to those improvements

and innovations end users could reach their goals, but, unfortunately, there is still an important gap between new technologies available on the market and those really used by the farmers, with special regards to innovations produced by small and medium enterprises that normally have difficulties in promoting and diffusing their products on a large scale (Liu *et al*., 2021). If this gap is closed, then European agriculture could become more sustainable with lower environmental, socioeconomic and human health impact.

The H2020 INNOSETA Project (Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture through the mobilization of Agricultural Knowledge and Innovation Systems) aims to close this existing gap in knowledge, gathering and selecting information about the latest techniques, available technologies, and best practices to reduce and optimize PPPs application in the four main cropping systems: open field crops, orchards, vineyards and greenhouse. By making them available for end users, there is a dramatically increased chance that such advertised technologies and practices are adopted also in European small-medium farming systems. To this extent, the INNOSETA Consortium produced the INNOSETA platform (www.platform.innoseta.eu), an online open access, multilingual platform in which information were collected and made freely available for stakeholders in the form of papers (peer reviewed and technical articles), projects (European and national), training and advising material (documents, applications, websites, videos, etc.) and industry solutions (spraying machinery and components developed by local and international companies).

The online platform was created with the contribution of all INNOSETA project partners: UPC, UPA (Spain); IFV (France); ILVO, CEMA, COPA-COGECA (Belgium); AUA, AGENSO, CERTH (Greece); ZLTO (The Netherlands); VISAVI (Sweden); DiSAFA-UNITO, Confagricoltura (Italy); ZODR (Poland).

Materials and Methods

The activities aimed at the creation of an online platform containing the latest information related to sprayers and spraying operations in the form of technical and scientific papers, projects, industry products, training and advising materials. All these innovations are hereinafter referred as SETAs (Spraying Equipment, Training and Advising). The work consisted of four steps (Fig. 1): (i) definition of SETA and set of search limits; (ii) collection of data (survey) in the reference period 2010–2021; (iii) data screening and aggregation; (iv) Platform implementation.

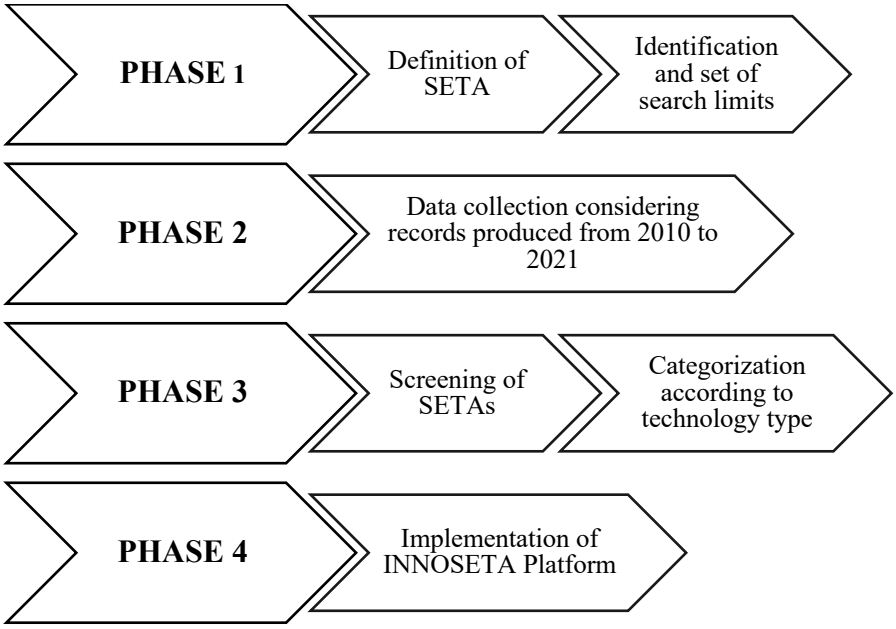


Fig. 1. Phases and operation for gathering of SETAs.

Definition of SETAs and set of search limits

This first phase had the objective to clarify in an unequivocal way the concept of SETA and to narrow the field of research. Partners agreed to consider as SETAs (and therefore to be suitable for publication on the platform), papers, projects, industry products and training and advising material related to:

- whatsoever component, device, tool, etc. that can be fitted to spraying machineries enhancing the environmental sustainability of spraying operation;
- a whole sprayer that presents innovative components/accessories;
- novel devices/tools/good practices referred to sprayers and spraying operations.

Survey (SETAs collection)

Project partners carried out the surveys by focusing on peer reviewed and technical papers, national/local and international projects, industry products and training and advising materials dealing with PPP spraying. For Industry Solutions data were collected from manufacturers' websites, direct contacts, technical magazines, and official websites related to national and international fairs/exhibitions on agricultural machinery. Projects were retrieved by looking for EU funded projects (in frameworks such as FP7, LIFE, INTERREG, ERA-NET, H2020 etc.) and national projects (self/co-funded or totally funded by public and private Institutions). The available EU (e.g. Cordis, EIP-Agri, etc.) or national databases were exploited to this extent. Information on scientific Papers dealing with PPP application were collected by using reference search engines (e.g. Scopus, WoS) whereas technical articles by consulting mainly national databases. Records about the last category of SETA, namely Training and Advising materials, were retrieved by looking for documents, applications, websites, videos, books, leaflets, and other type of material already developed by different universities, research institutions, official bodies and private companies. The data collection was repeated three times: one per each of the 3 years of the project life. In the first round of the survey (year 1) partners focused on SETAs produced in the reference period 2010–2018, whereas during the second and third year, the research was extended to 2020 and 2021 respectively.

Data screening and aggregation

Collected records were cleared from malicious, duplicate, and incomplete entries in order to endure data integrity and unbiased analysis. A screening process was afterwards activated. To do so, acceptance criteria were agreed by partners (Table 1). As a general rule, generic entries such as records in which Integrated Pest Management (IPM) and PA is dealt in general terms were considered as non-pertinent records (e.g. data referring just to guidance and mapping systems that are not exclusive for spraying applications). Therefore, records uploaded to the platform are strictly connected to sprayers, sprayers' components and spraying operations.

Data aggregation was the very last step to take into account before publishing records on the INNOSETA Platform. In general, the effort was to categorize SETAs in a harmonized category, group, and subgroup system, which emerged from the screening itself.

Identified categories are the following: Components, Sensors, Integrated Systems, Support Systems, Innovative Sprayers, Best Management Practices, and Other SETAs. Groups and subgroups belonging to each category are listed in Table 2 and already described in Gil *et al.* (2020).

The INNOSETA Platform structure and working principle

The INNOSETA platform, freely accessible at https://platform.innoseta.eu, has a simple and intuitive interface. The aim of the project was indeed to make the SETA repository as user-friendly as possible and, to this extent, the platform is available in seven languages (English, Italian, Spanish, Dutch, French, Polish, Swedish).

Table 1. *This table explains in detail the criteria agreed by INNOSETA project partners*

Criterion	Description
The SETA must be specific to PPP spray	Only innovations about PPP application and not PA in general
The technology or technique of application of PPPs should be preferably innovative	Small innovations providing an advantage in terms of sustainability and efficacy of PPP application were also considered valid
Technologies should be environmental sustainability-oriented	The technology must explicitly be an improvement of the application of PPP. These types of technologies were considered more relevant as the main goal is improving sustainability
New technologies even though not particularly innovative	Accepted when the diffusion of information about said technologies amongst farmers was deemed necessary as this complies with the goal of bridging the gap between research and farmers
Prototypes and new technology designs	These types of entries were kept only when the innovation was quite recent (material published up to 5 years ago). Otherwise, it is probable that the prototype/design was not carried to commercialization
Technologies submitted had to comply with current EU regulation on pesticide use.	Innovations must be compliant with EU regulations in terms of pesticide use

Table 2. *Categories, groups, and sub-categories of SETAs identified to classify the records into*

Group	Category	Sub-category
Components	Nozzles	
	Nozzles Accessories	
	Valves	
	Fans	
	Sprayer Booms	
	Cleaning Systems	
	Filling Systems	Closed transfer systems Direct Injection Filling level monitoring Induction Hopper
Sensors	Canopy Sensing	
	Target detection	Weed detection Disease detection
Integrated Systems	Boom Height Control	
	Control Units	
	Nozzle Control	Variable rate/PWM On/Off boom section or single nozzle GPS based nozzle control
Support systems	Guidance	Automated guidance Assisted Steering
	DSS	
	Monitoring	Single/Multiple operation monitoring Sprayer position via GPS Nozzle activity monitoring
	Mapping/recording	Field operations (automated data collection) Field mapping (Drones/Satellite)

Table 2 (cont'd)

Group	Category	Sub-category
Innovative sprayers	Sprayers for field crops	
	Sprayers for arboreal crops	
	Sprayers for greenhouses	
Best Management Practices		
Other SETAs		

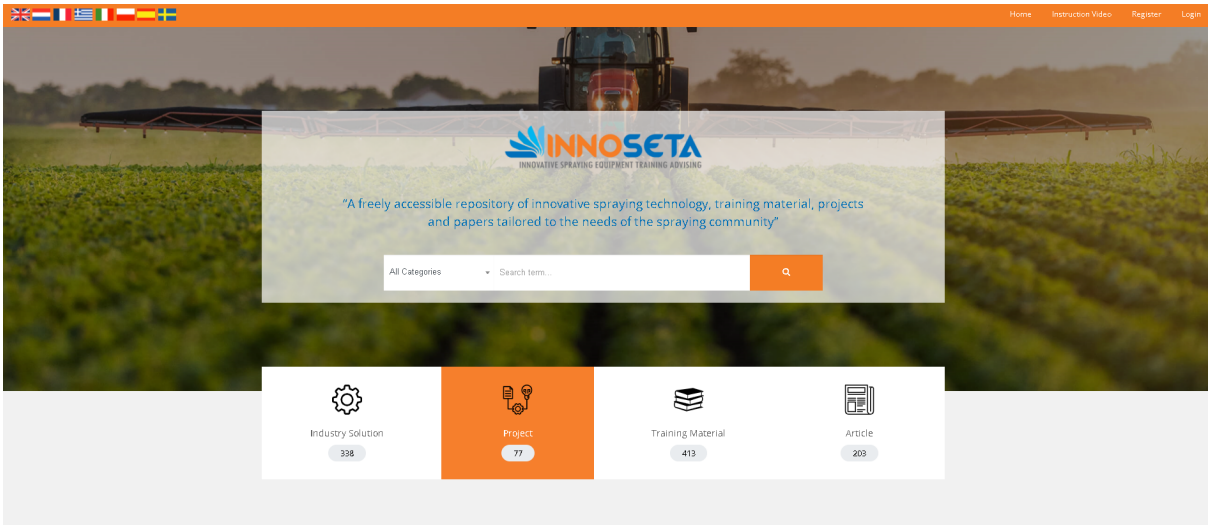


Fig. 2. INNOSETA Platform homepage (updated 30 September 2021).

Consultation is possible without logging in. Nevertheless, interested users can actively contribute to feed it by submitting new SETAs. In this second case, the contributor (e.g. a manufacturer of machineries or components, a researcher, a technician, etc.) is asked to register to the platform and to fill a specific form with information on SETAs he/she wants to submit. The new record is not automatically published on the platform but undergoes an approval/rejection process carried out by a panel of reviewers belonging to the INNOSETA consortium. This "interactive" function allows to have the INNOSETA platform constantly up to date with the most recent innovations in the PPP sector.

Referring to the use of the platform for consultation only, the home page (Fig. 2) displays: (i) a top menu with the list of available languages on the left upper corner and the "login" and "registration" buttons on right upper one; (ii) a search bar in which users can type the keywords of interest; (iii) four boxes (below the search bar) displaying the number of records available on the platform per type of SETA (industry solutions, projects, etc.). By clicking the box of interest, user is redirected to the specific section. Moreover, a list of the latest-added SETAs, links to video tutorials on how to propose new SETAs and the list of criteria adopted in the record selection are also available on the main page.

When the user types the keyword of interest in the search engine of the platform, a list of search results is displayed. Results can be filtered afterwards to narrow the number of records returned by the platform. The search-fine-tuning process can be performed by using a specific menu that enables the user to direct his/her search to its field of interest (e.g. SETAs tailored to a specific cropping system, desired effect of the SETA, etc.). Once the record of interest is identified, the user can click on it and be redirected to the relevant tab containing all the specifications of the SETA. For industry products (Fig. 3), relevant information displayed are:

- name of the SETA and a picture of the product

- the Technology Readiness Level (TRL)
- a general description including innovative elements of the products
- contact details of the producer and link to the webpage of manufacturer where further details can be retrieved
- link to audio-video material (if any)a list of keywords related to that SETA. The latter are interactive and can be clicked to have the user redirected to other related industry solutions.

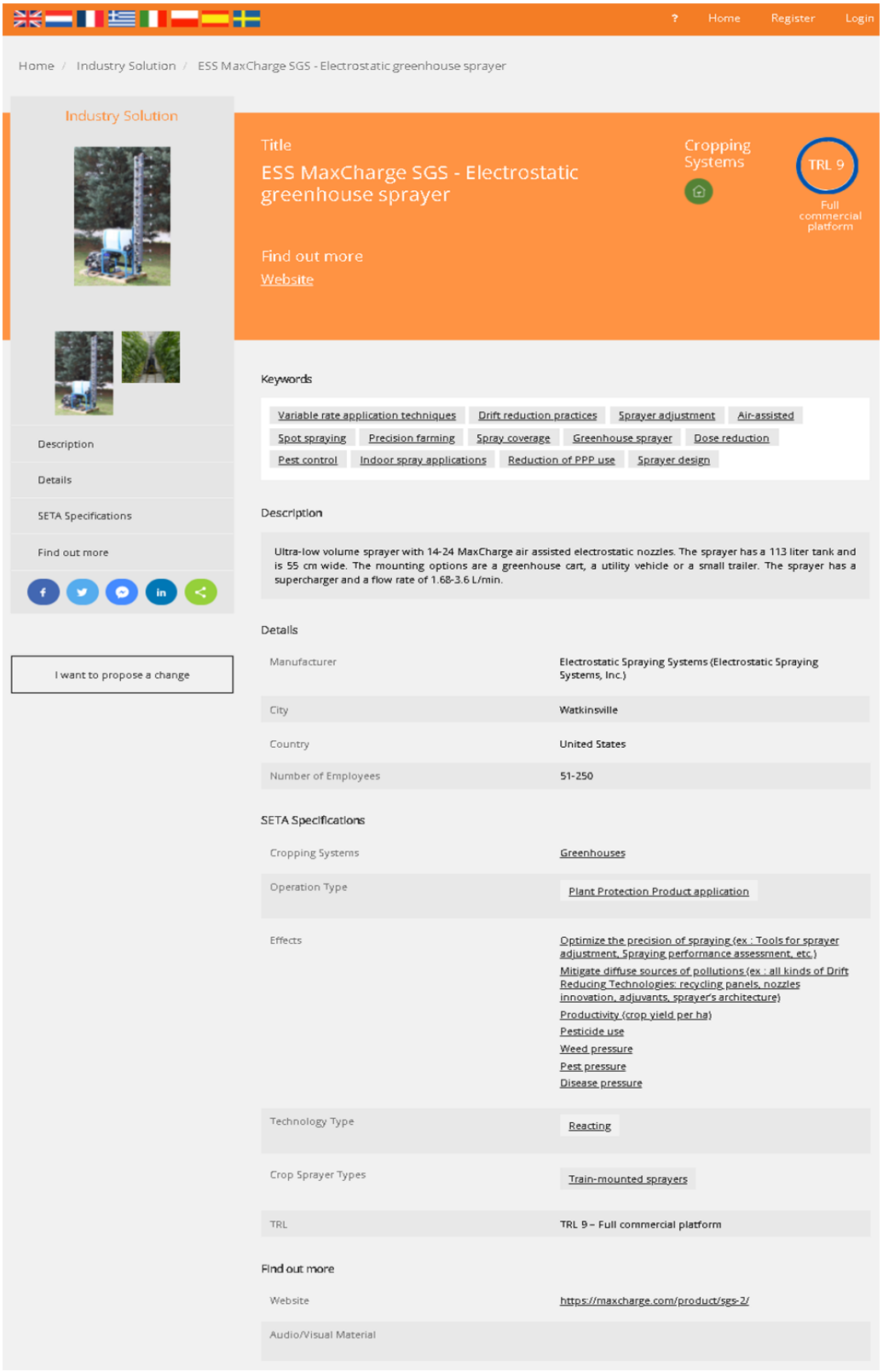


Fig. 3. Example of mock-up card for industry solution category.

For technical and scientific papers, in addition to the cultivation system on which the work focuses, the list of authors, bibliographical references (Journal name, title and year of publication, etc.), abstract as well as the type of operation for which the SETA was studied/tested are presented. The framework dedicated to projects contain information about the contents and objectives of the project, as well as the link to the database from which the information was obtained, the type of crop and operation on which the project was carried out and its objectives. As for the fourth category of SETAs (training and advising material), a brief description of the type of publication/ video/brochure presented in the sheet is shown in addition to the link to the original material, the field of application of SETA (e.g. sprayer calibration), as well as the crops to which it is tailored.

Results and Discussion

Results of SETAs collection

In Fig. 4 the accepted records for publication after the 3 years of the INNOSETA project activity are displayed. The first-round SETA collection set the baseline for the launch of the INNOSETA interactive online platform: 55 projects and 109 articles (both scientific and technical) were selected – after screening – to serve as first inputs for the platform as well as 188 industry products and 315 training and advising materials. The records covered a wide range of technical solutions (from sprayers' components to whole machineries, from DSS to mapping systems). Records came from 23 countries (including extra EU) and represented eight different languages. The following survey led to the collection of further 12 projects, 37 articles, 69 industry solutions and 39 training and advising materials. As for the first-round inventory, innovative sprayers represented the majority of records available and covered 36% of the records collected during the second-round inventory. After the third and final round of the survey more than 1000 SETAs were made available on the platform: 338 industry solutions, 77 research projects, 413 training materials and 203 scientific and technical articles.

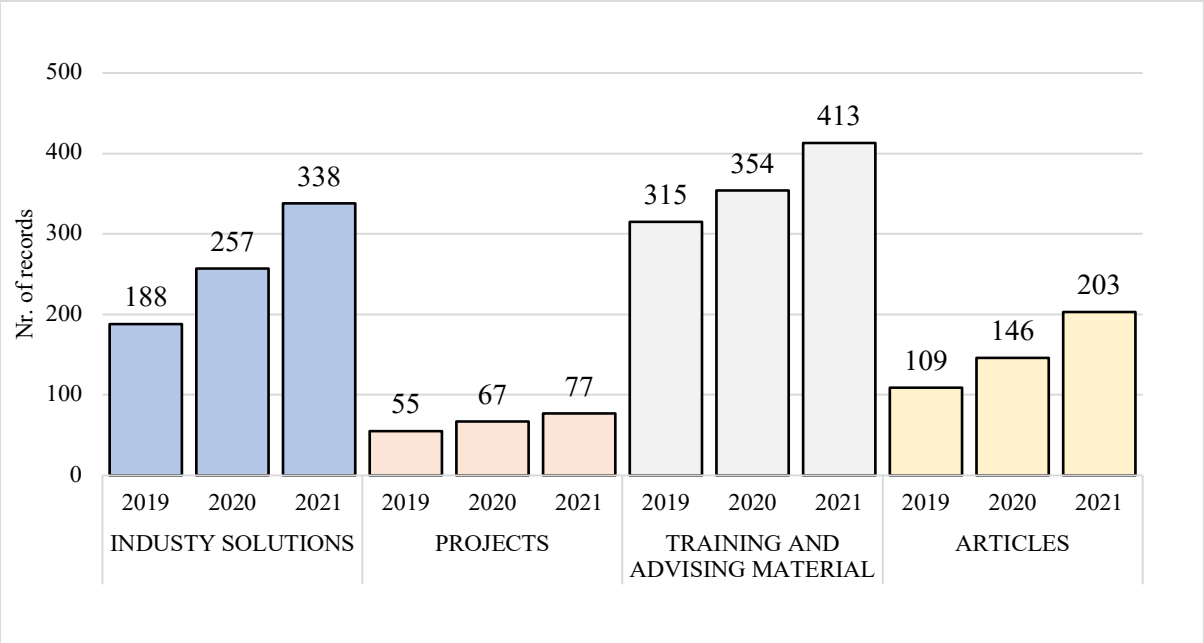
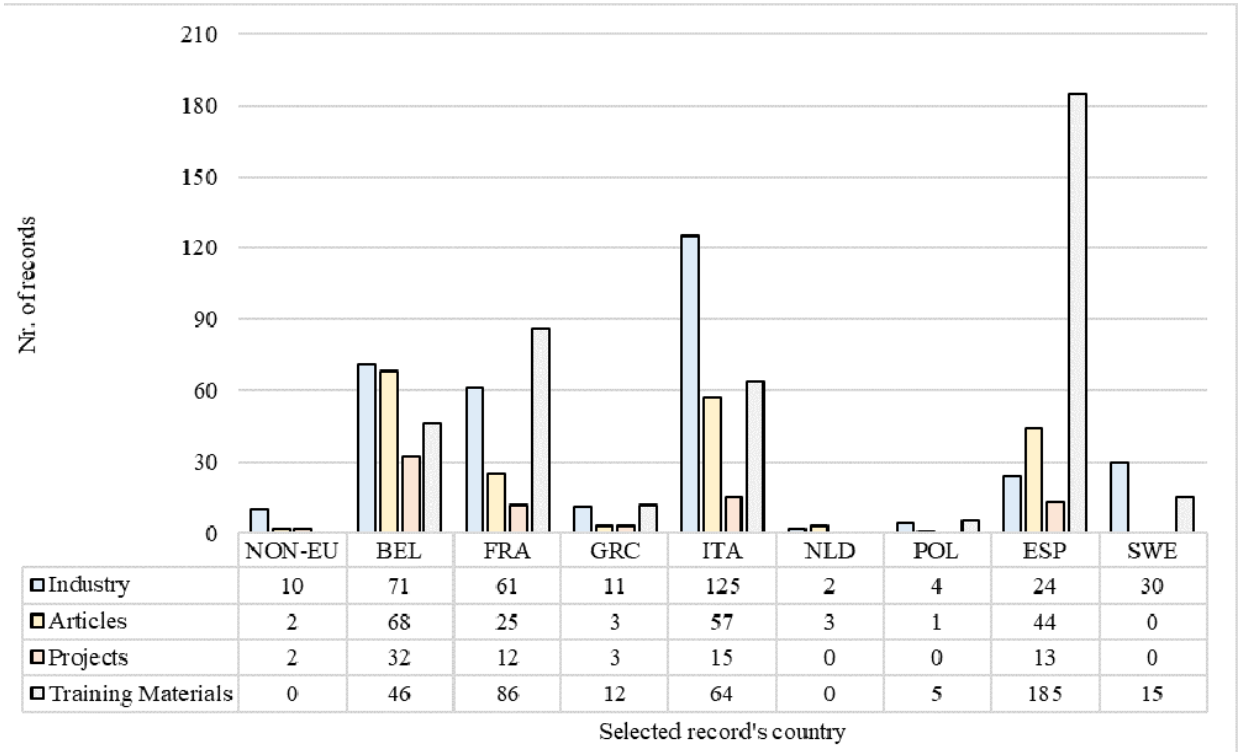


Fig. 4. Number of records per category available on the INNOSETA Platform in project period (updated 30 September 2021).

Considering the "Industry solutions" category, the majority of records are represented by innovative sprayers (n=130), components such as nozzles, sensors, filling and mixing systems (n=75) and integrated systems (n=62). The remaining 21% of the published industry products consists in support



	NON-EU	BEL	FRA	GRC	ITA	NLD	POL	ESP	SWE
Industry	10	71	61	11	125	2	4	24	30
Articles	2	68	25	3	57	3	1	44	0
Projects	2	32	12	3	15	0	0	13	0
Training Materials	0	46	86	12	64	0	5	185	15

Fig. 5. Records published on the INNOSETA Platform and divided according to the country of the users who proposed them (updated 30 September 2021).

systems (e.g. mapping and monitoring and steering guidance systems), sensors (weed and canopy detection sensors) and Personal Protective Equipment (PPE). Likewise, "innovative sprayers" is the numerically most represented group when it comes to collected projects and articles (30% and 40% of the records respectively).

For training materials and articles, records were proposed and collected also by non-EU Countries (i.e. USA, UK, Brazil, and China), reflecting how the aim of INNOSETA project matches not only EU Countries needs but also those from non-EU ones.

However, it should be emphasized that currently most of the selected records come from countries where at least one partner of the project is based (Fig. 5).

The Platform Use

Up to September 2021 Industry solutions resulted to be the most viewed category (4186 views) followed by Training Materials (2547 views), Projects (1265 views) and Articles (1058 views). In addition, looking at the most used filters available on the platform, it was shown that users are mostly interested in "optimizing the precision of spraying" (SETA-effect), "drift reduction practices" (keyword) and "bush & tree crops sprayers" (sprayer type).

A web traffic analysis showed that users are differently "guided" to the INNOSETA platform. Visits come through the direct (48.2%) and organic search (44.5%), but it was also shown that referrals and social traffic (7.3%) are important as well. In fact, the platform visitors are slowly, but constantly, increasing such as their interactions with it.

Conclusion

The INNOSETA Platform is a useful tool for stakeholders for gathering a wide range of information on PPP sprayers, sprayers' components and spraying operations. The effort by the partners in constructing it was to include the latest innovations and relative declinations.

The platform is "self-sustainable" as project partners consider that, by raising awareness about its existence among relevant stakeholders, more inputs will be provided. By setting this first solid base and implemented methodology to gather valid innovative and useful records, partners are confident that the implementation of the platform will be effective for its end goal and its further expansion will be easier as precise instructions and requirements can be followed.

The INNOSETA Platform will adopt different strategies to ensure long lasting impact thanks to Partners' further input and maintenance in collaboration with the three EU associations, COPA-COGECA, CEMA and ECPA (now CropLife Europe), that took part in INNOSETA, as well as with private sprayers and spraying components manufacturers and the link with EIP-AGRI.

Acknowledgements

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