INNOSETA
INNOVATIVE SPRAYING EQUIPMENT TRAINING ADVISING

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Deliverable 1.8: Industry solutions SETA material – second update

Accelerating Innovative practices for Spraying Equipment, Training and Advising in European agriculture

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Author(s): Fabrizio Gioelli, Paolo Marucco, Eric Mozzanini and Paolo Balsari (UNITO)

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Reviewer(s): Emilio Gil (UPC), David Nuyttens (EV ILVO), Sebastien Codis (IFV), Thanos Balafoutis (CERTH)

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Abstract

The final goal of Task 1.3 was to gather innovative **SETA**s (**S**praying, **E**quipment, **T**raining and **A**dvising**) regarding industry solutions**.

This third report illustrates the steps of the work, methods, including screening criteria, and results obtained in the third round of SETAs collection. A general overview of the number and type of records collected during the three years of project is also provided.

With the third round of the inventory, 129 industry solutions were collected and 77 were afterwards successfully validated as SETAs.

All newly collected records have been uploaded to the INNOSETA platform and are already available for farmers, contractors, suppliers, technicians and other stakeholders. Currently, considering the three rounds of the inventory, 334 industry solutions are freely accessible on the platform.

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Introduction

The main goal of WP 1 was to collect the latest innovations in terms of technology advancements in spraying and application techniques of PPPs in four cropping systems: open field, greenhouse, orchards and vineyards. Said innovations are defined as Innovative SETA (**Spraying, Equipment, Training and Advising)** and are gathered in the form of:

- **peer reviewed and technical papers**
- **national and international projects**
- **industry products**
- **training and advising materials**

The specific goal of WP1 – Task 1.3 is to provide the platform with records about the latest technical innovations in the field of PPPs application. Deliverable 1.8 reports the activity carried out to collect new records for the platform, the third survey outcomes and a general overview of the industry SETAs collected along the three years of project. Nevertheless, due to project extension, SETAs collection will continue until the new project deadline (October 31st).

1   Definition of SETA

As for the previous two years of activity, all partners were asked by the WP leader UNITO to look for and to collect data about SETA-related industry solutions.

As a basic criterion, SETAs had to deal with novel technologies for PPPs spraying, allowing farmers to optimize PPPs application, to avoid environmental pollution and to minimize PPPs residues on products.

To be consistent with the first two rounds of the inventory, partners were instructed to consider as a SETA:

-    I.   *every component, device, tool etc. that can be fitted to spraying machineries,*
-   II.   *a whole sprayer that presents innovative components/accessories,*
- III.   *devices/tools enhancing the environmental sustainability of spraying operation (e.g. closed transfer systems)*
- IV.   *training and advising material referred to sprayers and spraying operations*
-   V.   *a recent innovation (2010-2021).*

Therefore, the third round of the inventory focused on SETAs belonging to one of the above-mentioned categories. Industry products not directly connected to sprayers, to their setting and control and to spraying operations (including the operators' safety) were excluded from the search.

2 Third round survey

2.1 Data collection: roles of partners, data sources and search parameters

As described also in D1.6, collection of data was carried out during the whole period of time interested by this deliverable (month 24-month 36). In addition, a specific and thorough survey was also carried out in February - March 2021.

All partners were instructed to look for novel industry solutions belonging to one of the following categories:

- **spraying machinery and related components (nozzles, booms, etc.);**
- **software and hardware applied to sprayers and in spraying operations;**
- **devices and tools enhancing the operators' safety (e.g. PPE) or the environmental sustainability of spraying operations (e.g. test benches for the calibration of the sprayers).**

Partners looked for SETAs developed by local or international companies. As data-sources were considered:

- manufacturers' websites;
- personal contacts with private Companies;
- magazines and official websites concerning national and international fairs on agricultural machinery awards and mentions (e.g., FIMA, Agrilevante, Agritechnica, EIMA, ENOVITIS, MACFRUIT, SITEVI, etc.)

As for the second-round inventory, new SETAs were directly uploaded to the platform in "pending format" so that it was made it possible to track new entries and to screen results prior to final acceptance.

As stated also in D1.6, external users (e.g., academics, Companies, etc.) actively contributed to the database by uploading new SETAs. In order to promote external uploads, dissemination activities promoting the INNOSETA platform were organised and an instruction video 'How to upload SETAs" was produced. Therefore, the very last inventory result comprises data retrieved by the INNOSETA partners, SETAs producers and end users.

2.2 Results of the survey

The second-round survey led to the collection of 129 new industry solutions, 67% of which having the manufacturer located in Europe.

An overview of the number of *collected industry solutions sorted by country of location of the manufacturer* is reported in **Errore. L'origine riferimento non è stata trovata.**.

Table 1.Number of collected SETA-related industry solutions. Country is referred to manufacturer location

non-EU countries	Nr. of industry products	EU countries	Nr. of industry products
Argentina	1	Bulgaria	1
Australia	1	Czech Republic	1
Brazil	1	Denmark	3
Chile	1	France	6
China	3	Germany	16
Israel	1	Greece	5
Norway	1	Ireland	1
Switzerland	4	Italy	27
United Kingdom	16	The Netherlands	10
United States	15	Poland	1
		Spain	14
Total	**44**	**Total**	**85**

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As displayed in Figure 1, most of the new records (n=91) were proposed by the Innoseta partners, 3 by other institutions (namely the USDA and INRAE) and 35 by private Companies.
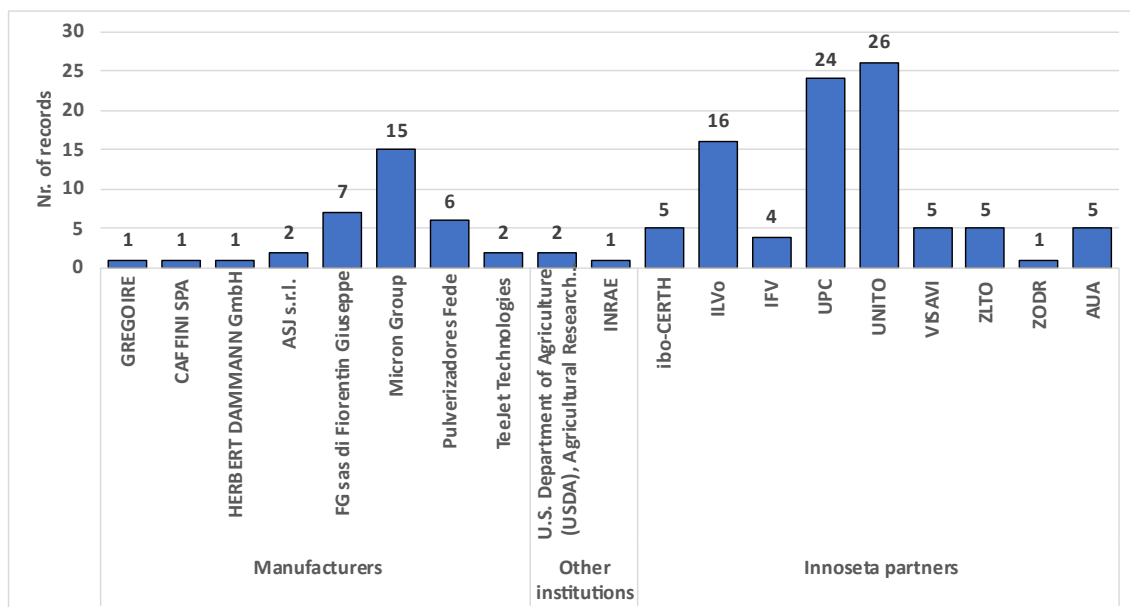

Figure 1. Contributors to the third-round survey (the figure is referred to pre-screening)

After collection a screening process was started. The followed procedure is described at the following paragraph.

2.3   Screening

As specified also in D1.6, since August 2020 the screening procedure has been improved and is now performed on a biweekly basis.

New entries (fed directly to the platform in pending mode by external users and project partners) are now exported to an Excel file by ILVO. The Excel file containing the records to screen is then uploaded by EV ILVO in a shared Google Drive folder. UNITO (for projects, papers and industry products) and UPC (for training materials) take care of the screening process. Records are at first checked to delete duplicates and incomplete entries. After this first screening, links to the final and screened files are sent to all partners for their feedback and translation of the approved records in their mother languages. Also, in case of "*incomplete entries*" (those lacking an exhaustive description and information) an integration of data or clarifications are asked to contributors. As for the first and second round SETAs collection, the screening process was based on acceptance and exclusion criteria summarized in Table 2 and 3.

Table 2. Detailed description of acceptance criteria used for selecting valid industry SETAs.

Criteria	Description
1. The technology must be **directly applicable or relative** to the sprayer machine	Any component, sensor or integrated system (sensor + actuator), tracking systems, monitoring systems and control units.
2.The technology or technique of application of PPPs should be **preferably innovative**	Completely new technologies are quite rare, declinations and small innovations that provide an advantage in terms of sustainability and efficacy of PPP application were considered valid.
3.Technologies should be **environmental sustainability-oriented**	The aim of the technology must explicitly be an improvement of the application of PPP in order to make the agricultural operation more sustainable that in previous/conventional ways. This type of technologies was considered more relevant as the main goal is improving the sustainability.
4.New technologies even though not particularly innovative	Some technologies have been developed over the course of the last decade. As aforementioned, this is not directly linked to a proper information and adoption by farmers. The diffusion of information about said technologies amongst farmers was hence deemed necessary. This complies with the goal of closing the gap between research and farmers.
5.Prototypes and new technology designs	Some companies advertise their technology advancements in the form of prototypes or designs. These types of entries were kept whether the innovation was quite recent (material published up to 5 years ago). Otherwise it is probable that the prototype/design was not carried out to commercialization.

Table 3. This table explains in detail type of industry solutions that have been excluded and why they were not considered valid.

Type of industry products excluded	Motivation
Guidance systems and mapping systems	Product can be used for a wide variety of field operations and are not exclusive for PPP application. For example, generic ISOBUS systems and field mapping for crop vigour and disease detection via satellite/drones.
Drones for application of PPP	in compliance with the ban implemented in article 9 of Directive 2009/128/EC of the European Parliament that restricts any type of aerial application of PPPs.
Operative technologies	Operative technologies related to machine movement or field maneuvers (e.g., machine movement facilitation, headland maneuvers).
Prototypes and new technology designs	Part of projects concluded/ideas proposed 5 or more years before survey that didn't end up to commercial exploitation.

2.4   Screening results

At the end of the screening process 77 out of 129 new industry solutions were approved by the consortium and were made available online on the INNOSETA platform. Table 4 shows the country of origin of the industry solutions according to the location of the manufacturer.

60% of the newly accepted SETAs are from the EU countries. Italian, German and Spanish industry solutions cover the 54% of the records collected and accepted within the third-round survey. When it comes to non-EU Countries, UK and USA contribute approximately to the 21% of new industry solutions.

Table 4. Number of selected industry SETAs after the screening process per location of manufacturer.

non-EU countries	Nr. of industry products	EU countries	Nr. of industry products
Argentina	1	Czech Republic	1
Australia	1	Denmark	3
Israel	1	France	2
Norway	1	Germany	14
Switzerland	2	Ireland	1
United Kingdom	9	Italy	21
United States	7	The Netherlands	6
		Spain	7
Total	**22**	**Total**	**55**

A list of collected SETAs sorted per manufacturer is displayed in Figure 2.
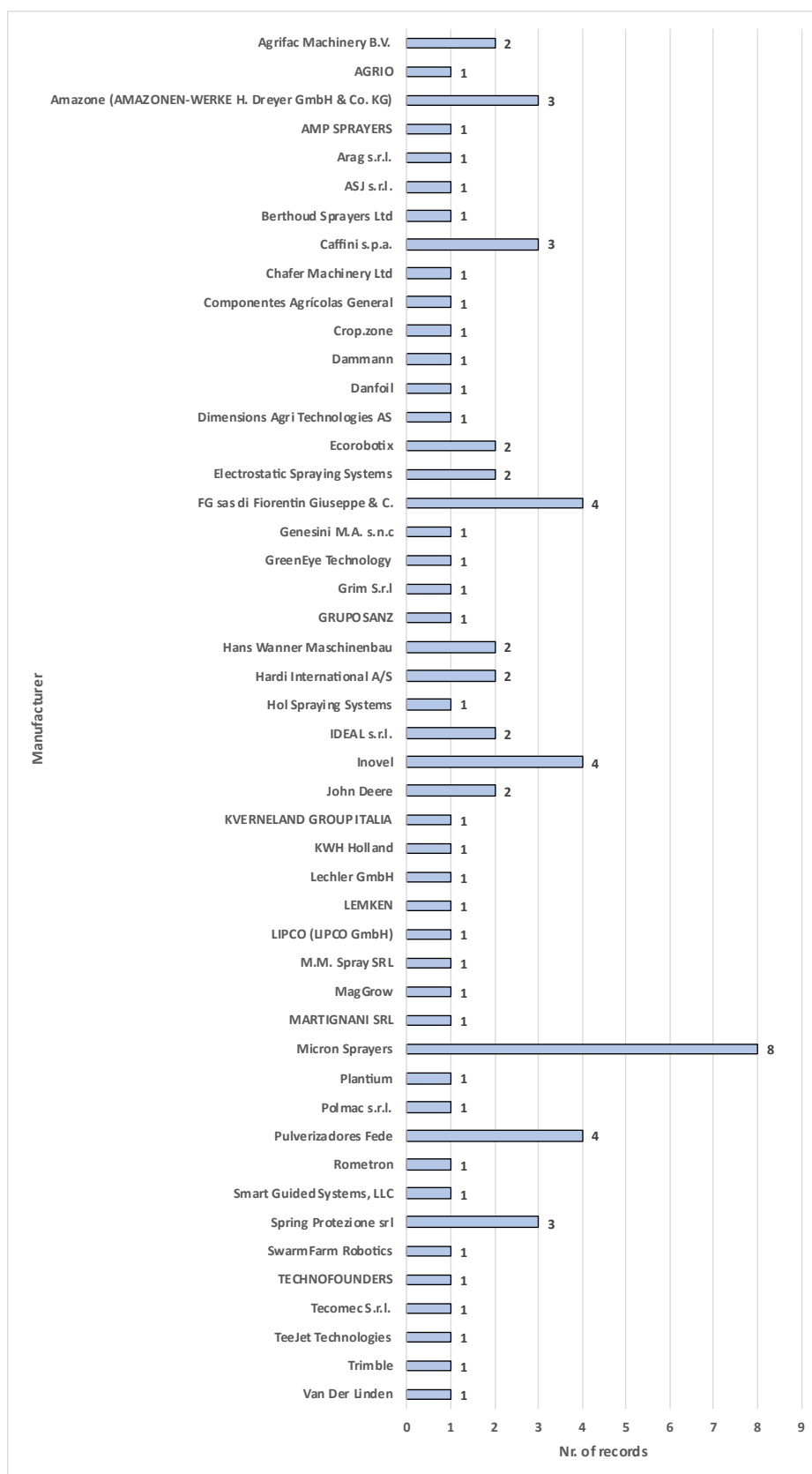
Figure 1. Accepted industry products sorted per manufacturer and accepted at the end of the third-round SETAs collection

3   Phase 3: Data aggregation

3.1   Methods

After screening, accepted SETAs were grouped and categorized. The categorization system emerged from the screening process itself and from the activity carried out at the end of the first and second-round inventory. This categorization ensues the technical nature of the industry product considered. Identified groups, categories and sub-categories are summarized in Table 5.

Table 5. Group, categories and sub-categories of Industry SETAS identified to classify the records into homogeneous sets of data.

GROUP	CATEGORY	SUB-CATEGORY	DESCRIPTION
Components			Any mechanical/electronic component of the spraying machine.
	Nozzles		Anti-drift nozzles, caps and accessories that facilitate and /or optimize the PPP application
	Nozzles Accessories		
	Valves		With sensor guided or automatic shut-off
	Fans		New types of distribution fans
	Sprayer Booms		Booms with innovative design
	Cleaning Systems		Cleaning nozzles and innovative systems to clean the tank, the hydraulic circuit or the sprayer exterior surface
	Filling Systems:		
		Closed transfer systems	Components that allow to easier insert the PPP in the sprayer without dispersing the product, contaminate the operator and the environment
		Direct Injection	Direct injection of PPP in the sprayer hydraulic circuit
		Filling level monitoring	Device that allows to automatically check the liquid level in the tank and to avoid overfilling
		Pre-mixers	Mixer tanks directly applicable to sprayers that allow to easier fill the sprayer and pre-mix the PPP with water. This reduces the risk of spillage and exposure of operators and contamination of the environment.
Sensors			Devices able to detect relevant information to optimize PPPs application

	Canopy Sensing		Sensors able to scan and perceive the dimension of the canopy and its density. This is essential for a correct the dose/volume of PPPs and for avoid over/underapplication
	Target detection:		--
		Weed detection	Ultrasound or LIDAR imaging systems able to detect weeds presence and or signs and symptoms of diseases and that allow to obtain a precise target spray
		Disease detection	
Integrated Systems			Systems that integrate the signal coming from a sensor component with that of the actuator
	Boom height control		System able to control and adjusts the position of the boom following the characteristics of the ground detected by a sensor, resulting in a more uniform application
	Control Units		It includes devices for automated spraying, computers that allow sprayers' adjustments
	Nozzle Control:		
		Variable rate/PWM	Recent technology that employs the duty cycle of a pulsing solenoid instead of spray pressure to control nozzle output. It ensures constant droplet size, ability to change pressure with instant response and doesn't drip
		On/Off section or single nozzle	Control of single nozzles that allows to more precisely apply PPPs where needed. For example, this technology can be combined with weed detection systems to treat only unwanted weeds
		GPS based nozzle control	A GPS system that detects where the PPP has to be applied, following prescription maps or operation data to avoid overlaps with already treated areas. It controls the nozzle activity

Support systems			Systems that support the farmer in the application process to reduce stress of decision making and operations.
	Guidance:		
		Automated guidance	Guidance of machinery automated following prescription map / pre-determined path
		Assisted Steering	Steering is made easier thanks to an automated system which reduces the stress for the operator
	Decision support System (DSS)		It might be an online page, software or app for smartphones/tablets to help farmer to decide when/how much PPPs to apply
	Monitoring		Monitoring operations is important to avoid overlapping of treatments
		Single/Multiple operation monitoring	One or more operations are monitored and registered
		Sprayer position via GPS	GPS system that allows to know where the machinery is located / has applied PPP
		Nozzle activity monitoring	Sensors that detect the activity and adjustment of the sprayer and its parts (e.g. nozzle pressure, eventual clogging, speed)
	Sprayer calibration support		Devices/tools (e.g. test benches, flow meters…) for the sprayers' calibration
	Mapping/recording		
		Field operations (automated data collection)	Software and apps for smartphones and/or tablets that keep track of treatments (area, date and time, product used), products in stock.
		Field mapping (Drones/Satellite)	Prescription maps obtained by Satellite or Drone imaging systems
Innovative sprayers			Spraying machineries with innovative elements
	Sprayers for field crops		In these subgroups were included sprayers that carry an innovative element (component or sensor) but were presented as a whole new innovative machine by the manufacturer. They were divided by crop type of use.
	Sprayers for arboreal crops		
	Sprayers for greenhouses		
Personal Protective Equipment (PPE)			Devices and items designed to protect operators from contamination by PPPs

3.2 Final results after SETAs' categorization

Results of the 77-industry solutions categorization is shown in Figure 3. As for the first two rounds, innovative sprayers (39 records) represent the majority of collected SETAs covering the 51% of the records. Arboreal crops sprayers (n=15) and field crop sprayers (n=13) represent the majority of newly approved SETAs in this group.

Integrated systems (12 SETAs) and Support systems (9 records) are the other groups with the highest number of innovative SETAs (27% of the newly collected industry solutions). Sensors and Components (7 records each) together with PPE (n=3) complete the list of industry products approved at the end of the third-round survey (22% of the total industrial products). In Figure 4, a general assessment of the quantity of SETAs considering both the categorization and country of manufacturer is shown.
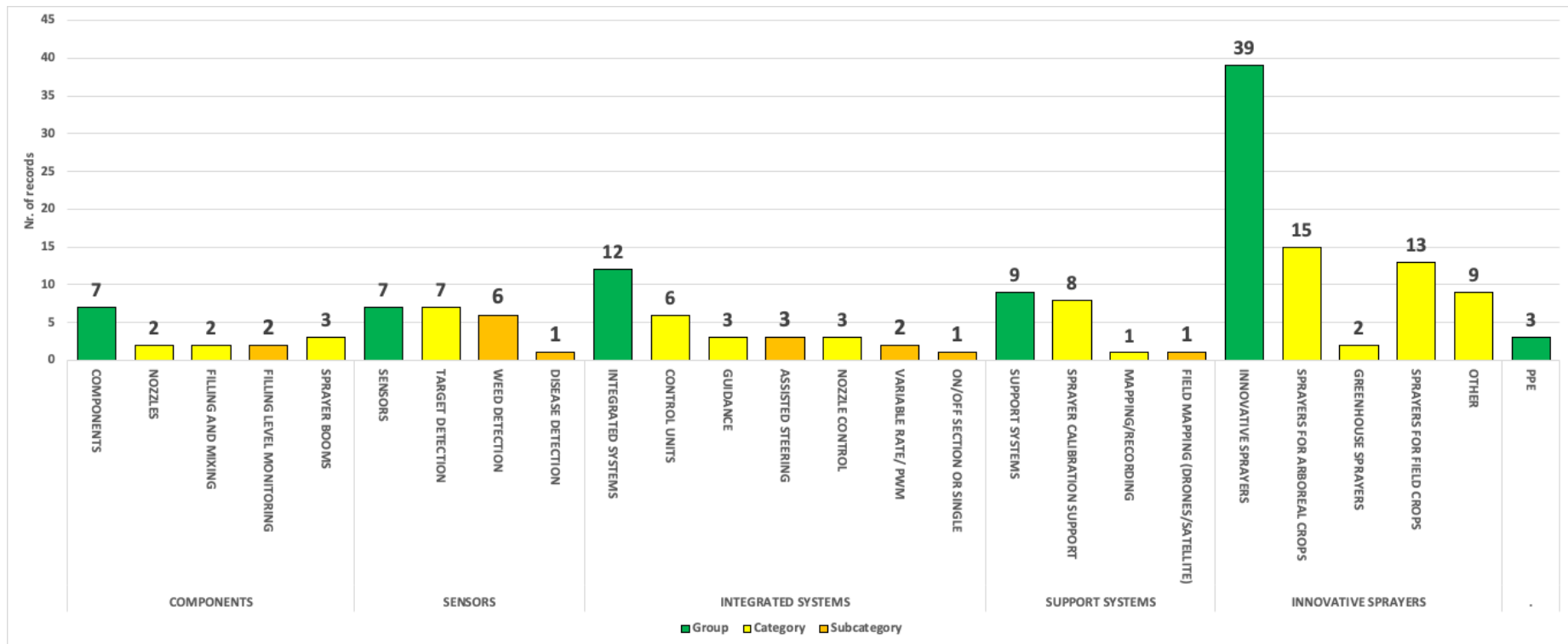
Figure 2. Number of approved industry SETAs listed in groups, categories and subcategories

	Germany	Ireland	Italy	Czech Republic	Denmark	United Kingdom	Argentina	Australia	France	Netherlands	Spain	Switzerland	United States	Israel	Norway
■ Innovative sprayers	5		10	1	2	7	1	1	1	2	5	1	3		
■ Support systems	1		4						1		1	1	1		
■ Integrated systems	5		2		1					3	1				
■ Sensors	1									2			2	1	1
■ PPE			3												
■ Components	2	1	2			2									

■ Components ■ PPE ■ Sensors ■ Integrated systems ■ Support systems ■ Innovative sprayers

Figure 4. Accepted SETAs in the third collection round categorized according to SETA type and Country of manufacturer

4   Conclusions

In Figure 5 an overview of the industry solutions uploaded to the platform at the end of the three rounds of the inventory is provided. It can be noticed how the number of records evenly increased from the 188 initial records (end of round 1) to 257 at the end of round 2 to the present 334 SETAs.

A figure of the 334 industry SETAs available on the platform is provided in Figure 6. SETAs are grouped per type and manufacturer's country. Data show that the collected SETAs belong 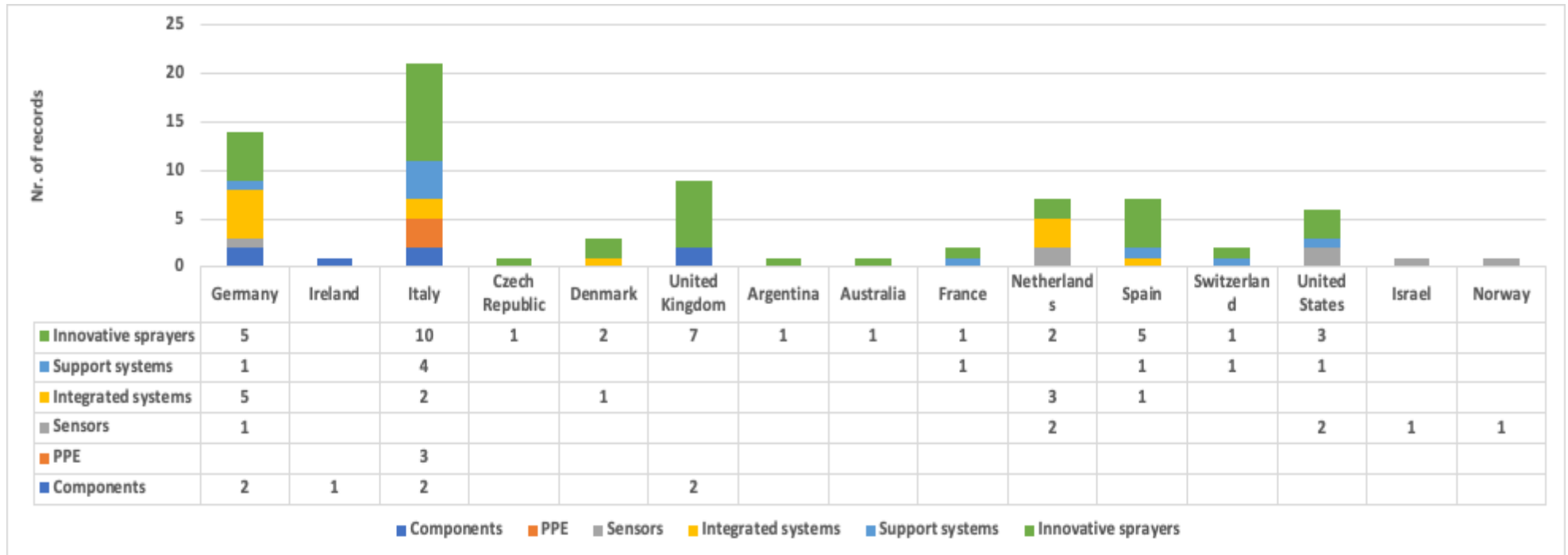mostly to innovative sprayers (39%), components (24%) and integrated systems (18%) groups. Innovative sprayers have their manufacturers mainly based in Italy (25%). Spanish, Belgian and Dutch manufacturers cover 34% of the records. The second most represented group of SETA is "components" mostly produced by French (23%), German (18%) and USA (14%) Companies. For integrated systems German manufacturers alone covers the 30% of the records.

Figure 7 displays all records collected during the three years of project categorized in groups, categories and subcategories. As it can be noticed, sprayers for arboreal and for field crops are the two most represented categories of SETAs available on the platform.
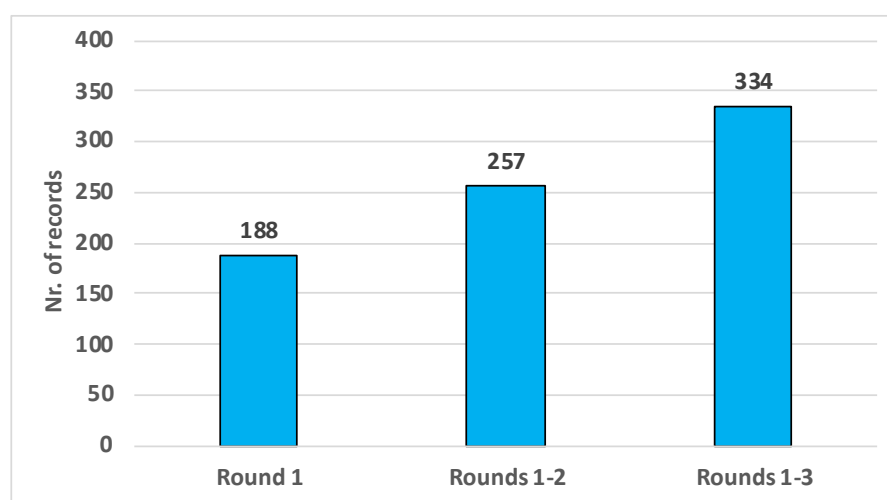

Fig. 5. Number of industry SETAs available online after each survey (2019, 2020, 2021)

In Table 6 the complete list of industry SETAs present on the platform divided per manufacturer is shown. Currently, 149 manufacturers are present on the platform.

	Belgium	Brazil	Canada	DK	France	Germany	Greece	Italy	NL	Norway	Poland	Slovenia	South Africa	Spain	Sweden	UK	USA	Ireland	Czech Rep.	Argentina	Australia	CH	Israel	Norway
■ Innovative sprayers	15	1		5	8	9	1	33	14	1	5	1	1	16		12	4			1	1	1		
■ Support systems	15				7	4	1	8						1		1	3					1		
■ Integrated systems	3		2	4	5	18		8	9					3		6	3							
■ Sensors					3	2		1	3							2	4						1	1
■ PPE					4			3																
■ Components	4			7	18	14	1	9	3					2	1	8	11	1						

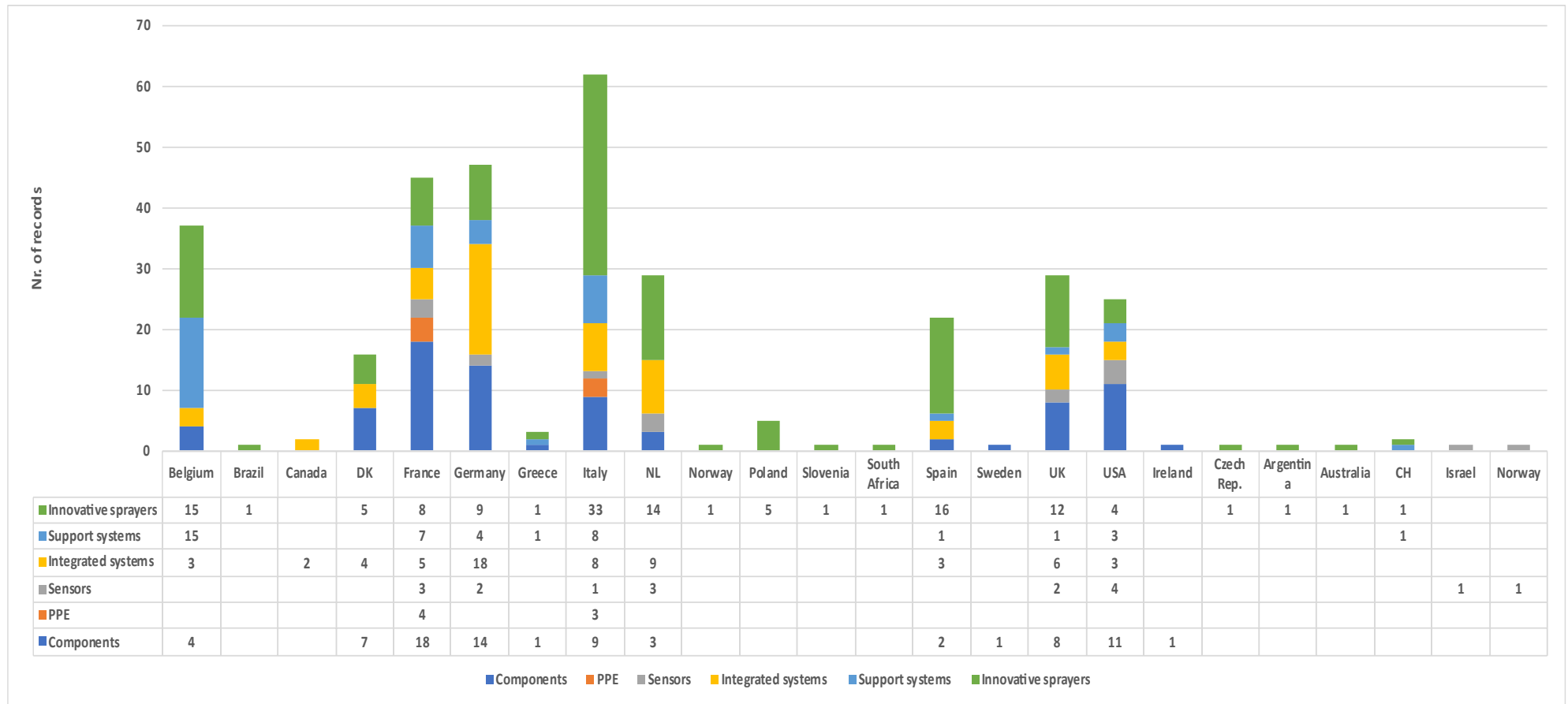■ Components ■ PPE ■ Sensors ■ Integrated systems ■ Support systems ■ Innovative sprayers

Fig. 6. The 334 industry solution SETAs available on the platform - at the end of round 3 - classified according to the manufacturer's Country and SETA type
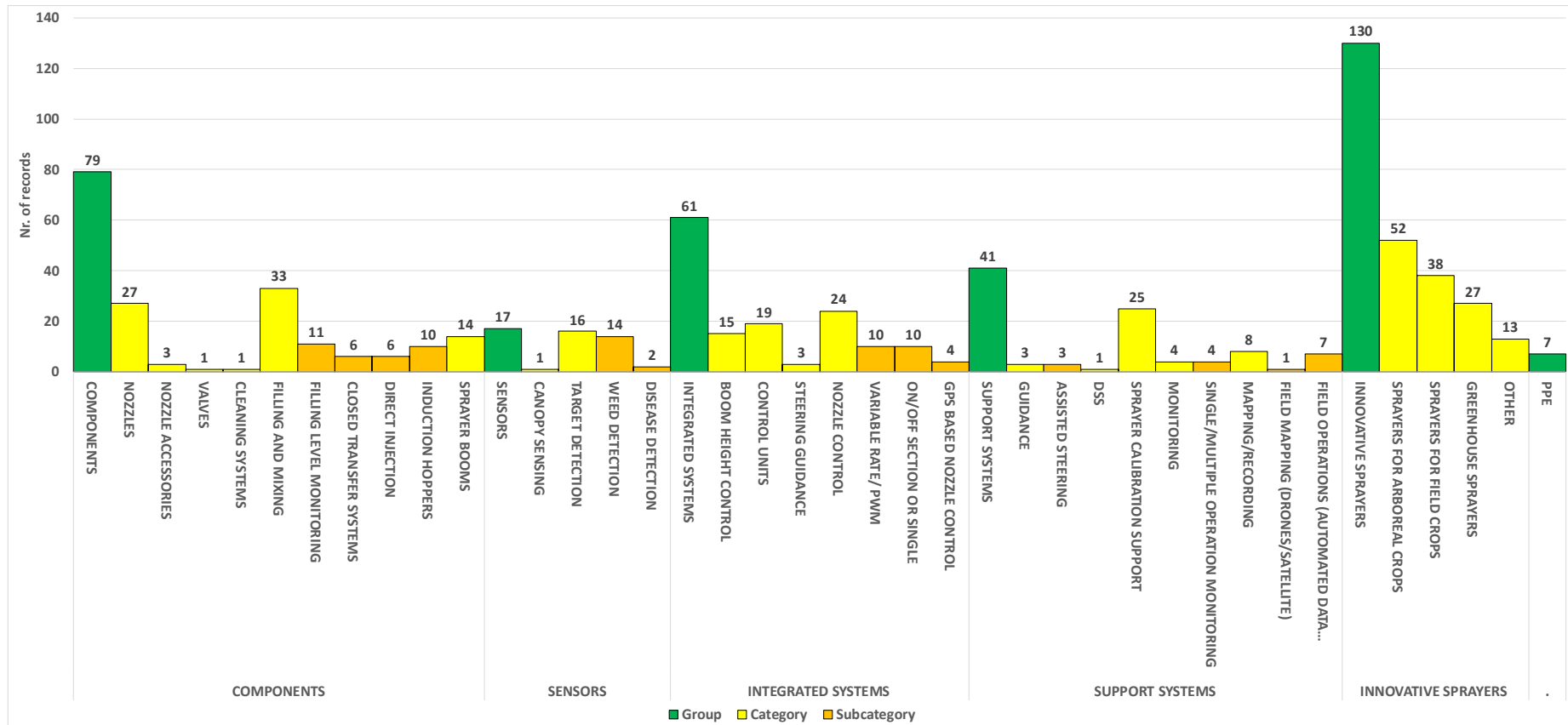
Fig. 7. The 334 industry solution SETAs available on the platform - at the end of round 3 – classified according to group, category and subcategory

Tab. 6. List of SETAs' manufacturers and number of records available on the platform

	MANUFACTURER	No. Of SETAs
1	AAMS - Salvarani	17
2	Aerts Landbouwmechanisatie	1
3	AFS SA	1
4	AGENSO	1
5	Agricolmeccanica s.r.l.	2
6	Agrifac Machinery B.V.	13
7	AGRIO	1
8	Agrotop Gmbh	3
9	Agrotronix	3
10	ALBUZ SOLCERA	4
11	Alsco Industrial Products, Inc.	1
12	Amazone (AMAZONEN-WERKE H. Dreyer GmbH & Co. KG)	7
13	AMP SPRAYERS	1
14	Arag s.r.l.	8
15	Arbos group s.p.a.	1
16	Arvatec	1
17	ASJ s.r.l.	2
18	Axe environnement	4
19	BAB-BAMPS	3
20	Baekelandt Machinebouw	1
21	Balven	1
22	BASF SE	2
23	Bateman Sprayer	1
24	Bayer	1
25	Bedouelle Distribution	1
26	Berthoud Sprayers Ltd	5
27	Bertoni s.r.l.	1
28	Bestway	1
29	Beyne NV	2
30	Bilberry	1
31	Billericay Farm Sevices Ltd	1
32	Blue River Technology	1
33	Bogaerts greenhouse logistics	7
34	Bosch Engineering GmbH	1
35	BRDR. TOFT MASKINFORRETNING A/S	1
36	CABEDO	1
37	Caffini s.p.a.	8
38	Cafralu bvba	1
39	Carbon Bee AgTech SAS	1
40	Carretillas Amate	1
41	Central Institute for Decision Support Systems in Crop Protection (ZEPP)	1

42	Cepovett	1
43	Chafer Machinery Ltd	1
44	Chambre d'agriculture du gard	5
45	CICLONE S.R.L.	1
46	Cima s.p.a.	2
47	Cole-Parmer Instrument Company, LLC	1
48	Comatra Camera Monitor Systems	1
49	COMPONENTES AGRÍCOLAS GENERAL S.L	2
50	Crinklaw Farm Services Inc	1
51	Crop.zone	1
52	Dagnaud	1
53	Dammann	1
54	Danfoil	1
55	Deere & Company	10
56	Delvano	3
57	Dhugues	1
58	DiiMOTION	2
59	Dimensions Agri Technologies AS	1
60	Dragone	1
61	Dubex B.V.	1
62	Ecorobotix	2
63	Egreen Technology bvba	1
64	Elatec	1
65	Electrostatic Spraying Systems	2
66	Elivent s.r.l.	1
67	Estel	1
68	Evrard	1
69	FG sas di Fiorentin Giuseppe & C.	6
70	Garford Farm machinery Ltd	2
71	Genesini M.A. s.n.c	1
72	GOtrack Sp. z o.o.	1
73	GreenEye Technology	1
74	Greentronics	1
75	GREGOIRE	1
76	Grim S.r.l	1
77	Grupo Jacto	1
78	GRUPOSANZ	1
79	Hans Wanner Maschinenbau	2
80	Hardi International A/S	12
81	Herbst	1
82	Herpa	1
83	Hol Spraying Systems	1
84	Holland Green Machine	Greenhouse Equipment	2

85	Horsch Maschinenbau Gmbh	1
86	Househam Sprayer Ltd	2
87	Hypro	1
88	I and M Smith	1
89	IDEAL s.r.l.	3
90	IDM	2
91	Inovel	4
92	Knight Farm Machinery Ltd	3
93	Kuhn	7
94	KVERNELAND GROUP ITALIA	2
95	KWH Holland	1
96	Landquip Ltd	1
97	Lechler GmbH	8
98	Lemken - The Agrovision Company	2
99	LIPCO (LIPCO GmbH)	2
100	Logiqs B.V.	1
101	M.M. Spray SRL	1
102	MagGrow	1
103	Mañez y Lozano	1
104	Marechal Agricole	1
105	Marisan	1
106	MARTIGNANI SRL	3
107	MASTROLAB s.r.l.	1
108	MC Elettronica S.r.l.	1
109	Micron Sprayers	11
110	Müller-Elektronik GmbH und Co. KG	13
111	Munckhof	1
112	NOBILI S.p.a.	3
113	Norac	1
114	Ouvry	1
115	Oxford Lasers Ltd	1
116	Plantium	1
117	Polmac s.r.l.	4
118	Precision Makers	1
119	Pulverizadores Fede	5
120	Pythagoras Spray K. Genou & Co	1
121	Raven Precision	1
122	Ricosma	1
123	Rometron	1
124	Royal Brinkman International BV	1
125	SIKA Dr. Siebert & Kühn GmbH	1
126	Skovhave	1
127	Smart Guided Systems, LLC	1

128	Spezia srl	1
129	Spring Protezione srl	3
130	Steketee	1
131	SwarmFarm Robotics	1
132	Syngenta	4
133	TECHNOFOUNDERS	1
134	TechProdis	1
135	Tecomec S.r.l.	1
136	Teejet	7
137	Toselli Srl	1
138	Trimble	3
139	UNIA Grudziądz	2
140	Van Der Linden	1
141	Vantage Atlantique-Méditerranée - Trimble	1
142	Viby Teknik	1
143	Visser Horti Systems	2
144	VitiBot	1
145	Weber GmbH & Co. KG	1
146	Windontec	1
147	Wingssprayer	1
148	Zupan sprayers d.o.o.	1

Attached to this deliverable the complete database in the form of an Excel file is also provided. Four datasheets are available: i) data from first round inventory, ii) data from second round inventory, iii) data from third round inventory and, iv) all data currently available on the platform (rounds 1 through 3).

The platform will be further implemented in the coming months until the end of the project (October 31st 2021). Nevertheless, the platform functionality will be further guaranteed also after the INNOSETA closure.