FARMDROID

FarmDroid +Spray System

User Manual

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1 General Information

This user manual is exclusively for the **FarmDroid +SPRAY System**. It provides **essential operational and safety guidelines** for users.

In this manual, two different symbols are used to highlight **critical information**:

Safety Warning: Used to indicate **important safety-related** precautions that must be followed to prevent hazards.

Operational Note: Highlights **key operational details** for optimal system performance.

Important:
Due to **continuous software improvements**, this manual may refer to the **FarmDroid Knowledge Base** for up-to-date guidance on **specific procedures**. While this manual provides a structured overview, some sections will direct you to an **online knowledge base article** for the **most current and detailed information** on that topic.

For further assistance, visit the **FarmDroid Knowledge Base** or contact your **local distributor**.

1.1 FarmDroid Knowledge Base:

The FarmDroid Knowledge Base is an online resource where FarmDroid provides continuously updated guides, troubleshooting steps, and technical documentation for its products. It serves as a central hub for users, ensuring access to the latest best practices, software updates, and maintenance procedures.

Why Use the Knowledge Base?

Up-to-Date Information: The Knowledge Base is regularly updated to reflect the latest software changes, hardware improvements, and operational guidelines.

Practical Instructions: While this manual provides structured reference material, detailed processes such as priming, calibration, and software adjustments are covered in the Knowledge Base with step-by-step instructions, images, and videos.

Easy Access: Throughout this manual, you will find references to relevant Knowledge Base articles, guiding you to more in-depth resources when needed.

Access the Knowledge Base here: https://knowledge.farmdroid.io/

1.2 Manufacturer contact information:
FarmDroid ApS
Industrisvinget 5
DK - 6600 Vejen

Web: www.farmdroid.com
Mail: info@farmdroid.com

1.3   Certificate of Conformity

EU Declaration of Conformity

Manufacturer

FarmDroid ApS
Industrisvinget 5
DK – 6600 Vejen

Authorized person in the Community to compile technical file

Thomas V. Olesen
FarmDroid ApS
Industrisvinget 5
DK – 6600 Vejen

Product:	Spot Application System v1.5
Commercial name:	⁺SPRAY
Functional description:	The ⁺SPRAY is a precision mixing and dozing system of plant protection chemicals used for weed control in farming. It is only used with the Farmdroid FD20, self-propelled sowing and weeding robot, where it can be factory mounted, or retrofitted.
Accessories:	Tubing, connection wires, spray nozzles.

Example photo, setup may vary

We, Farmdroid ApS, declare under our sole responsibility that the abovementioned product is in conformity with the relevant Union harmonization legislation:

- Machine Directive   2006/42/EU
- EMC Directive   2014/30/EU
- RoHS 2 Directive   2011/65/EU with Directive (EU) 2015/863

The following harmonized standards and technical specifications have been applied:

Safety	ISO 13849-1:2015
	ISO 13850:2015

Thomas V. Olesen (signature)

Thomas V. Olesen

Head of R&D
Position

28-01-2025, Vejen
Date / Place

Ver. 1.0 20-09-2024

2 Safety Information

The **FarmDroid +Spray** has been designed with a focus on safety and sustainability. Before operating the +SPRAY system, it is essential to follow **general safety precautions** to ensure **safe operation, longevity of the system, and environmental responsibility**. These warnings must be **strictly adhered to** during **setup, operation, maintenance, and storage** of the +SPRAY system.

Avoid High-Pressure Cleaning of Electrical Components.
Never clean the electrical components of the robot, including the **+Spray electrical box**, solar panel charger, or any other part of the **FD20**, using a pressure washer. Water must not come into direct contact with these components to avoid damage or potential safety risks.

Follow the Recommended Service Schedule.
Adhering to the **service schedule** outlined in this manual is essential for maintaining optimal performance and ensuring the durability of the product.

The **+Spray** must be turned on manually on the HMI under the "Tools" section before usage and all the readings must be followed on the dedicated page on the HMI.

Wear Protective Gear.
Always wear the recommended **protective clothing** and gloves while operating the **+Spray system** or handling agricultural products.
Wash hands thoroughly after completing any work involving the system or handling chemicals.

Observe FD20 Safety Instructions.
All **FD20 safety instructions** must be followed when operating the **+Spray system**, as it is an integral part of the robot's operation.

Use Chemicals Responsibly.
Always handle and apply chemicals according to the **safety instructions provided by product manufacturer.**
Ensure proper labelling and usage to prevent misuse and potential harm.

Prevent Environmental Contamination.
Be cautious of the **environmental dispersion of harmful chemicals**. Use the system in accordance with local environmental regulations to minimize contamination risks.

Read All Labels Carefully.
Carefully review all chemical product labels before use. The correct handling, mixing, and application of chemicals is critical for safe and effective operation.

2.1   Label Description and Safety indications

The **+SPRAY system** is equipped with **safety labels** designed to ensure **proper handling and minimize risks** during operation, maintenance, and storage. These labels provide **critical warnings and guidelines** to protect both the **operator** and the **equipment**.

Some safety labels are **standalone**, while others may be **grouped inside larger information panels** in specific areas of the system where multiple warnings are necessary. Each label is designed according to **international safety standards (ISO 7010:2019E)** to ensure **clear and universally recognized hazard communication**.

In this section, you will find **illustrations and descriptions** of the key safety labels present on the +SPRAY system, including:

Their **ISO reference number**

Their **meaning** and **associated hazard**

Their **location** on the system

The **necessary precautions** to follow

Important: Always read and follow the **instructions on each label** before operating or servicing the system. If a label is **damaged, faded, or unreadable**, it must be **replaced immediately** to maintain safe operation.

Label	ISO Reference Nr.	Description	Hazard
	M001	*General mandatory action sign*	Risk to people not following the mandatory action specified by the supplementary sign
	M002	*Refer to instruction manual/booklet*	Not reading the instruction manual before starting work or before operating could lead to equipment malfunction.
	M004	*Wear eye protection*	Flying object, particles
	M009	*Wear Protective Gloves*	*Protection from liquid that can cause bodily harm*
	N/A	*Wear full suit Protective clothing, including gloves, body suit, mask and eye protection*	Chemicals, heat or cold
	M011	*Wash your hands*	Infection or contamination

	N/A	*Rinsing water*	*Water should only be used for rinsing purposes*
	W001	*Warning General warning sign Toxic material*	Risk to people by the supplementary sign
	W016	*Warning; Toxic material*	Poisoning
	P005	*Not drinking water*	Water unsuitable for drinking

The following safety labels are **integrated into the machine's labeling system**, ensuring clear and visible placement in critical areas of the +SPRAY system.

Below, you will find a **table illustrating the labels used on the +SPRAY system**, along with their **ISO reference number, meaning, and specific location** on the machine.

Label	Location	*Overview*
	WATER TANK	Instructions for the correct usage of the water tank. Water can be contaminated, do not drink or use the water for cleaning purposes
	APPLICATION TANK	Instructions for the correct handling of the product tank. Contains agricultural product that could represent a harm for human and animal health.
	MIXING UNIT	Handling and safety instruction of the +SPRAY system, and overview of the handling of the mixing unit.

	9 SERVICE POINT	Service spots indicating screws or zoned of easy access to perform service and inspection operations.
	RENSING VALVE	Section where the Valves are located, parts of the system in charge of the cleaning the spraying lines.

2.2 Technical Data

General	
Product name	+Spray System v1.5
Version	V1.0
Item no.	104010005R00
Technical	
Clean water tank volume	55 litres
Product application tank volume	55 litres
Mix tank volume	0,15 litres
System internal volume [1]	0,15 litres
System design pressure	10 bar
System operating pressure	2-4 bars
System flow	0,05l/min-0,4 l/min
Operating capacity spot spray [2]	Approx. 24 hours
Operating capacity band spray [3]	Approx. 12 Hours
Pump type application tank circulation	Closed impeller type Qmax 20 l/min@0,5bar
Pump type fill/mix	Positive displacement Diaphragm Pump Qmax 1l/min@6 bar, 100 PSI bypass springs, VITON seals, Santoprene Diaphragm
Pump type main system	Positive displacement Diaphragm Pump Qmax 1l/min@6 bar, 100 PSI bypass springs, VITON seals, Santoprene Diaphragm
Nozzle types	TeeJet TP250025 – 0,025GPM(0,1l/min)@3bar, 25° spray angle TeeJet TP250040 – 0,025GPM(0,1l/min)@3bar, 40° spray angle
Nozzle control	PWM controlled with adaptive frequency 0-20Hz, duty cycle control 0-100%
Operational power consumption	30-60 Watts
Standby power consumption [4]	15-20 Watts

1) Internal volume calculated downstream Mix Tank, based on 6-row configuration.
2) Based on 6-row machine, 2,7m working width, 720 m/h working speed and 8x8cm spray on crop.
3) Based on 6-row machine, 2,7m working width, 720 m/h working speed and 8cm wide band spray.
4) Standby power consumption includes power for application circulating pump.

3 System Overview

3.1   General overview of the +SPRAY System

The FarmDroid +Spray System (from hereon after mentioned as "+Spray") is an embedded add-on for the FD20 robot. The +Spray enhances the operative capabilities of the robot by making it possible to perform chemical regulation of weeds, insects, diseases, or alternatively apply liquid fertilization, in combination with mechanical weed control.

The +Spray is controlled by the FD20 and is fully integrated with the software of the robot. For this reason, please refer to the main FD20 manual to understand the functionalities of all the other systems and operations, which are not covered by the +Spray System.

ℹ️   The +Spray can only perform chemical application in fields that have been seeded with the FarmDroid FD20.

3.2   Working Principle of the +SPRAY System

The **FarmDroid +SPRAY** system utilizes a one-to-one mixing process that combines clean water with a pre-diluted agricultural product. This ensures that clean water is always available on the sprayer, improving efficiency and safety.

Since the system maintains a one-to-one mixing ratio, the concentration of the agricultural product in the product application tank must always be **twice the target concentration**. This concept is illustrated in the figure below:
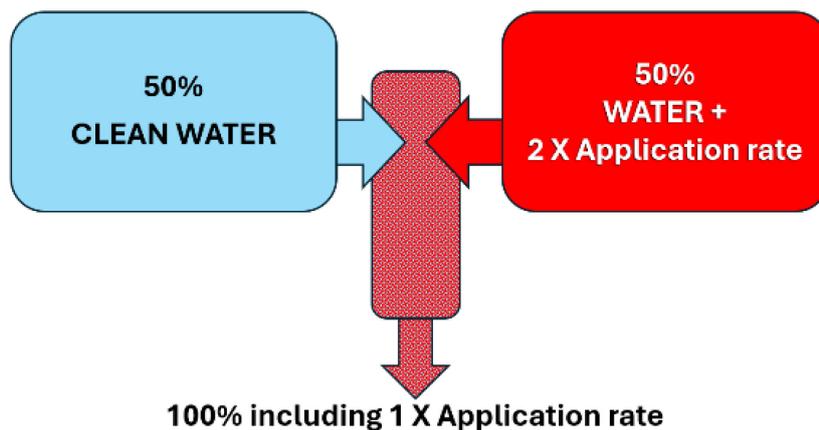
Figure 1: The basic principle in the unique and innovative FarmDroid +Spray System

(Figure 1: One-to-One Mixing Principle)

(Illustration of how clean water and a pre-diluted agricultural product are combined to achieve the correct application concentration.)

![Insert the provided diagram here]

Besides being part of the spraying system, the availability of clean water offers additional functionalities, including:

- Rinsing and cleaning of system components
- Handwashing for operator safety
- Reduced risk of contamination in case of maintenance or refilling operations

Side Note: Product Tank Agitation System

To prevent sedimentation and agglomeration of the agricultural product, the **product tank is equipped with an agitation system** consisting of a pump and a valve. This ensures circulation and uniform mixing, maintaining the proper consistency of the agricultural product throughout the spraying process.

3.2.1 Description for Diagram 4: +SPRAY Detailed Piping & Instrumentation Diagram (P&ID)
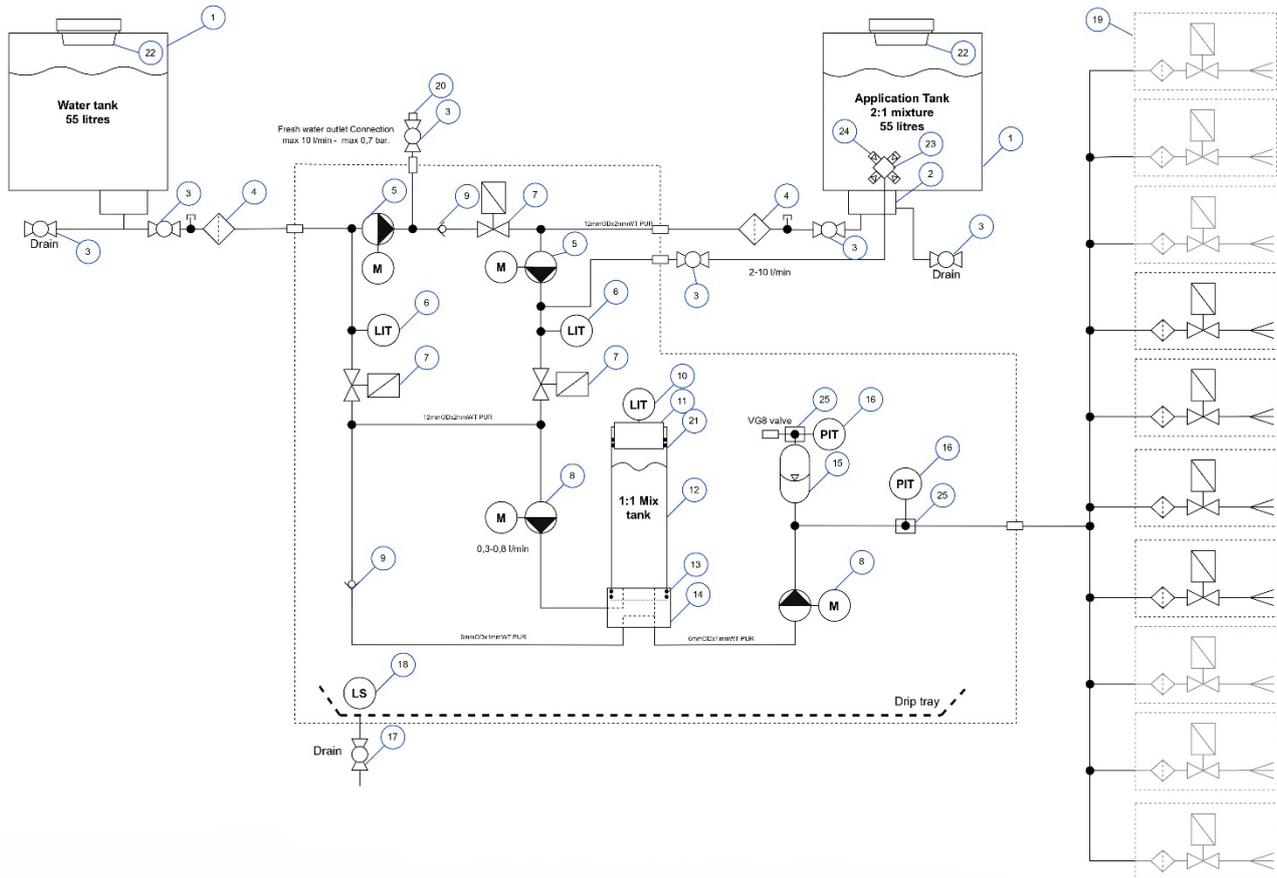
1	Storage tank, 55 liters	14	Bottom console for mix tank
2	Circulation manifold for Application tank	15	Pulsation Dampener, 0,1 l volume
3	Block valve	16	Pressure Sensor 0-10 bar
4	Inlet filter unit, 100 mesh filter insert	17	Drain valve for drip tray
5	Closed impeller pump, controllable 4-20 l/min	18	Leak sensor for drip tray
6	Level sensors for storage tanks (pressure sensor)	19	TeeJet Filter+Valve+Nozzle assembly, 200 mesh filter insert, TP250025 nozzle
7	Solenoid valves	20	Male hose coupling, NITO DN13
8	Diaphragm Pump, Pmax 6,9bar, controllable 0,2 to 1 l/min	21	O-ring seals for mix tube top
9	Check valve	22	Tank basket filter

10	Level sensor for mix tank (Ultrasonic sensor)	23	Agitation distribution block
11	Lid for mix tank	24	Mini Eductor nozzle
12	Mix tank tube	25	Transmitter adaptor block
13	O-ring seals for mix tank tube bottom		

3.3   Mechanical Component Overview - General

The +Spray consists of three main modules, which are shown in Figure 1:
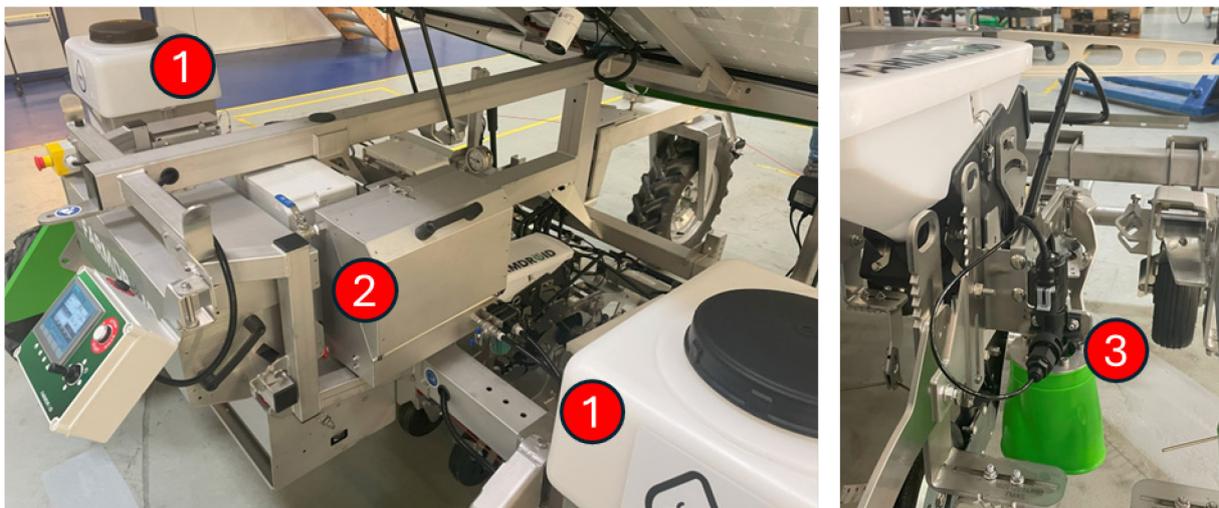
Figure 1: overview of the +Spray components

ℹ️   Be careful to add the correct amount of agrochemical product and water in the APPLICATION TANK. NEVER add chemical products to the CLEAN WATER TANK.

Number	Name	Description
1	**Liquid Storage System**	The liquid storage system includes two tanks of 55 Litres each, placed underneath the solar panels and the valves, hoses and filters, which feed the liquids to the spray system. The contents of the two tanks will be mixed to the correct dose rate when applying.
1.a	**Clean Water Tank**	The clean water tank is indicated with the label "Water tank" and placed on the left side of the robot in the robot driving direction. The tank must only be filled with clean freshwater.
1.b	**Application Tank**	The product tank is indicated with the label "Product tank" and can be found on the other side of the robot. The product tank is filled with. • Clean fresh water to a level as in the clean water tank but subtracted an eventual volume of chemical product. • All the agrochemical product in the amount as it has been calculated for the specific spray operation.

| 2 | **Mixing Unit** | The mixing unit is in stainless-steel cases at the side of the main control box of the FD20 and includes the electronic components and the electro actuated pumps and electrical control system. |
| 3 | **Spray System** | The spray system consists of hoses and filters linking the mixing unit to the nozzle valves and nozzles. |

ℹ️ Be careful to add the correct amount of agrochemical product and water in the APPLICATION. NEVER add chemical products to the CLEAN WATER TANK.

3.3.1 Mechanical Component Overview - Mixer Unit

In the following images you can find an overview and a description of the components of the mixer unit.
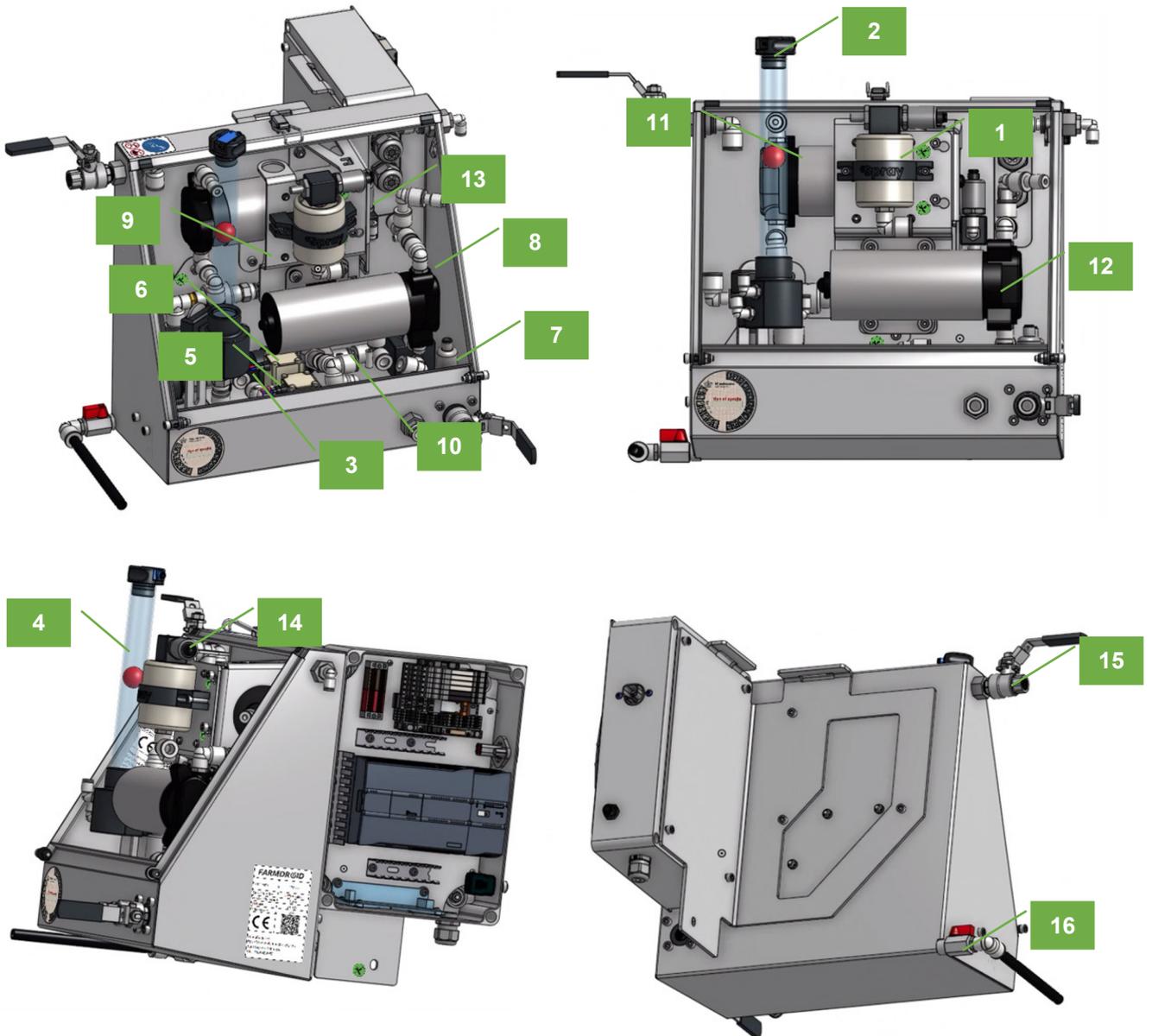
1	Pulsation damper	9	Rinse valve
2	Mix tank level sensor	10	Circulation pump
3	Rinse pump	11	Mix pump
4	Mix tank	12	Pressure pump
5	Application tank valve	13	System pressure sensor
6	Water tank valve	14	Pre-charge pressure sensor
7	Application tank level sensor	15	Water outlet valve
8	Water tank level sensor	16	Drain valve

Components in the mixing unit indicated with the numbers and explained in the table

3.3.2 Mechanical Component Overview – External Components

In the following image you can find the external storage boxes present in the +Spray System dedicated to being used while handling the system.
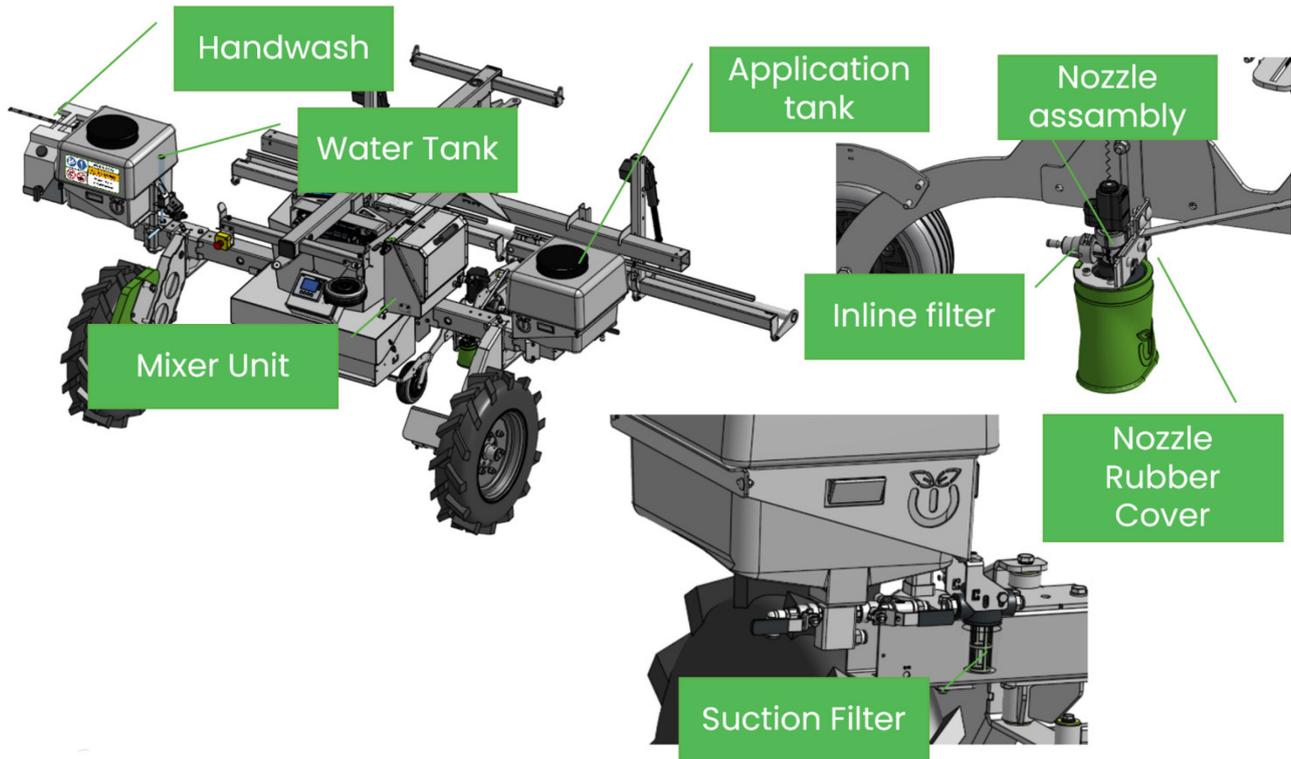
Number	Name	Description
1	**Handwash Canister**	The handwash tank can be found on the left side of the FD20 attached to the water tank. The tank can contain 12 Litres of water. Its main scope is to be used after handling any equipment and products in the +Spray System. It contains fresh water and a soap dispenser.
2	**Suction Filters**	The in-line filters can be found on each side of the FD20 on the bottom of the water and product tank

3.3.3 Spray System

The **+SPRAY system** is designed to efficiently mix and distribute an agricultural product using a **clean water supply and a pre-diluted agricultural mixture**. The system ensures a **precise and even application** while maintaining flexibility for rinsing and cleaning. Below are the detailed descriptions of the spray system diagrams.
The +spray system consists of hoses, line filters and the nozzle assemblies. In a standard configuration, nozzles are mounted in the assembly.

The system supports ISO even spray nozzles up to a 40-degree spray angle. FarmDroid has tested and recommends the TeeJet nozzles listed below Each nozzle assembly is supplied with a removable shield to minimize wind drift.

Suggested nozzles:

- **TeeJet TP250025** – 0,025GPM (0,095l/min) @ 3bar, 25° spray angle
- **TeeJet TP400025** – 0,025GPM (0,095l/min) @ 3bar, 40° spray angle
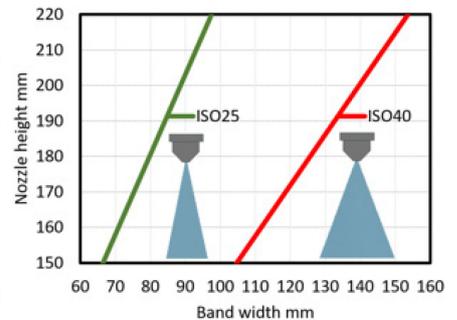
2Nozzle assembly with and without the wind-drift shield

+SPRAY System Flow Overview

This diagram provides a high-level overview of how **clean water, and an agricultural product mixture** are combined and processed through the mix tank before being distributed to the spray system nozzles.
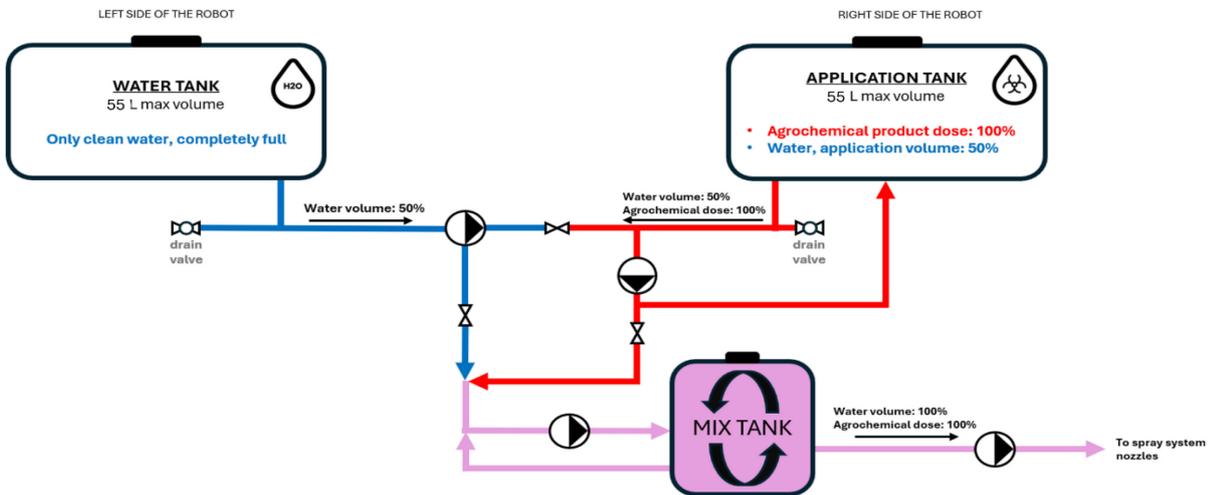
3 The fluid system of the +SPRAY

3.4   Description of Key features

The **FarmDroid +SPRAY system** is designed with key features that ensure **consistent performance, precision, and durability** during operation. These built-in components play a crucial role in maintaining the **effectiveness of the spraying process** and ensuring the system runs smoothly.

The two main features included in the system are:

- **Agitation System** – Designed to keep the **agricultural products in constant movement** inside the application/product tank, preventing sedimentation and ensuring a uniform mix. The **agitation system** consists of a dedicated **valve and pump**, which operate independently from the spraying process. This means that the agitation function remains active even when the droid is in **standby or not actively spraying**. The system's design allows for continuous mixing, avoiding product separation and improving spray consistency. The **layout of the agitation system can be seen in the diagrams under section 3.2.1**

- **Pulsation Dampener** – The **purpose of the pulsation dampener** is to **minimize pressure fluctuations pressure fluctuations** in the system. Since the liquid flow in the +SPRAY system is generated in pulses, the dampener absorbs these variations to ensure a **stable pressure** The **pulsation dampener is a bladder type dampener which** that acts as a shock absorber for pressure peaks.

    o   If the pulsation dampener pressure is too high, it means that pulses are not being properly absorbed. This results in unstable pressure, preventing the system from maintaining the desired working pressure.

    o   When set correctly, the dampener pressure should be **slightly lower than the working pressure** of the system, allowing it to effectively absorb pulses.

- If the dampener is too flat, it may still absorb pressure fluctuations, but there is a risk of damaging the bladder. This does not lead to increased wear on the system, but it can compromise the longevity of the bladder itself.

These components function to preserve the lifespan of the pulsation dampener but do not influence spray efficiency or impact the overall system longevity

4   Preparing for Operations

In this chapter, the user will find the necessary steps to prepare the +SPRAY system before use. Proper preparation ensures optimal performance, accuracy, and system longevity. This section covers routine checks, system setup, calibration, and parameter adjustments that need to be completed before beginning spray operations.

By following FarmDroid's specifications and guidelines, users can ensure that the +SPRAY system is properly configured and operates efficiently, reducing the risk of errors and maintaining consistent spray application throughout the season.

Before-Operation Considerations

Before starting any operation, it is essential to perform a **routine maintenance check** to ensure the +SPRAY system is in optimal condition. Begin by **powering up the system** and checking for any **errors or alarms** on the HMI. A **visual inspection** of the system should be carried out to confirm that no components are damaged or loose. If operations are resuming after winter storage, **inspect the system paying attention to the filters for potential frost damage** and replace damaged components before continuing. These steps help prevent issues and ensure a smooth start to the spraying process.

To provide a **clear overview** of the process, the following section includes an **illustration summarizing the key steps** in setting up and operating the +SPRAY system. This visual guide highlights the **main considerations** users should be aware of before starting their work.
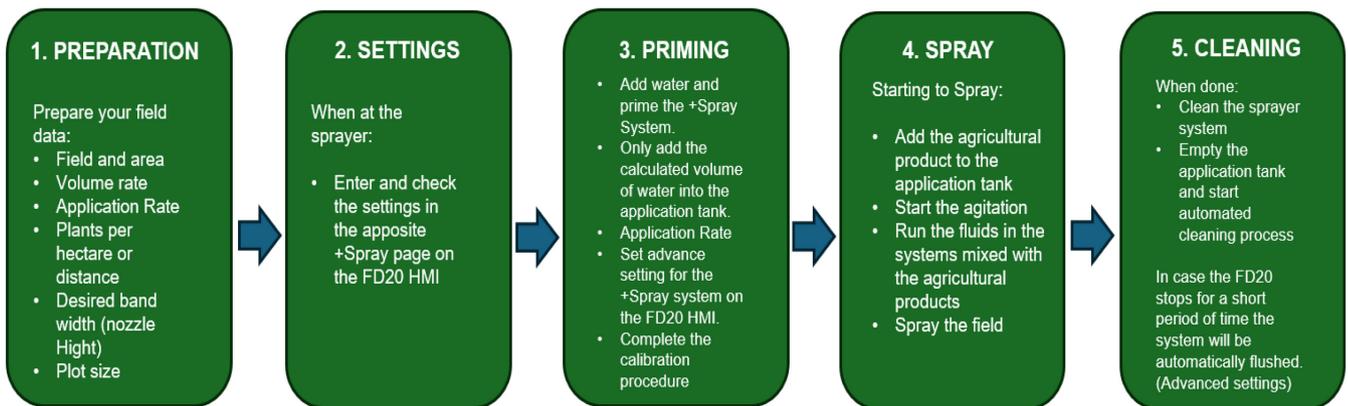
5 steps in the spray operation

4.1   Starting the Operations of the +SPRAY System – APPLICATION PLANNER TOOL

The preparation of the spray characteristics can be done in advance on your PC, tablet, or iPad using the FarmDroid Application Planner. This tool is essential for planning the settings of the sprayer and calculating the amount of product and water needed for a specific spray operation. It can be used before moving to the field, allowing for adjustments to be made in advance, such as setting the height of the nozzle position and selecting the nozzle type. Make sure that the sprayer is calibrated with the nozzles in use, and that the area to be sprayed and the number of plants per hectare are defined. Based on the data entered, the program will calculate the amount of product needed for the spray and the amount of water that should be added to each tank.

The FarmDroid Application Planner contains three tables, which are prepared for entering your data. In the following descriptions, categories that require data entry are marked with red arrows.

The FarmDroid Application Planner spreadsheet can be found in the FarmDroid Knowledge Base by clicking the following link: https://knowledge.farmdroid.io/.

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APPLICATION PLANNER TOOL

"Settings" Table

Settings		
User		
Name:		
Date:		
Field		
Nominal Application Rate (Default 300)	300	l/ha
Row distance	50	cm
Crop distance	20	cm
Spot- or bandspray	Spot	
Sprayer		
Spray band width	80	mm
Nozzle spray angle (default 25)	25	°
Spray before crop	30	mm
Spray after crop	30	mm
Pulse distance (Default 20)	20	mm
Spray pressure (Default 3,0)	3,0	bar
Required nozzle height	180	mm

- In "**Normal Application Rate"** enter the water volume that would the target for a conventional broadacre spray.
- In "**Row distance"** enter row distance used when seeded in cm (50cm in most cases).
- In **"Crop distance**" enter the distance between plants in the row when seeding in cm. From this value, the planner calculates the number of plants per hectare (see figure below).
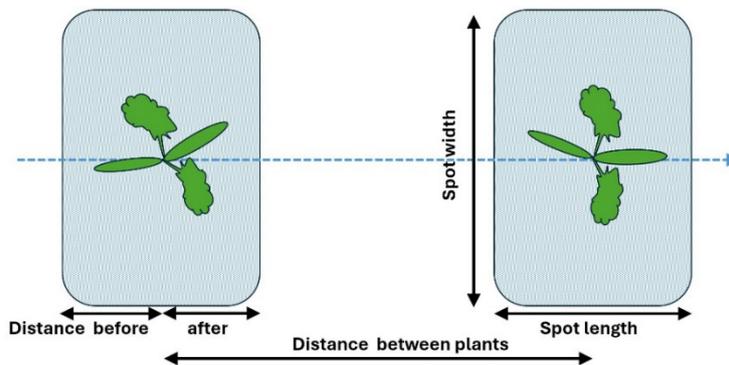
- In **"Spot- or band spray**", you select whether the spray is a spot spray on the plants, or if it is as a band spray in the complete length of the row.
- In "**Spray band width"** you enter the targeted band width in millimetres (see figure below).
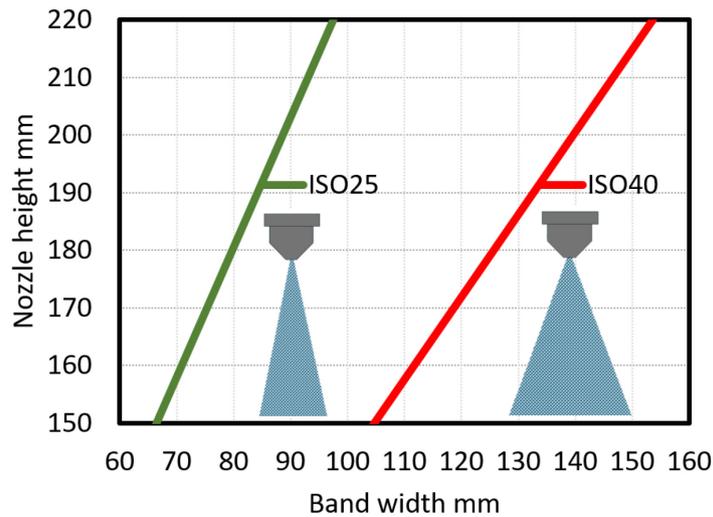
- In **"Nozzle spray angle"**, you select whether you will use a 25-degree nozzle (narrow bands) or the 40-degree nozzle (wider bands).
- In "**Spray before crop"** enter how far ahead (in mm) of the plant, the spot spray shall begin.
- In **"Spray after crop"** you enter how far after the plant (in mm), the spray shall continue. The sum of the two will be the length of the spot.
- "**Pulse distance**" and "**Spray pressure"** are set default from the factory.

Required Nozzle Height

If conditions are known in advance, the easiest solution can be to change nozzles and adjust the height before moving to the field. The planning tool can be a way to test different settings to identify the right combination of band width and water volumes.

Be aware that the field **"Required nozzle height"** is calculated based on the other data entered and should not be modified.

- If the field **"Required nozzle height"** turns **WHITE**, the chosen combination is available.

- If the field **"Required nozzle height"** turns **RED**, the chosen combination of parameters is **out of range** and cannot be achieved. This happens if the nozzle height falls outside the allowed range of 150-220mm.

Note: The water rate will also turn **RED** if it's too low or too thigh.

"Calculations" table
The result of the data entered in "Settings" can be found in the table "Calculations".

In this table you enter the area planned to be treated and can see the calculated need for chemicals for the complete operation. In the example, 8 ha are covered of which only 4,8% of the area is treated resulting in a total need for 112,3 litres for the complete operation.

Calculations			
Field			
No crops per hectare		100.000	crops/ha
Total sprayed area %		4,8%	
Actual application rate		14,4	l/ha
Savings %		95,2%	
Applications			
Field or plot area [ha]		7,8	Hectares ⬅
Required water amount [Litres]		112,3	Litres
Product name	**Dosis/ha**	**Total Dosis**	**Units**
Nortron	0,2	0,07	l ⬅
Goltix	3	1,12	l ⬅
Betanal	0,5	0,19	l ⬅

- **"No crops per hectare"** is the number of plants per hectare achieved when seeded.
- "**Actual application rate"** is the water volume sprayed per hectare by the FarmDroid
- **"Total sprayed area %"** is calculated from the plot size and the number of plants per hectare
- **"Savings %"** are the residual and not sprayed part of the field
- In **"Field or plot area (ha)"** you enter the area of the field or part of a field that shall be covered in the spray operation. This field must be filled out, and based on the area, a final recipe is calculated.
- **"Required water amount (Litres)"** is the total amount of water (both tanks) which is needed for a spray operation with the entered specifications.

"Dosing Recipes" Table

The results are transferred to the table "Dosing recipe", which can be seen below.

In this example, it is recommended to add 55 litres of clean water to the CLEAN WATER TANK and 50 litres to the APPLICATION TANK. The total volume in this tank must be exactly 50 litres in this example to meet the correct solution for the final application on the ground. The additional 5 litres in the CLEAN WATER TANK are used for flushing, ventilation and in the end cleaning the system.

The recipe can never exceed an application volume higher than 100 litres since 5 litres must be kept in the clean water tank for cleaning and rinsing.

Be aware that this limit is included in the calculation of the recipe, and a new mixture must be calculated.

Before usage make sure the liquid system is Primed and run the desired parameters are set, the mixture of Agricultural products and water will be automatically run to the nozzles.

4.2 Starting the Operations of the +SPRAY System

Before starting the spray operation, ensure that the nozzle type and height above the ground match the values calculated using the FarmDroid Application Planner Tool. These settings are essential not only for optimal coverage but also for applying the correct amount of product.

Additionally, make sure the FD20 is positioned within the defined field boundaries. If the robot is outside these boundaries, it will not be able to start the operation.

Navigating to Spray Parameters on the HMI

To adjust or verify the spray settings on the **HMI**, follow these steps:

1. Navigate to the **Tools Section** on the HMI.

2. Locate the Spray Settings Menu, where parameters such as pressure, spray coverage, nozzle activation, and operation modes can be adjusted.

3. Ensure that the correct settings are applied before starting the operation.

Note: Due to the continuous development of the FarmDroid software, the **HMI layout and menu navigation may change over time**. The descriptions in this manual serve **as an illustrative guide only**.

For the most **up-to-date and detailed instructions**, please refer to the **FarmDroid Knowledge Base** at [FarmDroid Knowledge Base](#).

HMI PAGE	ACTION
	After selecting the field and starting "Auto" operations the +Spray System need to be activated on the "Tool Section" showed on the picture.
	On the "Tool Activation" Page it will be possible to start the +Spray System and access to the spraying settings as shown on the indicative picture. The top button indicates the ON/OFF function of the system and the bottom Pulsant allow you to activate the +Spray when the robot operates.
	On the "Setting Page" there are two submenus where the parameters obtain by the *application planner tool* can be inserted. "Spray Corrections" and "Nozzle"
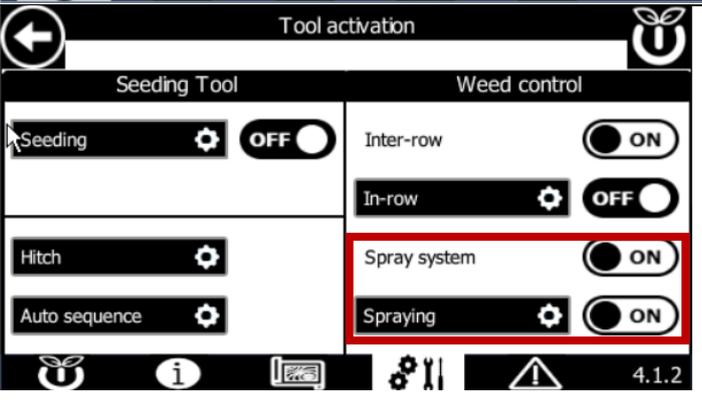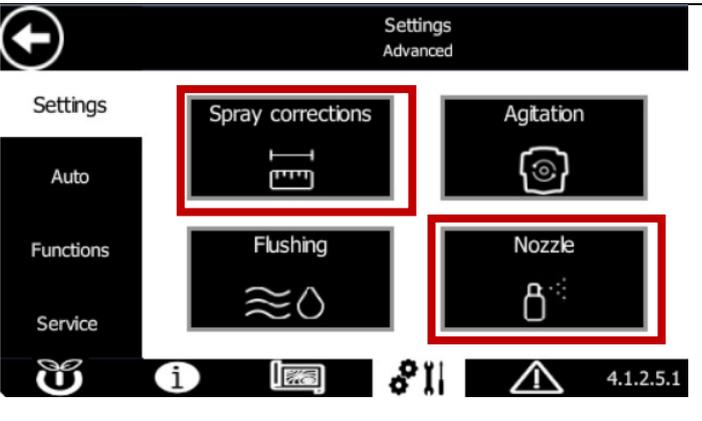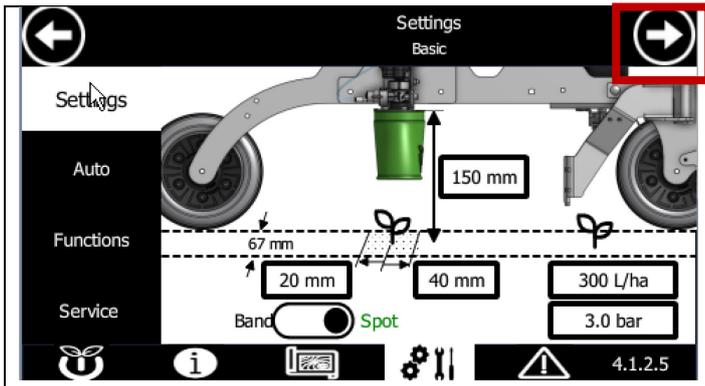
	Use the same values as when preparing in the FarmDroid Application Planner: • **The target volume per hectare in l/ha** • **Nozzle height**: Above ground level in mm • **Spray pressure:** 3 bar is the standard value • **Spray distance ahead of the plant in mm** • **Spray distance after the plant in mm**
	"Pulse distance" in the "Spray Corrections" menu. To get there, press the arrow on "basic functions" on the upper right part of the screen of the previous page. Then check those values for "Nozzle spray angle" and "Pulse distance" correspond with the values used in the FarmDroid Application Planer Tool.
	On the "settings" menu, select the Nozzles menu to access the Nozzle settings In this section there is the possibility to select the type of recommended nozzle.
	It is also possible to select the "manual" function in the nozzle, where is possible to customize the spraying angle and volume.
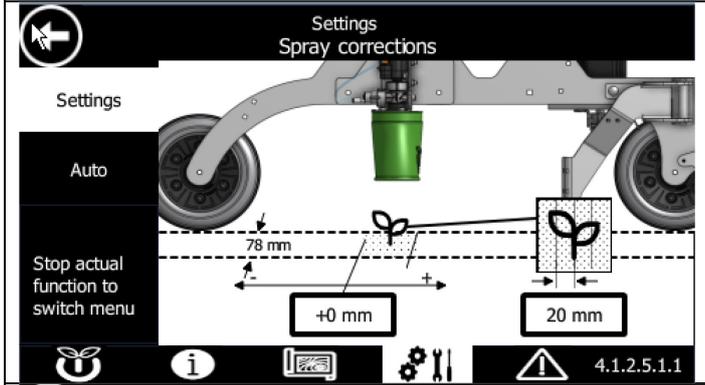
4.2.1) Functions Advance: Nozzles and Spraying

The +SPRAY system allows for customization of advanced nozzle settings to optimize spraying performance. FarmDroid do not recommends changing the settings along the nozzle type. Different settings will be available depend on the nozzle type selected.

Advanced Nozzle Settings:

1. **Nozzle Spray Angle (Not customizable):**

   o Use **25°** when operating with the **TeeJet TP25 0025** nozzle.

   o Use **40°** when operating with the **TeeJet TP40 0025** nozzle.

2. **Nominal Nozzle Flow:**

   o This setting defines the **rated flow of the nozzle at 3 bar pressure**.

   o The value is **determined by the nozzle selection and remains fixed unless "Custom" is selected**.

   o This is **not a correction factor** but rather the actual predefined flow rate of the selected nozzle.

3. **Pulse Distance (To be set on the "Spray Corrections" menu):**

   o Defines the spacing between spray pulses, ensuring uniform coverage across the field.

4. **Nozzle Plant Correction:**

   o Adjusts the spray impulse timing to either anticipate or delay application.

   o This feature is particularly useful for targeting the area between plants instead of directly on top of them, or for the *Spraying While Seeding* option if the kit is mounted.

Spray Pattern:

The spray pattern is determined by the system configuration and the selected parameters. These settings influence the uniformity and precision of chemical application. The key parameters affecting the spray pattern are outlined in the following table and illustrated in the figure below.

ⓘ Please note that the advanced settings are not mandatory to edit, as they are pre-filled with recommended values

4
Pulse Distance and
Spray Pattern Adjustments: The
vertical dashed lines illustrate each
spray pulse from the nozzle
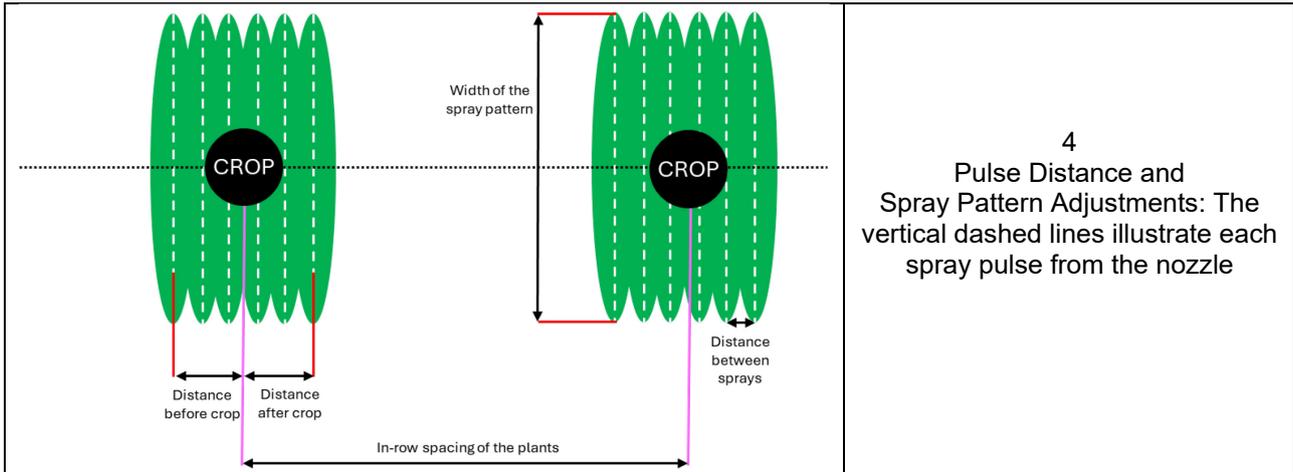
4.3 Starting the Operations of the +SPRAY System – ADDING WATER AND PRIMING

In this section, we will walk through the priming process of the +SPRAY system, outlining the necessary steps to ensure proper functionality before beginning any spraying operations. This process is crucial to remove air from the system and ensure that the application mix flows correctly through the nozzles.

Before starting the priming process, **add water to the tanks according to the recommendations provided by the FarmDroid Application Planner Tool.** Ensure that the volume in the Application tank does **not** exceed the calculated amount. Once the correct volumes are added, the system must be Primed and ventilated to eliminate any air pockets that could affect performance.

Due to the continuous development and improvements of the system, the layout and navigation of the HMI may change over time. While this manual provides an overview of the priming process, we strongly recommend referring to the **FarmDroid Knowledge Base** for the latest step-by-step instructions and updated visuals. You can always find the most up-to-date version of the priming guide here: https://knowledge.farmdroid.io/13-spray-system

For further details on the procedure, see the following sections:

a) Adding Water
The **+SPRAY system** is designed with a **dual-tank storage system**, consisting of a **clean water tank** and a **product tank**, each clearly labelled on the side for easy identification. Each tank has a **capacity of 55 liter**, providing a **total system capacity of 110 liter.**

When filling the tanks, follow the volume recommendations provided by the **FarmDroid Application Planner Tool** to ensure accurate mixing and optimal spraying performance. **If necessary, you may leave up to 1 litre of space in the application**

ank to accommodate the addition of agricultural products. However, if this approach is used, it is crucial to **refill the product tank to the exact calculated level before starting the spraying operation** to maintain correct dilution ratios and avoid inconsistencies in application.

By adhering to these filling guidelines, you can ensure precise and efficient operation of the +SPRAY system while maintaining compliance with recommended application parameters.

ℹ️ The **CLEAN WATER TANK**, located on the left side of the robot, **must only contain fresh water**.

ℹ️ The **APPLICATION TANK**, located on the right side of the robot, **follow the suggested amounts in the tool application planner**. If desired, leave out 1 litre to add chemicals. Do not add chemicals until the system has been ventilated/primed.

b) Priming

The purpose of the process is to eliminate air bubbles in the fluid system. It is done with the "Priming" function.

Select "Prime & Calibration" from the "Functions" menu, the red arrow in the figure.
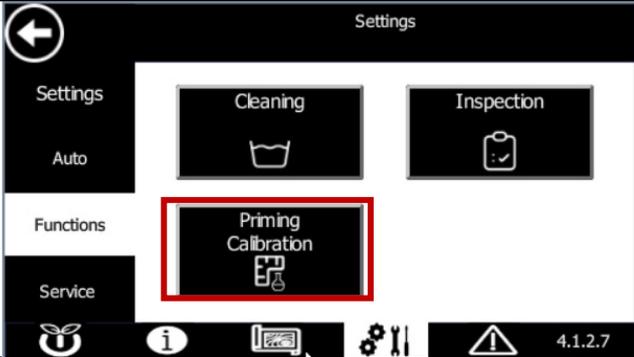
HMI PAGE	ACTION
	On the +Spray menu, select the "functions" option to access the menu "Priming and Calibration"
	Open the freshwater tap and position a container to collect water
	On the Function menu, click on the dedicated option to turn "ON" the Priming process.
	Start "RINSE" mode by pressing the Rinse button. It turns green when started. Let the system run with the valve open until water comes out. Then close the tap and let the mode finish.
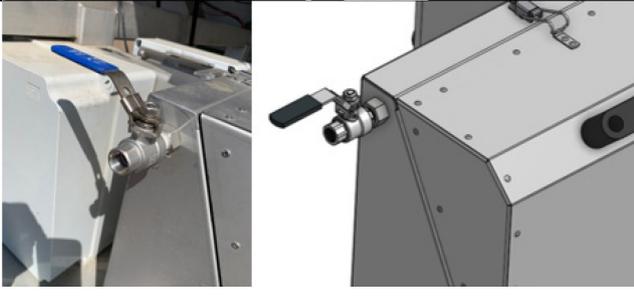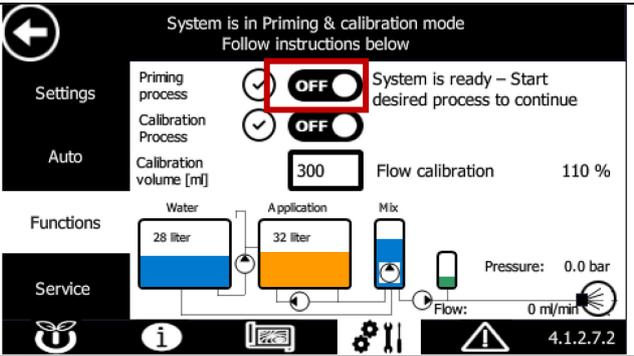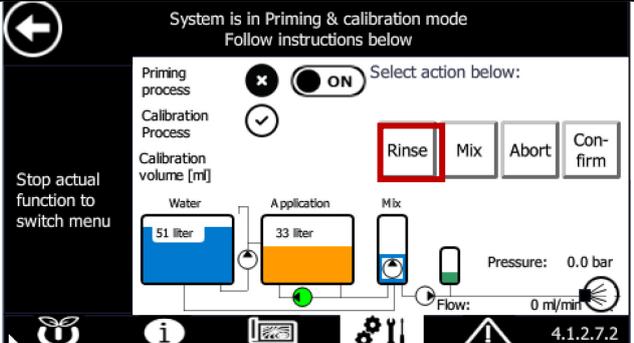
	Repeat RINSE mode one more time with freshwater tap closed to make sure that all air is out of the rinse system.
Be aware to watch for air bubbles in the mix tank while it is being filled during *MIX* mode, not *RINSE* mode.	.
	Move to the "MIX" mode to prime the rest of the system. Press the "MIX" button, and it will turn green when running. In this mode, the system will work with open nozzles and fill the mix tank
Before starting the system, it is important to check the **pre-charge pressure** of the pulsation dampener on the dedicated HMI. On the HMI, the dampener status should appear **green**, indicating that the pressure is within the acceptable range. If the status is not green, the pressure is out of range and should be checked by pressing the **dampener icon** to view the exact pressure level.	• If the **pressure needs to be higher**: Pressure can be applied with the provided pump. • If the **pressure needs to be lower**: Use the valve manually to release pressure from the transmitter.

c) Adjusting the Pressure – PULSATION DAMPENER

The pulsation dampener stabilizes system pressure by absorbing pump fluctuations. Check the **HMI**—if the **dampener icon is not green**, the pressure is out of range.

- **Too high**: The dampener is **too stiff**, causing unstable pressure and affecting spray consistency.

- **Too low**: Risk of **damaging the bladder** over time.

For optimal performance, the **pre-charge pressure should be slightly below the system's working pressure**.

The following steps will guide you through the adjustment process via the HMI. Due to ongoing software updates, the interface may change, so we recommend checking the Knowledge Base for the latest instructions and illustrations.

Cleaning water outlet

Pulsation dampener

Mix pump

Pressure pump

Rinse valve

Mix tank

Rinse pump

Water valve

Application valve

Circulation pump
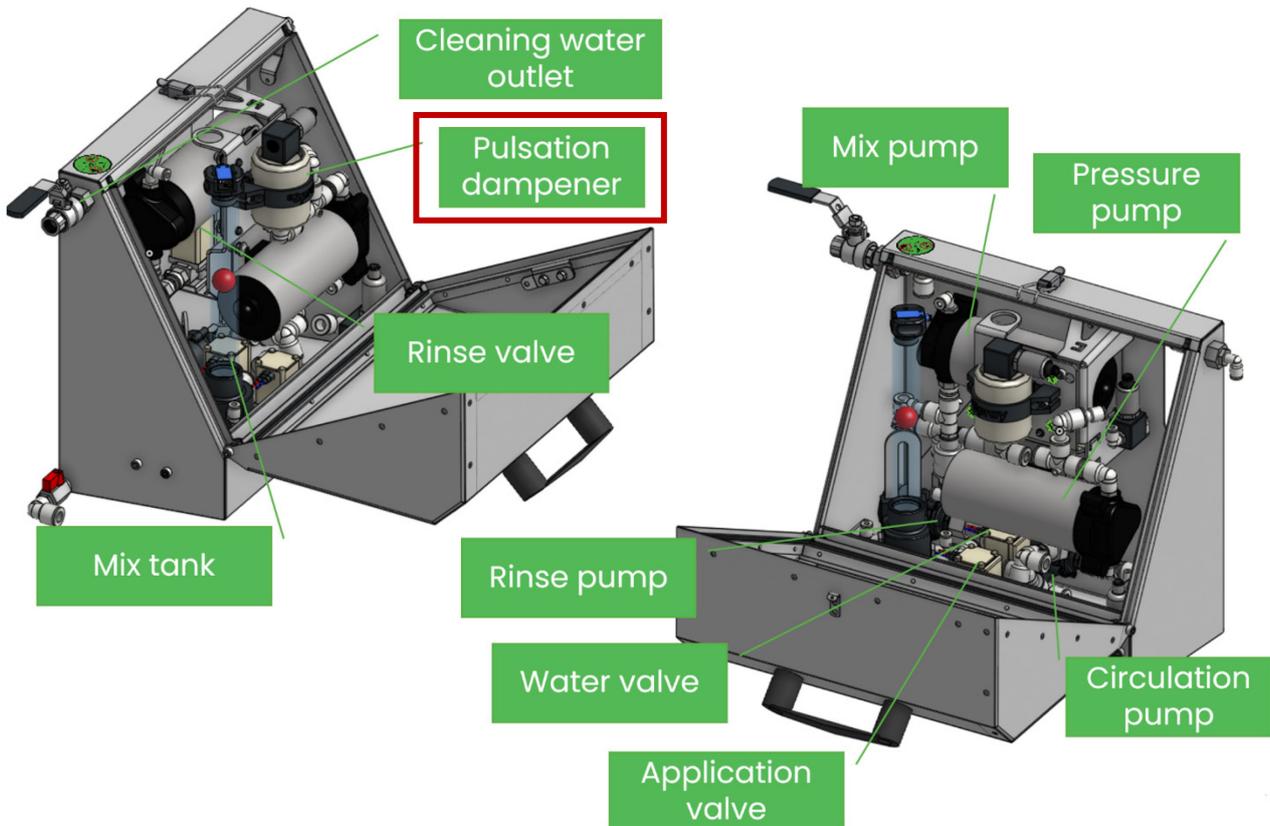
HMI PAGE	ACTION
ℹ️ A manual pump will be provided for the adjustments of the pressure of the Pulsation dampener.	
	On the "AUTO" screen section of the menu, click on the icon showed on the picture. In this section it will be display the current pressure of the dampener.

With a manual pump it will be possible to inflate or deflate the pressure of the dampener to set the pressure to the correct range for operations.
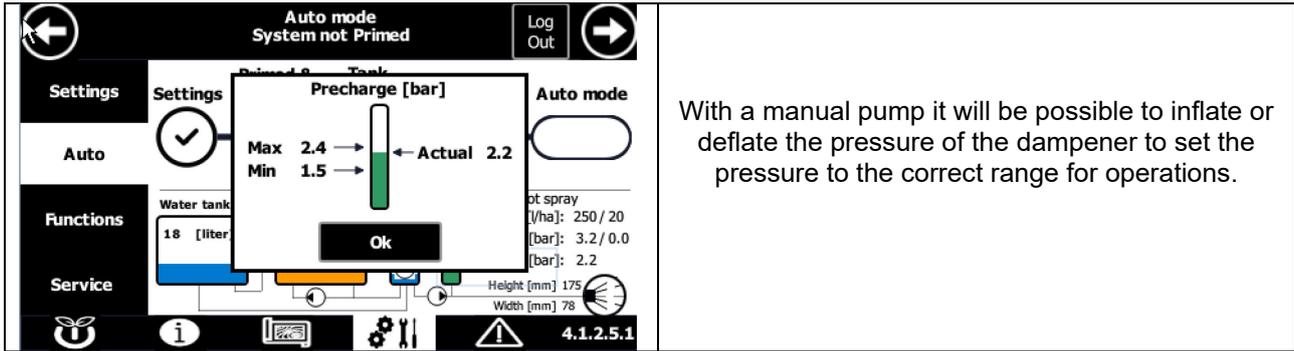
d) Calibration Process

The +SPRAY system is pre-calibrated from the factory. However, calibration is required before the start of the season, after extended periods of inactivity, or in case of significant changes in spray parameters, such as pressure, water rates, etc. This process ensures that the actual sprayed volume matches the planned application rate, maintaining accuracy and to avoid unintended flow alarms.

During calibration, a specific volume of liquid is sprayed and measured. The system then adjusts its settings based on the measured value to ensure precise dosing.

Starting Calibration

1. **Preparation:**

   o   Place collection containers under the nozzles to capture the sprayed liquid.

   o   You may collect from all nozzles and measured the volume accordingly.

   o   Have a measuring cup ready to accurately measure the collected liquid.

2. **Initiating Calibration:**

   o   Navigate to the **Functions Menu** and select **"Prime & Calibration Mode."**

   o   Before activating the calibration process, ensure the appropriate calibration volume is set. The **suggested volume is 200 ml per nozzle**, meaning a **total of 1200 ml for 6 nozzles**. Once confirmed, activate the calibration process—the system will begin spraying.

3. Once calibration is activated, you can **monitor the pressure, the actual calculated flow in ml/min, and track the calibration progress in %**.

4. **Measuring and Adjusting:**

   o   Once the system reaches the target volume, spraying will stop automatically.

   o   Measure the displaced volume from each nozzle and check for even distribution—variation should not exceed **15%**. Sum up the total displaced volume from all nozzles and enter it in the **calibration prompt box**.

   o   The system will then calculate and update the calibration settings accordingly.

ℹ️ Due to continuous software improvements, the calibration process interface may be updated over time. For the most up-to-date calibration procedure and interface guidance, please refer to the FarmDroid Knowledge Base.

HMI PAGE	ACTION
System is in Priming & calibration mode — Follow instructions below. Priming process ✗ OFF. Calibration not possible. Add water and/or perform priming. Calibration Process ✓. Calibration volume [ml]. Water 50 liter. Application 33 liter. Mix. Pressure: 0.0 bar. Flow: 0 ml/min. 4.1.2.7.2	On the **"Priming and Calibration"** HMI page, the calibration process can be started after completing a priming cycle. Ensure that **at least 10 litres of water** are present in each tank before initiating calibration. Pay attention to any system-required actions before proceeding.
System is in Priming & calibration mode — Follow instructions below. Priming process ✓. Calibration Process ✗ ON. Calibration process running. 0% 25 50 75 100%. Calibration volume [ml] 300. Stop actual function to switch menu. Water 50 liter. Application 33 liter. Mix. Pressure: 2.1 bar. Flow: 131 ml/min. 4.1.2.7.2	Set the process "ON" at the displayed option, the calibration will start and the percentage of the action will be displayed on the HMI.
System is in Priming & calibration mode — Follow instructions below. Priming process ✓ OFF. System is ready – Start desired process to continue. Calibration Process ✓ OFF. Calibration volume [ml] 300. Flow calibration 110 %. Water 28 liter. Application 32 liter. Mix. Pressure: 0.0 bar. Flow: 0 ml/min. 4.1.2.7.2	Enter the **desired total volume** in the menu before measuring the collected volume. Once measured, calculate the total volume from all nozzles and confirm the entry as indicated in the menu.
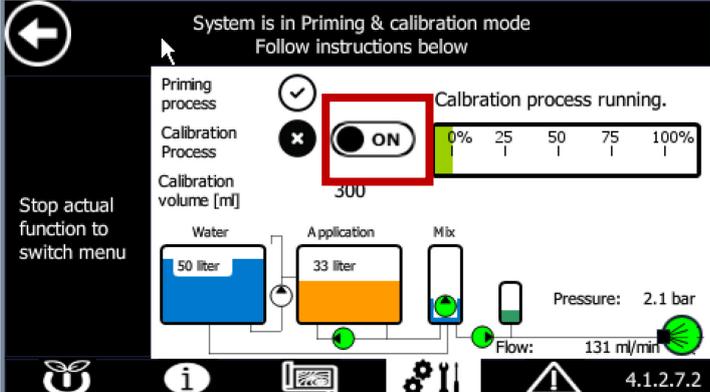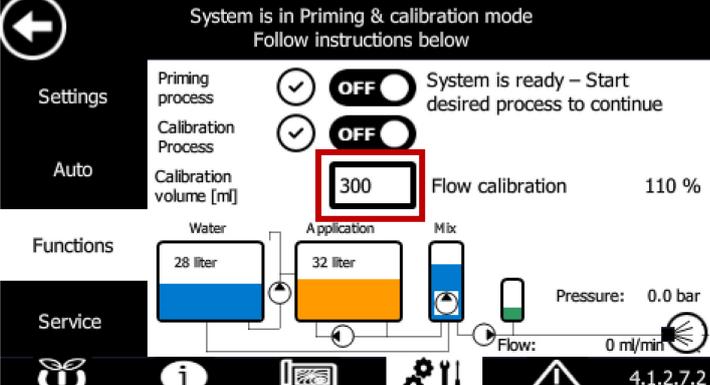
System is in Prime & Calibration mode - Follow instructions below	**Completing the Calibration:** Enter the actual measured volume in the menu before pressing confirm. Once confirmed, the new calibration value will be implemented in the system, completing the process.
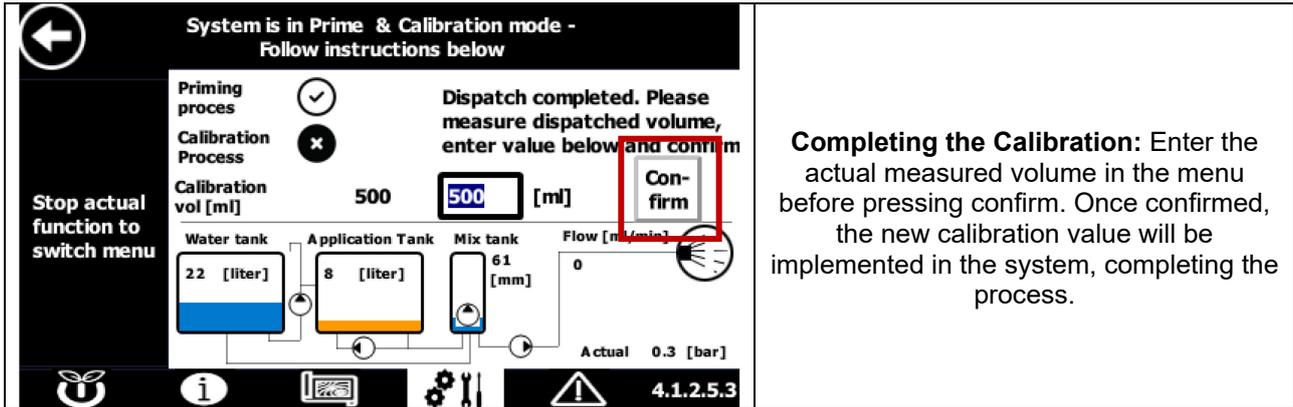
e) Agitation Settings: Power saving features

The +SPRAY system includes adjustable **agitation settings** and **hibernation power-saving features** to ensure optimal mixing of agricultural products while minimizing energy consumption. These settings allow users to fine-tune the system based on the characteristics of the applied product.

- **Agitation Intensity**: Determines the Power output to the circulation pump. If the product is easily agitated, a lower intensity is sufficient. If separation or sedimentation occurs, the intensity should be increased to maintain a uniform mixture.
- **Off-Time in Hibernation**: Defines the intervals at which the system agitates during "hibernation" This feature prevents sedimentation while conserving battery life when the droid is stopped.

The following sections will guide you on how to adjust these settings through the HMI to achieve the best performance based on your specific application needs.

e.1) INTENSITY
The **Intensity** setting controls the strength of the agitation process by adjusting the flow rate within the system. Increasing the intensity provides a stronger agitation effect, ensuring that agricultural products remain well-blended and preventing sedimentation. If the product is easy to mix, a lower intensity may be sufficient, while more challenging mixtures may require a higher setting to maintain consistency.

The following section provides details on adjusting this setting within the HMI.

e.2) OFF-TIME IN HIBERNATION
The **Off-Time** setting determines the duration the circulation pump remains inactive after the system enters hibernation mode. Once the system has run the initial **10 minutes of forced agitation**, it will pause for the selected **Off-Time** before restarting the 10 min circulation process. This function helps conserve power while ensuring that the product remains properly mixed during extended pauses in operation.

The following section provides details on adjusting this setting within the HMI.

HMI PAGE	ACTION
Functions Basic — Settings, Auto, Stop actual function to switch menu, 175 mm, 78 mm, Band/Spot, 175 L/ha, 3.0 bar, 4.1.2.5	On the "Functions Basic" menu of the +Spray page, when the upper right arrow is clicked the user will access the "advance" functions settings.
Settings Advanced — Spray corrections, Agitation, Flushing, Nozzle, 4.1.2.5.1	Click on the "Agitation" button to access the agitation menu.
Settings Agitation — Intensity 100/80/60/40%/20, Off time in hibernation 0/10/30 min/120/∞, 4.1.2.5.1.2	On this page can be selected the level of intensity of which the products on the application tank should be mixed, higher the percentage, higher the strength of mixing and power consumption. On this page can also be selected the "Off time in hibernation", indicating how much time after the nominal 10 minutes of agitation the system should be hibernate, Higher the amounts of minutes , more time will hibernate and lower the power consumption.
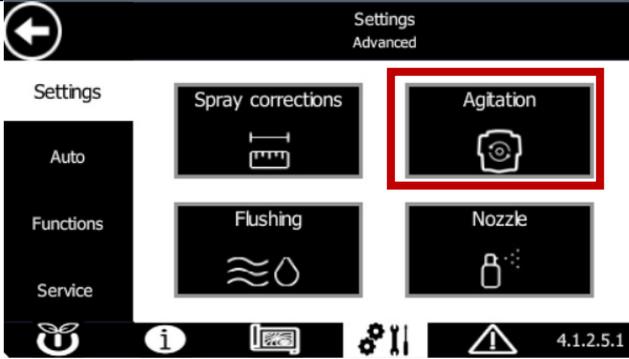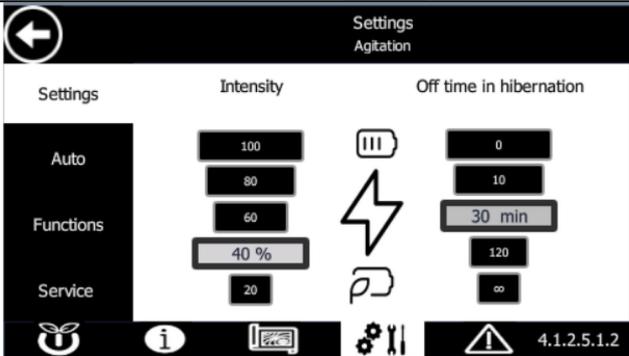
f) Anti-clogging Feature: Flushing

The flushing function ensures that the system remains clean and prevents residue build-up when the +SPRAY system is not actively spraying.

- **Time Until Flushing**
  When the droid is not spraying, the system will automatically flush the mix tank, hoses and nozzles. with clean water at the selected interval. This function is only triggered when the system is active but idle, ensuring the spray nozzles remain free of blockages.

For an optimal spraying performance, it is recommended to configure this setting based on the type of agricultural product being used and environmental conditions.

(For the latest details and step-by-step instructions on setting the flushing feature, refer to the Knowledge Base.)

HMI PAGE	ACTION
4.1.2.5.1	On the advance features menu, the option" Flushing" must be selected
4.1.2.5.1.3	On this page will be possible to select the time the time that the droid will wait until flushes the system with water when the spraying operation are not active (During Transportation on the field as an example)
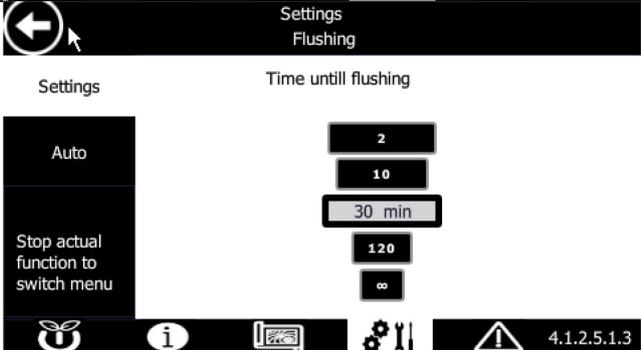
4.4   Adding Agricultural Products and Start the Spraying operations

Before beginning the spraying process, ensure that the correct product volume and system settings are in place.

1. **Verify Product Volume:**

   o **Tank Volume Check:** Physically inspect the tank volumes to ensure accuracy. Use the HMI tank levels only as an indication, not as the definitive measurement.

   o Leave enough space in the tank to accommodate the agricultural product(s) being added.

2. **Adding Agricultural Products:**

   o Add the product(s) according to the calculated amount.

   o **Activating Agitation:** Put the system into **AUTO mode** to start the agitation process and allow it to run until the product(s) is/are completely dissolved.

   o Adjust the **agitation intensity** settings based on the type of product being used.

3. **Initiating Spraying:**

Once the system is primed and agitation is complete, proceed by starting the robot to begin the spraying operation.

HMI PAGE	ACTION
⚠️ Always wear protective clothing and gloves before handling chemicals and contaminated areas. Wash and clean your hands after handling chemicals.	
	Make sure there are room for the chemicals in the application tank. Add each product as calculated by the FarmDroid Application Planner. Refill to the exact volume if needed. Agitate thoroughly using the following procedure. All the valves for the passing of liquid should be opened.
	Now that the products have been added it will be necessary to agitate the product mixture. Now that the products have been added, agitation will begin automatically when the system enters AUTO mode, transitioning into either hibernation or standby mode. Recalibration is not necessary.
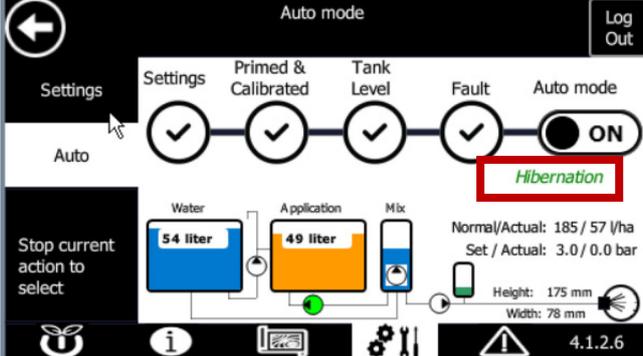
AUTO Mode, System Behaviour, and Priming Process

When the +SPRAY system enters AUTO mode, it follows a structured sequence to ensure **proper mixing, agitation, priming, and flushing** before and during operation. Below is an overview of the key operational states:

1. *Hibernation Mode*

- The system will enter either hibernation, standby, flushing, or preparation mode depending on the last AUTO mode state, flushing timer, and whether the cleaning process has been completed. This may require further clarification for the user. During hibernation, the **application tank is agitated for 10 minutes**, followed by a waiting period determined by the **"Off Time in Hibernation"** setting in the agitation menu.

- The system remains in **hibernation until the robot is activated** for operation.

2. *Preparation Mode* & Priming Process

- Before spraying operations can begin, the system must go through the preparation (prepping) process. Prepping ensures that the entire fluid system is prepared and ready for application.

- **Preparing the Fluid System:**

    - Ensure the correct volume of agricultural product is added to the product tank and that proper agitation has been performed.

    - Navigate to the +SPRAY main menu and select "Auto."

    - The Auto mode screen will display checkmarks confirming that:

        - All necessary conditions are met.

        - There are no faults in the system.

- Once Auto mode is ON, the system initiates the **Preparation process**:

    - All nozzles open, and the system begins mixing chemicals and water.

    - **The preparation sign will turn green when the mode is running, but this does not indicate that the system is fully prepped or pressurized.**

    - The **Preparation process will begin** if +SPRAY is in **hibernation** and the robot requests the system to operate. It will also be initiated if the **cleaning cycle has been activated**, as this ensures there is a properly mixed solution in the system.

    - Once prepping is complete:

        - Pressure is stabilized.

        - The nozzles are open.

        - The mixed fluid has reached the nozzles.

3. *Standby Mode*

- If the robot **stops during an operation**, the +SPRAY system will enter **Standby Mode**.

- While in Standby Mode, the system follows the **pre-set flush settings**. **After the selected flush time, the system will automatically flush**, ensuring the spray lines remain clean and ready for resumption.

4. System Behaviour When the System is Not in Operation

- If the **system is not actively operating**, only the **mix tank and product tank will be agitated**.

- **No pressure** is applied to the nozzles.

- The system will remain in **standby mode** until activation.

5. Preparation Process When the System Initiates Operation

- When the **FarmDroid sprayer system is activated**, it **enters Preparation Mode**.

- **Nozzles open** and **pressure is applied throughout the system**.

- The **priming cycle runs** ensuring:

    - **The mixed fluid reaches the nozzles**.

- - In-line filters and spray lines are fully primed.

  - Nozzles are pressurized and ready for spraying.

- Once the preparation process is complete, the system will enter Standby Mode, indicating that it is ready for spraying operations.

Important Note

- The ability to set the FarmDroid main control to Auto Mode depends on whether the spraying system is set to ON in the tools page. While the robot can be switched between MAN and AUTO regardless of this setting, the start button cannot be pressed if the spray system is activated (set to ON in the tools page) and the spot spray system is not in AUTO. If this step is skipped, **an error message will appear**.

For **updated instructions and interface changes**, refer to the [FarmDroid Knowledge Base](#).5

SPOT SPRAY: Can only be enabled if the seed has been seeded or while seeding with the seed valve automatic opening being "**ON**". The nozzles will follow the seeding pattern.

BAND SPRAY: Band spray can be used regardless of the seed valve setting. If the seed valve automatic opening is set to "OFF," the nozzles will remain continuously open over the row.

Watching the Spray and Error Messages
You can follow the development of the operation on your FarmDroid App.

The +SPRAY will stop spraying and flush the system in case the sprayer observes errors in the system. An error message will appear on the FarmDroid App.

Conditions that can trigger errors are causing the FarmDroid to stop moving/spraying among several others:

- Abnormal flowrates
- Abnormal pressure
- Low levels in the tanks
- Technical failures

If the spray has been stopped and re-initiated, it will automatically prepare the fluid system before starting to spray

Check nozzles and filters according to the service recommendations. Always make sure the fluid system is depressurized when working with filters on the pressure side.

The alarms listed in this table may be adjusted or updated in future software versions. For the most up-to-date information, please refer to the Knowledge Base.

5   After Spraying Operations and Cleaning

When the spraying is completed, clean the sprayer and the fluid system as described in the following. If the spraying is halted for a shorter period, the pump and fluid system to the nozzles can be cleaned with clean water.

⚠️ Always wear protective clothing before handling filters and other potentially contaminated areas.
Use a bucket to collect any spills or overflow.
Wash and clean your hands after handling chemicals.

ℹ️ The nozzles of the +Spray System are positioned in line with a bracket. While not essential, positioning the nozzles in the parking position (highest allowed position) after use can be beneficial, especially during the growth season or for easier cleaning. To lift the bracket, loosen the bolt and slide it upwards. The image below shows the bracket details.

a) Cleaning For a Short Stop
If the sprayer will be used with the same product in another field soon after this spray, it can be moved as is.

b) Cleaning For Long Stops: Filters or Nozzle Services
If filters on the pressure side needs cleaning, nozzles changed or if the sprayer is left with chemicals for hours or the next day, you must flush the fluid system with clean water.

The system does this automatically if it has not been spraying for the chosen amount of time (flushing menu). The mix tank, pump and nozzles will be flushed with clean water. Be aware that the flushing will result in a small volume of mixed product sprayed on the ground. If the system has been flushed, it will automatically prepare the system before the spraying is re-initiated in the field.

⚠️ In case of risk of frost, use anti-freeze liquid for the final cleaning

c) Cleaning if a complete stop or change of products or off-season storage
If you are done with the operation or change to another product you must empty the product tank and clean the system. You can spray residual products on the field, or you can collect it in a safe container.

ℹ️ If a cleaning procedure is given on the product label of the chosen product, follow it closely.

⚠️ In case of risk of frost, use anti-freeze liquid for the final cleaning

HMI PAGE	ACTION
	The +SPRAY has a semi-automated cleaning process which is accessible from page "*Functions*". Make sure there are sufficient water in the clean water tank (10 litres or more)
	On the cleaning mode page, you can start the system's cleaning process by selecting the desired number of cycles. The rinse pump can also be activated in this section for pressurizing the clean water outlet, which will also be pressurized during the automated cleaning process.
	Cleaning Process Started Once the system has now been cleaned. If further rinsing is required, you can repeat the procedure using a rinsing agent.
	Cleaning Process Aborted
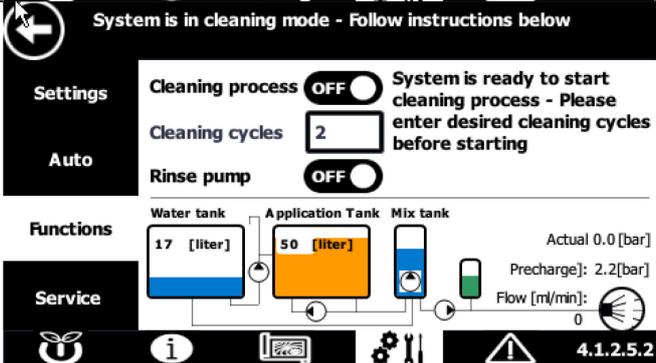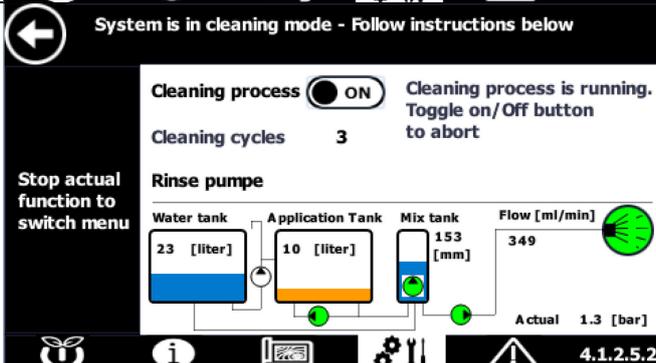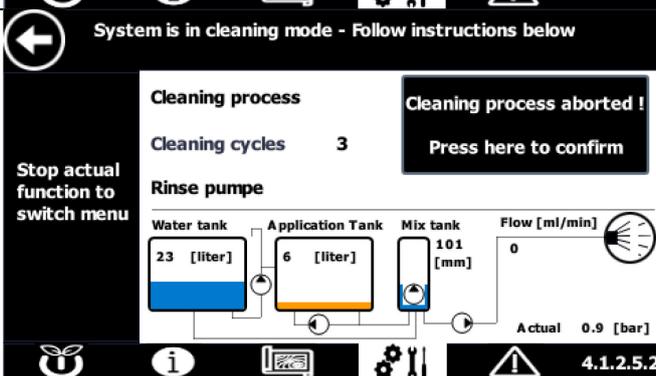
6The cleaning process will first drain the remaining liquid in the application tank through the nozzles until the mix pump is unable to draw any more liquid, indicating that the system is empty, and the mix tank can no longer be filled. At that point, approximately 1.5 litres of clean water will be transferred from the water tank to the application tank (takes approximately 10 seconds) where it will circulate automatically to further rinse the pipes. Finally, the system will drain the application tank from the nozzles again, until the pump is not able to draw any further liquid.

The above-mentioned procedure covers 1 cleaning cycle. You can decide how many times this cleaning process should be repeated by changing the value in the *"cleaning cycles"* slot. 3 cycles will be sufficient in most cases. You might need to clean manually the internal sides of the application tank.

To rinse inside, hook up a hose to the clean water and follow these steps:

Empty the product tank

1. Spray the residual on the field or use the drain valve below the product tank to let the chemical solution flow into a suitable container. Always dispose the solution according to local laws and regulations.

Run the automatic cleaning program
2. Make sure the **CLEAN WATER TANK** has at least 10 litres of clean fresh water for running the cleaning program.
3. Run the cleaning program with the desired amount of cleaning cycles.
4. Rinse manually the inside of the product tank and drain by opening valve. Spray the rinse water on the field or collect it and dispose the solution according to local laws and regulations

Wash and drain the tanks

5. Drain both the water and product tanks using the drain valves.
   To clean the mix tank properly, it might be needed to add a detergent for all-purpose cleaning or like the last rinsing rounds.

Cleaning the mixing unit

6. Use the **"Flush Mix Tank"** function in the cleaning mode to flush the mix tank with clean water before manual cleaning.
7. Tilt and lift the **mixing tube** upwards to remove it.
8. Ensure that the **red ball** is not lost and clean it thoroughly.
9. Make sure not to lose the red ball and to clean the ball properly.
10. Use a **bottle brush** to clean the inside of the mixing tube, removing any residue.
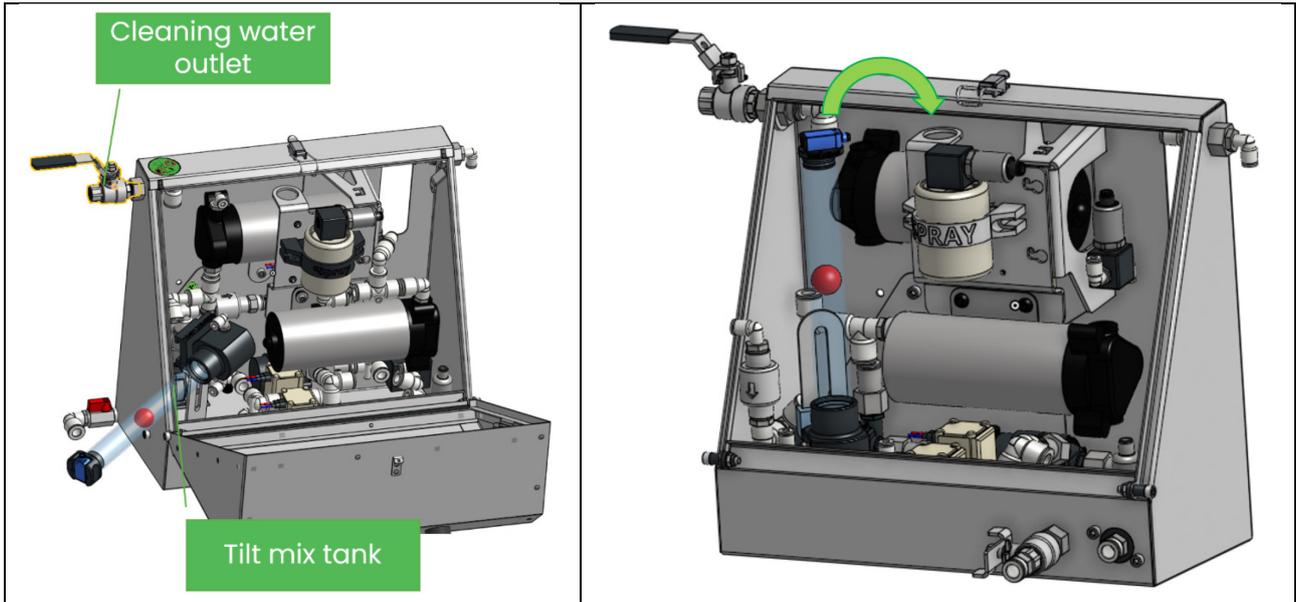
⚠️Always follow the instructions on the product label, as well as local laws and regulations when handling chemicals.

ℹ️ If there is a risk of frost, the system must be completely drained or applied anti frost liquid in the liquid system.

6   Service and Maintenance

The +Spray System must be cleaned, and service must be carried out following the recommendations. Filters must be replaced after usage. Application tanks and mixing units must be cleaned after each usage or change of Agricultural Product.

The mixer unit is equipped with **service labels** that help identify key areas involved in maintenance and servicing, making it easier to locate and handle components during operation. Additionally, the +SPRAY system features an **Inspection Mode**, specifically designed for certified entities to conduct official inspections and ensure compliance with regulations.

	Service labels for part replacement and inspection
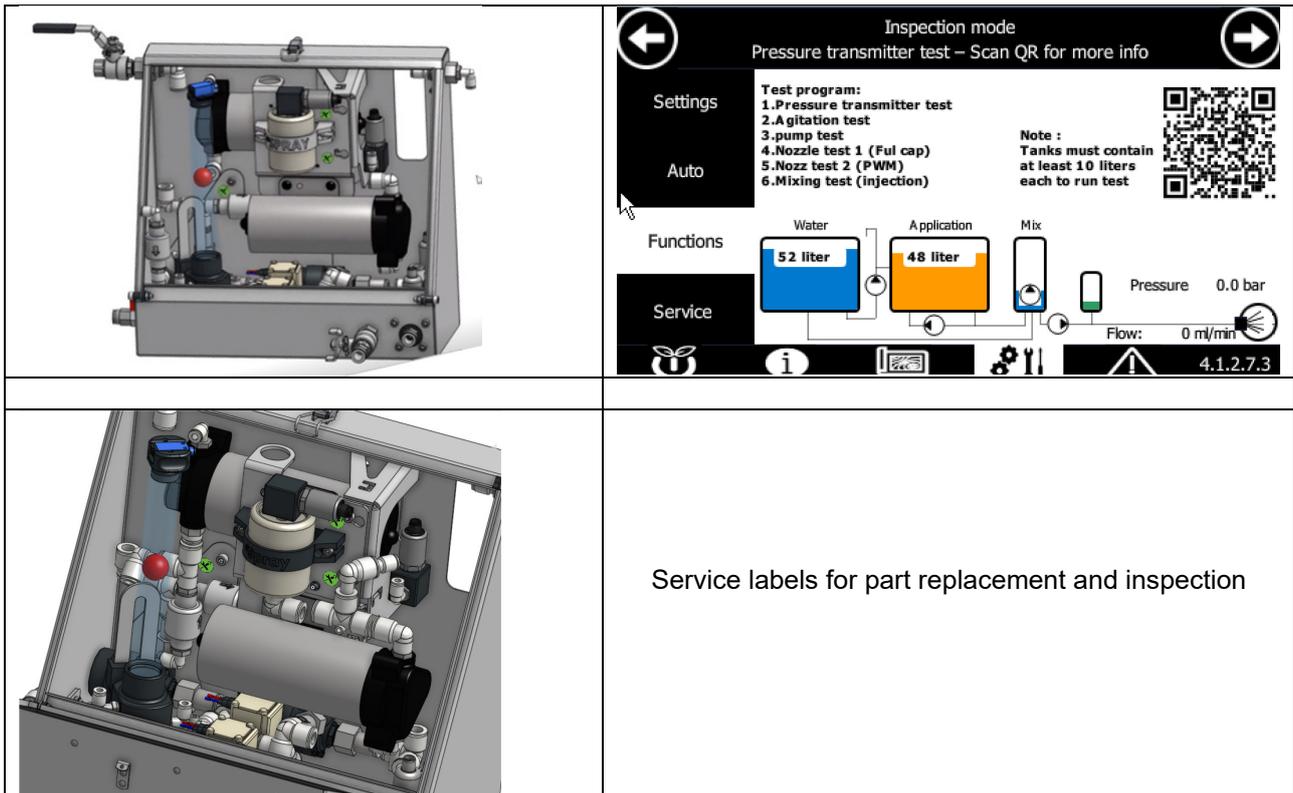
The following label can be found next to the screws and bolts, that need to be loosened or removed for facilitating the maintenance and service of the +Spray System:

6.1   Safety Instructions for Service

Please follow the recommended guidelines when performing services, cleanings and while handling products.

⚠ Wash and clean your hands after handling chemicals.

ℹ Collect any spills in a bucket or similar.

6.1.1 Cleaning and Replacement of Nozzle Filters

In the in-line system that arrives directly to the nozzles, there is a filter, that can be easily dismounted, when necessary, by twisting the case as shown in the picture below.

6.1.2 Cleaning and Replacement of Mechanical Filters

The mechanical filters that can be found on each side of the FD20 under the water- and application tank can be accessed by unscrewing the plastic case as shown in the picture below.