



Better Training for Safer Food *Initiative*

**Calibration, maintenance
and operation**

***How to use Pesticide Application
Equipment in a safe and efficient
way***



- ❑ Importance and benefits
- ❑ Calibration procedure
- ❑ Tools for an easy calibration
- ❑ Sprayer maintenance



Importance and benefits

Calibration procedure

Tools for an easy calibration

Sprayer maintenance

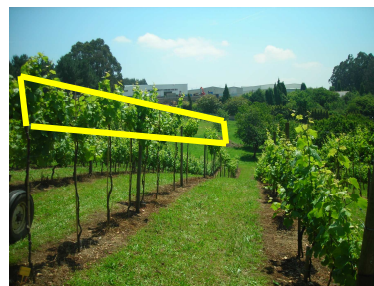
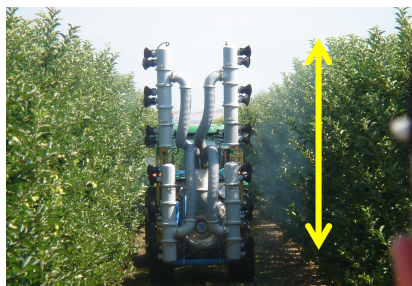
Calibration procedure, whatever method is chosen represents great benefits when it is developed prior the application task

- Less pesticide use (according 128/2009/CE Directive)
- Increase of efficiency/efficacy of pesticide application process
- Less investment (pesticide, water, fuel, time,...)
- Less risk of contamination (TOPPS, TOPPS-PROWADIS,...)

Adequate calibration

optimal adjustment

less drift losses



Interest and benefits of calibration/adjustment of pesticide application equipment

Official inspection of Sprayers (acc. article 8) (Basis)

- +
1) Calibration
- +
2) Adjustment related to the canopy structure
- +
3) Drift reducing Technology

} Procedure is mandatory for MS
(128/2009/CE)

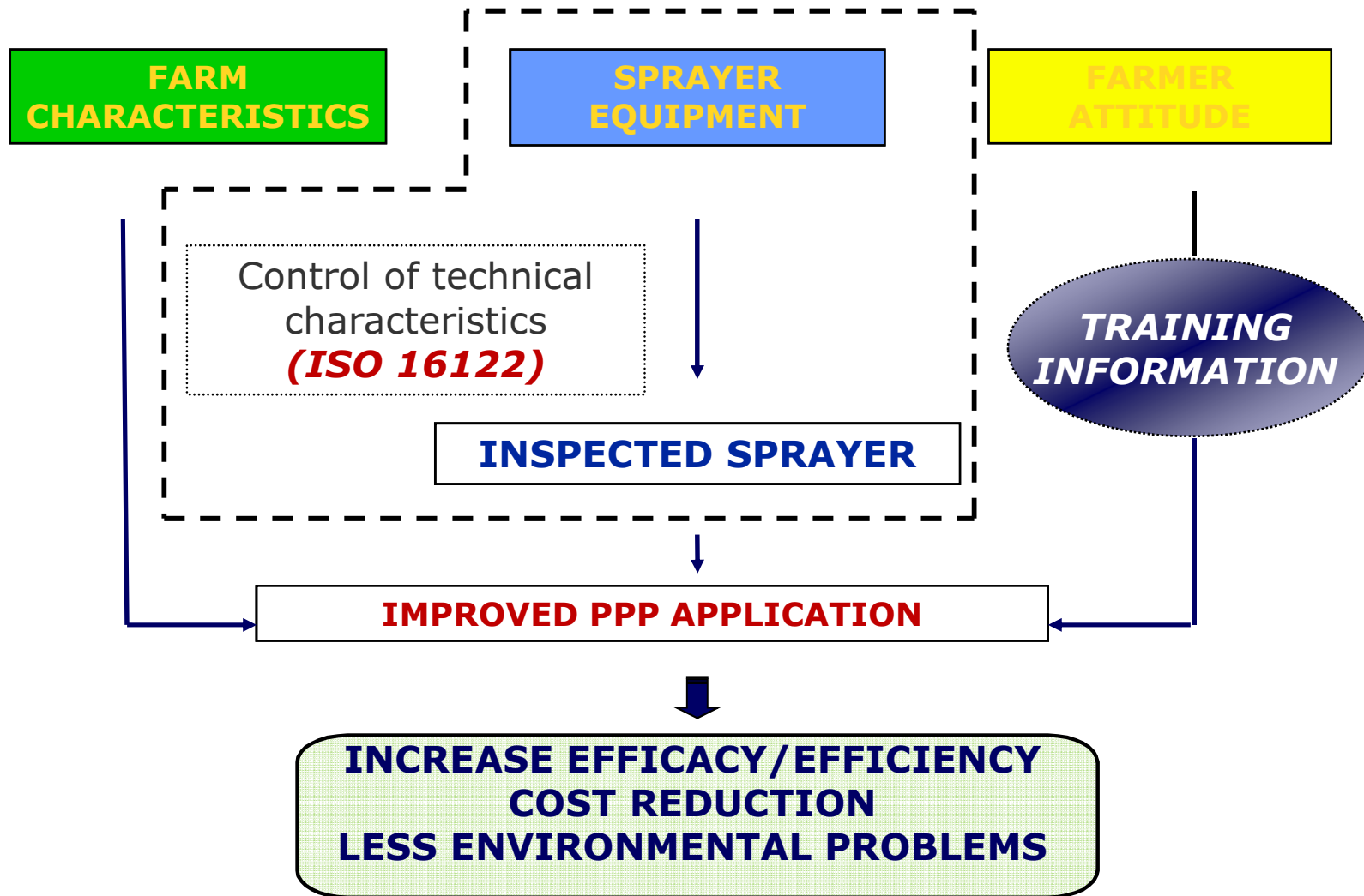
} Tools are voluntary
Tools on which growers
are manly interested
Tools can be implemented
step by step

The supplementation of the official inspection by additional tools will lead to a win- win situation with benefits for public and growers / added values!



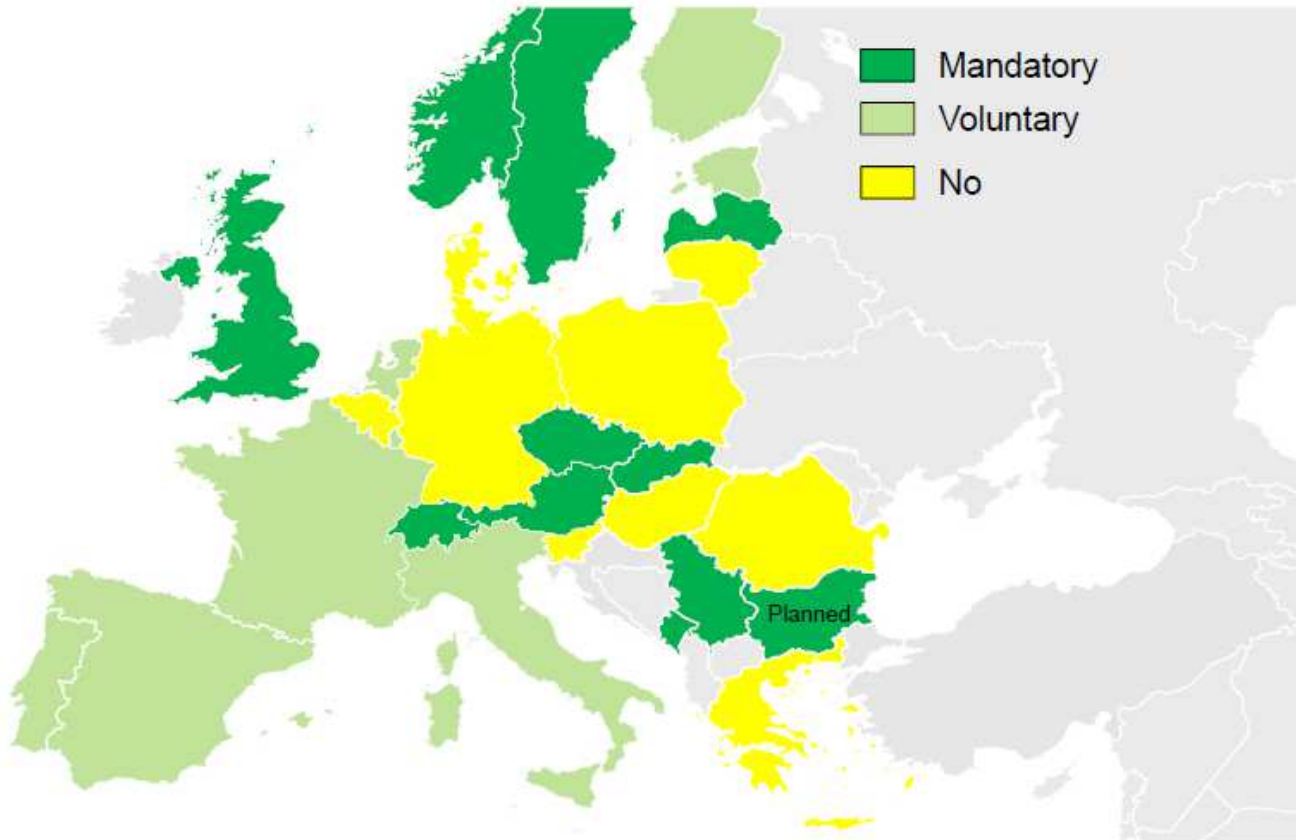


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Calibration and training activities during inspection procedure



(Wehmann, 2012 – SPISE Survey)



These sprayers have been successfully inspected

... but not calibrated !

Air flow volume/range – driving speed

Type / size / number of nozzles



- Importance and benefits
- **Calibration procedure**
- Tools for an easy calibration
- Sprayer maintenance

Preconditions for a good calibration process

- ✓ Simple ... and yet effective
- ✓ Not costly
- ✓ verifiable

USER-FRIENDLY



UNIVERSALITY

LARGE SCALE PERFORMANCE



PERMANENT and FIRM PROGRESS



Preconditions for a good calibration process

Whatever the selected process must be
SIMPLE and **PERFORMABLE**

- ✓ By the grower himself
- ✓ At the grower's site – field
- ✓ In the interaction with the target
- ✓ With simple tools
- ✓ With options for inquiring-minded growers



Parameters for a good calibration process

Assumed

- *Spray volume*
- *PPP type and characteristics*
- *Air flow volume*
- *Air flow range/direction*



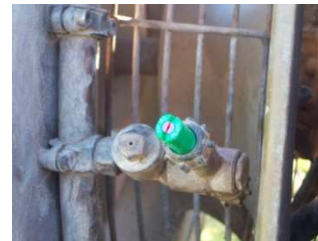
Measured

- *Boom width*
- *Boom height*
- *Forward speed*
- *Tree height and width*
- *Row spacing*



Determined

- *Nozzle flow rate*
- *Nozzle size*
- *Working pressure*
- *Nozzle type*
- *Number of nozzles*
- *Nozzle orientation*



Calibration procedure

Objective

Select the most adequate **working parameters** to obtain an uniform and precise distribution of the intended amount of pesticide over the target



Uniform target
"2D"
Liquid
Evenness
Low risk

Easy

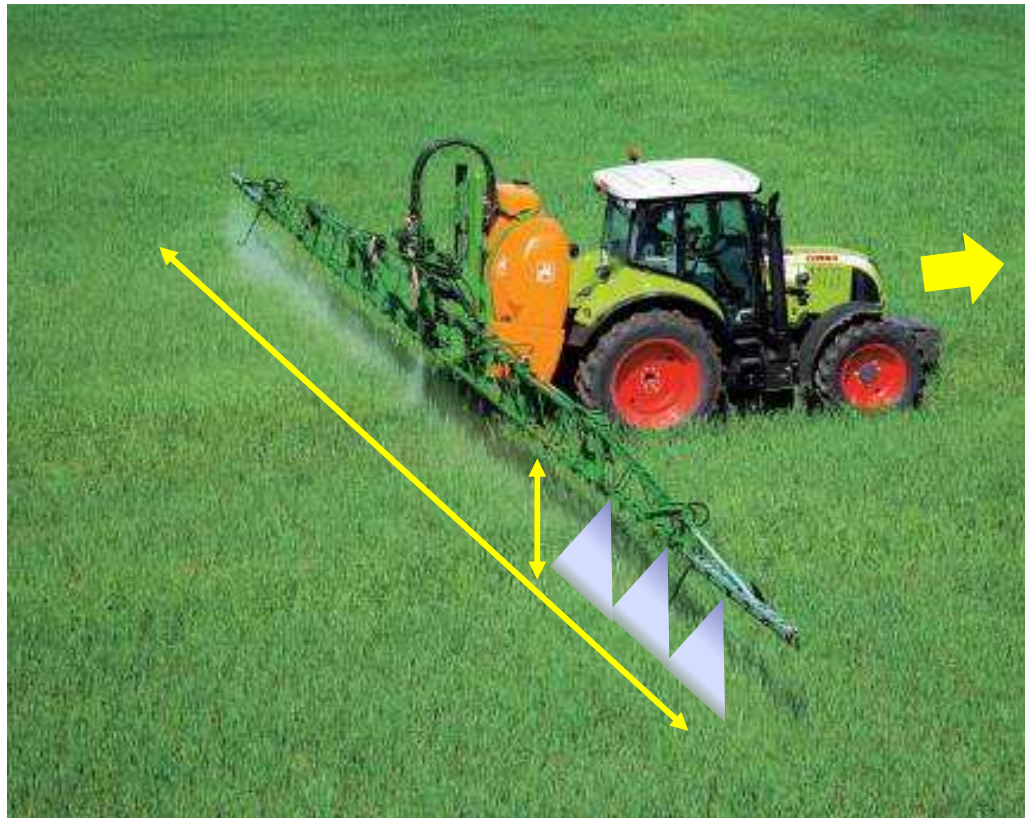


No Uniform target
"3D"
Liquid + air
Heterogeneity
High risk

Difficult



Field boom sprayer calibration process



Objective V (l/ha)
Even distribution over the field

Parameters (measured)

Boom width [**a**] (m)
Boom height [**h**] (m)
Forward speed [**v**](km/h)

Parameters (calculated)

Nozzle type
Flow rate [**q**](l/min)
Working pressure (**bar**)

$$q \text{ (l/min)} = \frac{V \text{ (l/ha)} \times a \text{ (m)} \times v \text{ (km/h)}}{600}$$

Example:

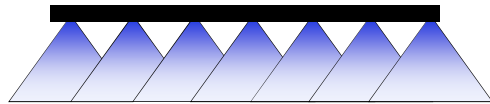
Calibration of a field boom sprayer for **200 l/ha**

1. Determine nozzle flow rate and working pressure

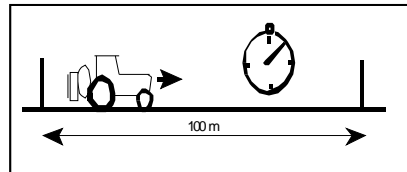


Fwd. speed: 100 m in 52 s

Boom width: 24 m



Volume: 200 l/ha



Recommended volume
200 l/ha

$$\text{Fwd. Speed (km/h)} = \frac{3,6 \times 100}{\text{time (s)}}$$

Fwd. speed table

t (s/100m)	45	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	85	90	95
v (km/h)	8,0	7,5	7,2	6,9	6,7	6,4	6,2	6,0	5,8	5,6	5,5	5,3	5,1	5,0	4,9	4,7	4,5	4,4	4,2	4,0	3,8

NOZZLE FLOW RATE CALCULATION

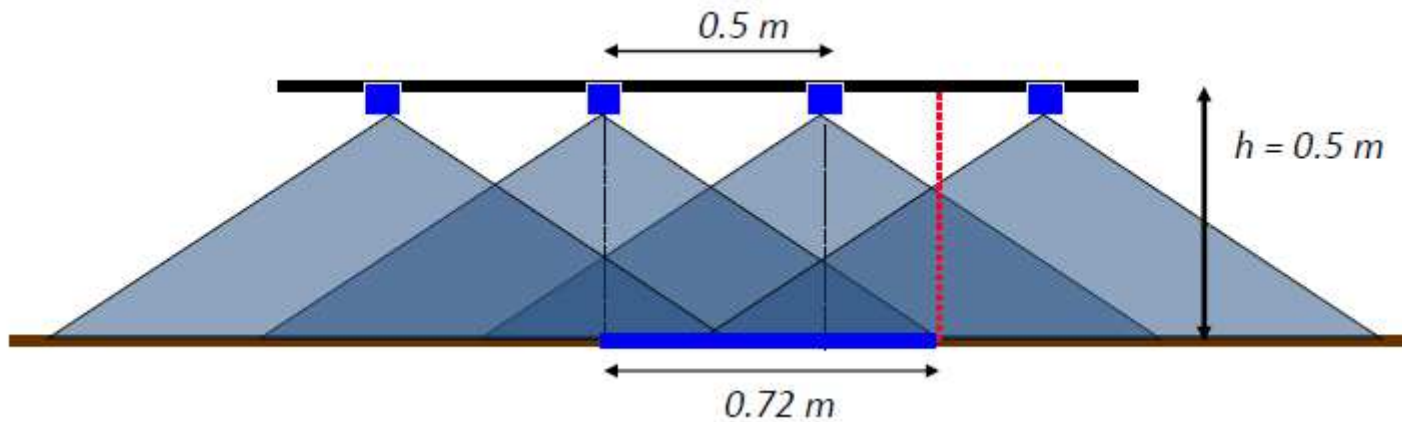
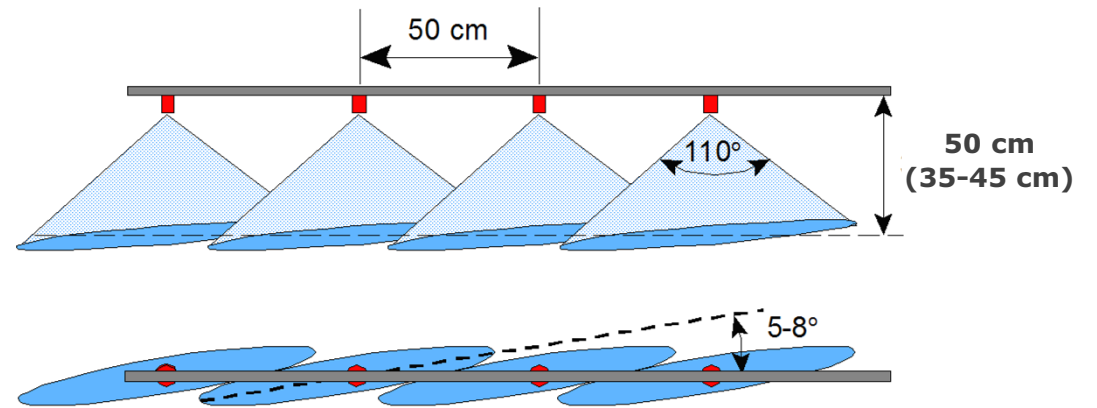
$$\frac{200 \times 6,9 \times 0,5}{600} = 1,15 \text{ l/min}$$

DROPLET SIZE
Product characteristics and environment conditions)

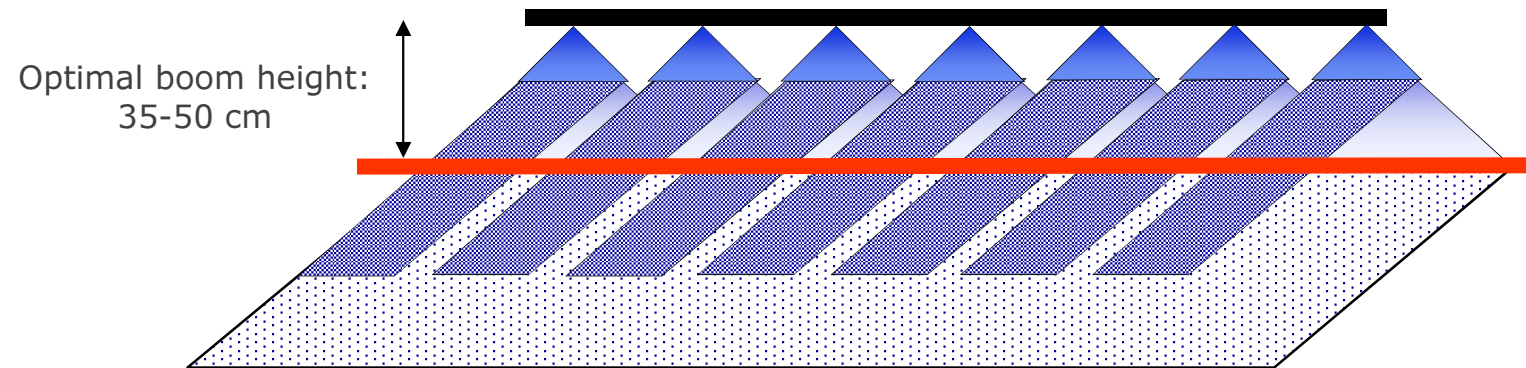
WORKING PRESSURE
Select according droplets characteristics

CHECK
Us a graduate recipient to check the real flow rate of the nozzles and compare with catalogue information

Boom height: distribution vs drift

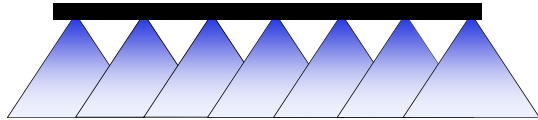


Effect of a boom too low



Uneven distribution





Volume: 200 l/ha



Search the intended flow rate on the adequate nozzle catalogue. In this case ISO nozzles

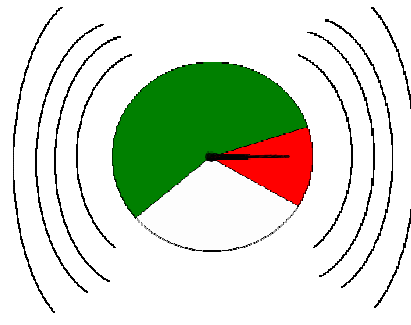
Intended flow rate – 1,15 l/min

*Closest flow rate on table – **1,18 l/min***

Pressure [bar]	Flow rate [l/min]								
	01	015	02	025	03	04	05	06	08
1	0,23	0,34	0,46	0,57	0,68	0,91	1,14	1,37	1,82
2	0,32	0,48	0,65	0,81	0,96	1,29	1,61	1,94	2,58
3	0,39	0,59	0,79	0,99	1,18	1,58	1,97	2,37	3,16
4	0,45	0,68	0,91	1,14	1,36	1,82	2,27	2,74	3,63
5	0,50	0,76	1,02	1,28	1,52	2,04	2,54	3,06	4,08

Factors for a correct calibration

$$Q = k \times \sqrt{P}$$



To increase flow rate x2
working pressure must be
increased x4


$$2 \times Q = k \times \sqrt{4 \times P}$$

Best option to modify flow rate is to select the adequate nozzle size according the droplet spectrum desired



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X 4

	Débit en l/mn									
	BLANCHE	LILAS	MARRON	JAUNE	ORANGE	ROUGE	GRISE	VERTE	NOIRE	BLEU
3	0,21	0,28	0,38	0,57	0,77	1,08	1,18	1,40	1,57	1,92
4	0,24	0,32	0,43	0,65	0,89	1,24	1,35	1,60	1,80	2,20
5	0,27	0,36	0,48	0,73	0,99	1,38	1,50	1,78	2,00	2,45
6	0,29	0,39	0,52	0,80	1,08	1,51	1,63	1,94	2,18	2,67
7	0,32	0,42	0,56	0,86	1,17	1,62	1,76	2,09	2,35	2,87
8	0,34	0,45	0,60	0,92	1,24	1,73	1,87	2,22	2,50	3,06
9	0,36	0,48	0,64	0,97	1,32	1,83	1,98	2,35	2,64	3,24
10	0,38	0,50	0,67	1,03	1,39	1,92	2,08	2,47	2,78	3,40
11	0,39	0,52	0,70	1,07	1,45	2,01	2,17	2,58	2,90	3,56
12	0,41	0,55	0,73	1,12	1,51	2,09	2,26	2,69	3,03	3,71
13	0,43	0,57	0,76	1,17	1,57	2,17	2,35	2,79	3,14	3,85
14	0,44	0,59	0,79	1,21	1,63	2,25	2,43	2,89	3,26	3,99
15	0,46	0,61	0,81	1,25	1,69	2,33	2,51	2,99	3,36	4,12
16	0,47	0,63	0,84	1,29	1,74	2,40	2,59	3,08	3,47	4,25
17	0,48	0,64	0,86	1,33	1,79	2,47	2,67	3,17	3,57	4,37
18	0,50	0,66	0,89	1,37	1,84	2,54	2,74	3,25	3,67	4,49
19	0,51	0,68	0,91	1,40	1,89	2,60	2,81	3,34	3,76	4,61
20	0,52	0,70	0,93	1,44	1,94	2,67	2,88	3,42	3,85	4,72
21	0,54	0,71	0,95	1,48	1,99	2,73	2,95	3,50	3,94	4,84
22	0,55	0,73	0,98	1,51	2,03	2,79	3,01	3,57	4,03	4,94
23	0,56	0,74	1,00	1,54	2,07	2,85	3,07	3,65	4,12	5,05
24	0,57	0,76	1,02	1,58	2,12	2,91	3,14	3,72	4,20	5,15
25	0,58	0,77	1,04	1,61	2,16	2,97	3,20	3,80	4,28	5,25

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Orchard sprayer calibration process

Objective **V** (l/ha) *Distribution according canopy*



Parameters (measured)

- Row spacing [r] (m)*
- Forward speed [v](km/h)*
- Tree height [h](m)*
- Tree width [w](m)*

Parameters (calculated)

- Nozzle type*
- Nozzle number [n]*
- Nozzle orientation*
- Nozzle flow rate [q](l/min)*
- Total flow rate [Q](l/min)*
- Working pressure (bar)*
- Air flow rate [A] (m³/h)*

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$$Q \text{ (l/min)} = \frac{V \text{ (l/ha)} \times a \text{ (m)} \times v \text{ (km/h)}}{600}$$

$$A \text{ (m}^3\text{/h)} = \frac{h \text{ (m)} \times r \text{ (m)} \times v \text{ (km/h)} \times 1000}{K \approx (2-3)}$$

Example for uniform orchard calibration

Volume 600 l/ha – 4 km/h – 4 m – 16 nozzles

$$\text{Flow rate (l/min)} = \frac{\text{Volume (l/ha)} \times w \text{ (m)} \times \text{Fwd. speed (km/h)}}{600}$$

$$\text{Flow rate (l/min)} = \frac{600 \text{ l/ha} \times 4 \text{ m} \times 4 \text{ km/h}}{600} = 16 \text{ l/min}$$

$$\frac{16 \text{ l/min}}{16 \text{ nozzles}} = 1 \text{ l/min}$$



Nozzle selection on catalogue



Flow rate (liters per minut)											
Nozzle	Pressure (bar)										
	5	6	7	8	9	10	11	12	13	14	15
lilac	0.37	0.40	0.43	0.45	0.48	0.50	0.53	0.55	0.57	0.59	0.61
brown	0.48	0.52	0.56	0.59	0.62	0.66	0.69	0.71	0.74	0.77	0.78
yellow	0.74	0.81	0.87	0.92	0.97	1.02	1.07	1.11	1.15	1.19	1.23
orange	0.98	1.06	1.14	1.21	1.28	1.34	1.40	1.46	1.51	1.57	1.62
red	1.39	1.51	1.62	1.72	1.82	1.91	1.99	2.07	2.15	2.22	2.30



- ✓ **600 l/ha**
- ✓ **4 km/h**
- ✓ **4 m (working width)**
- ✓ **16 nozzles ATR yellow**
- ✓ **10 bar**

Air flow adjustment: objective the canopy



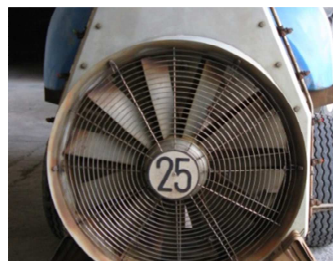
TRACTOR

- *RPM*
- *Tractor gear*



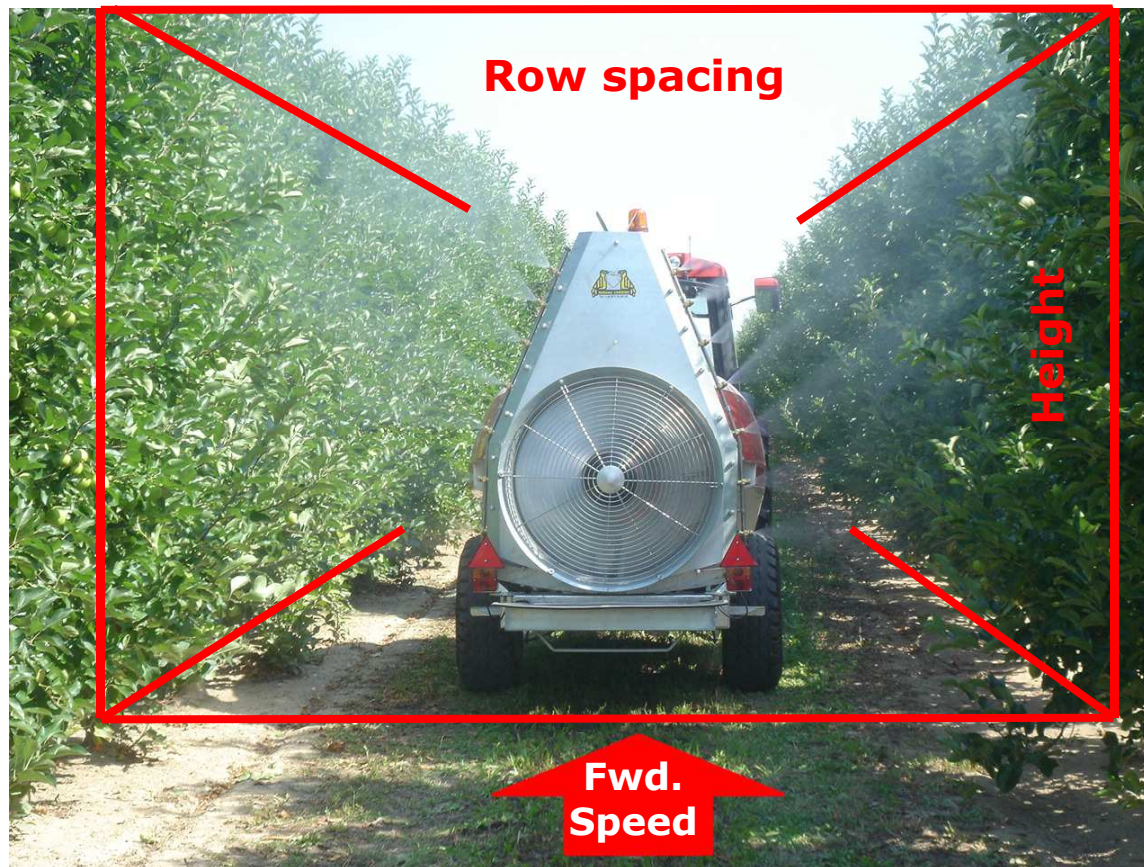
SPRAYER

- *Transmission gear*
- *Propeller blade setting*
- *Section air outlets*

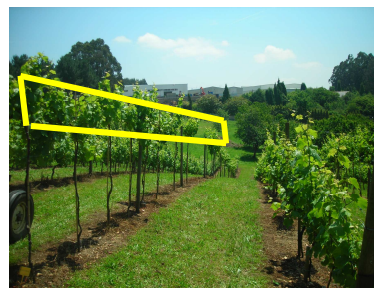
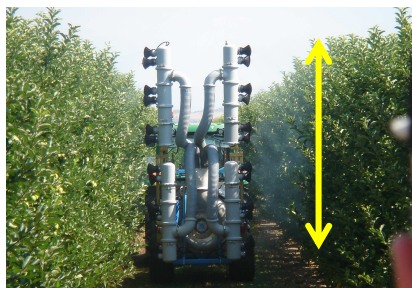


$$\text{Air Volume [m}^3\text{/h]} = \frac{\text{Tree height [m]} \times \text{Row spacing [m]} \times \text{Fwd. Speed [km/h]} \times 1000}{K \approx (2-3)}$$

How to calculate the
air needs

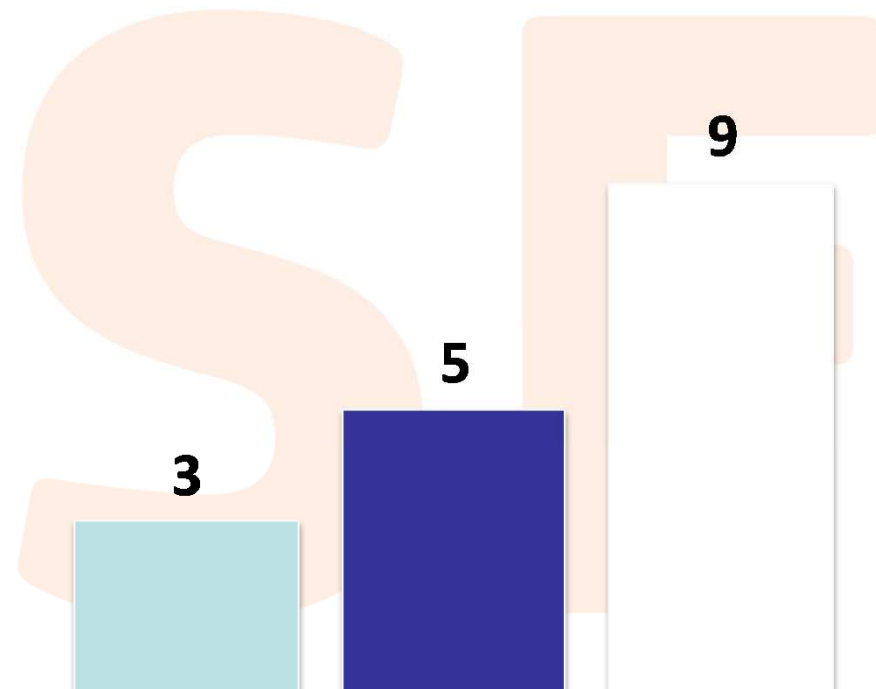


Adjustment according canopy structure implies:
Adequate selection of air flow characteristics (velocity, air flow rate,...)
Precise orientation of air outlets



If the intended applied volume is 150 l/ha and forward speed is 8 km/h, the nozzle flow rate will be:

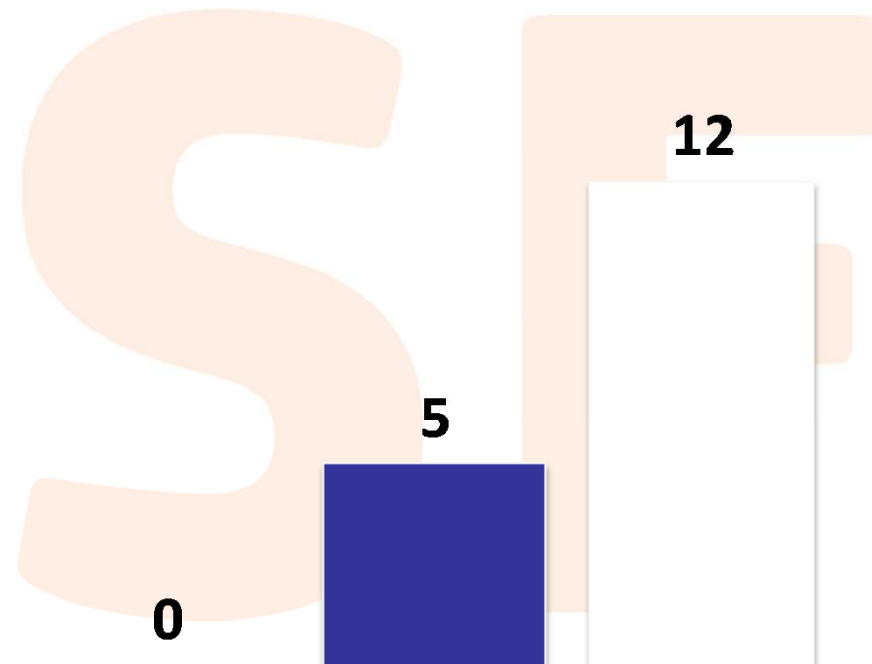
1. 0.5 L/min
2. 1.0 L/min
3. Boom width is a requested data to calculate the flow rate



■ A ■ B ■ C

**Nozzle flow rate is 0.5 L/min at 3 bar.
What should be the new pressure to obtain
1 L/min?**

1. 2.5 bar
2. 6 bar
3. 12 bar



■ A ■ B ■ C



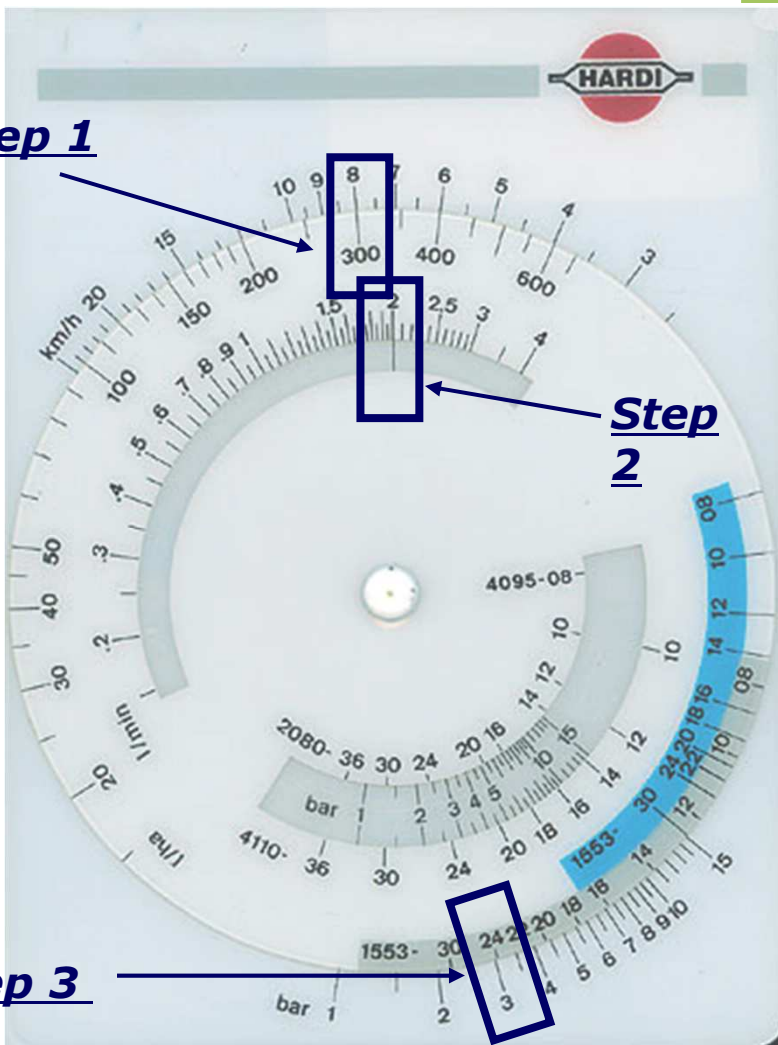
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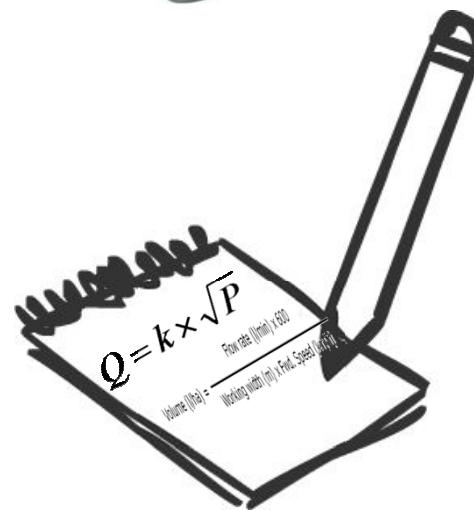
Calibration tools

Step 1

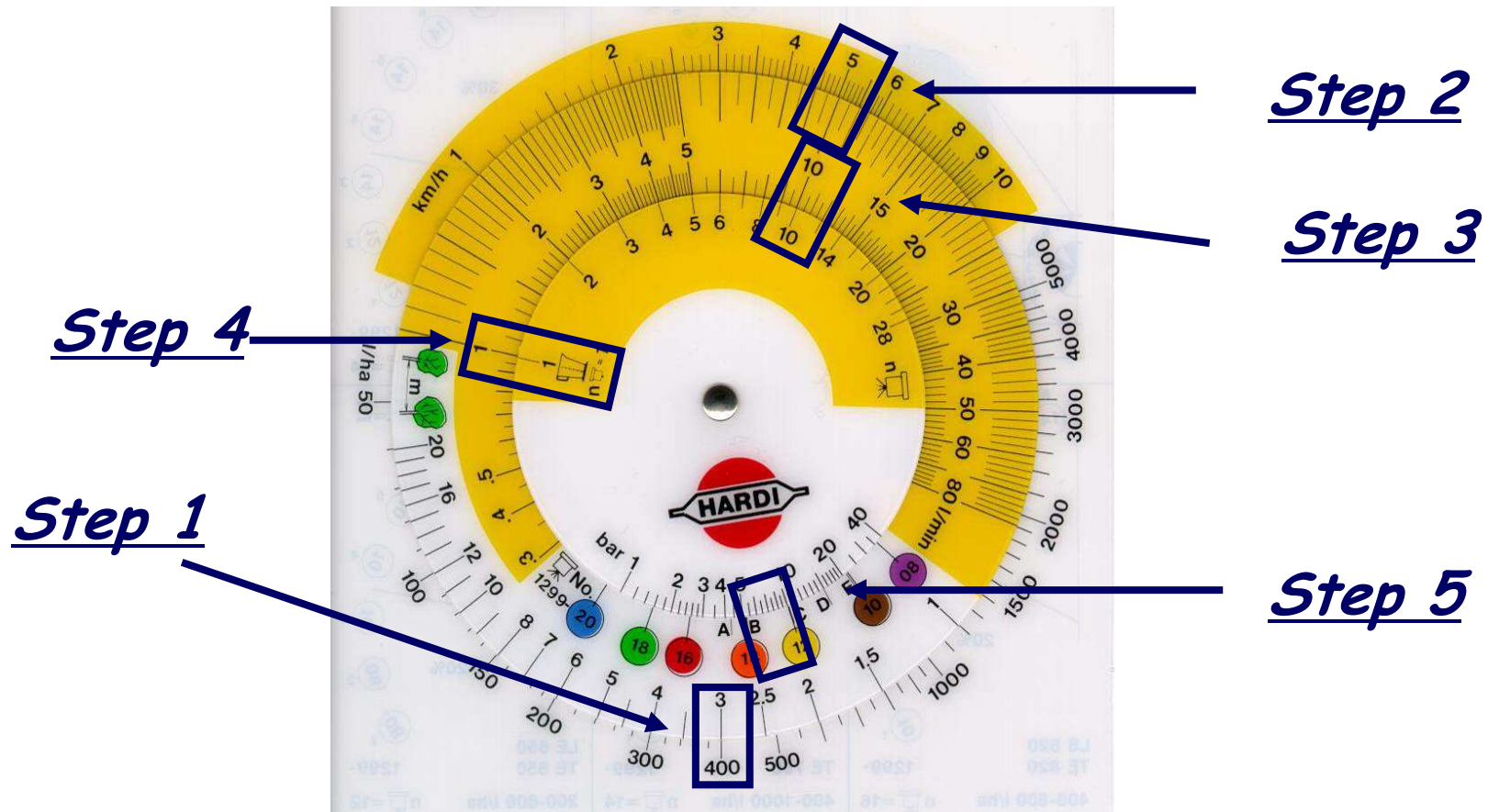


Step 2

Step 3



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 Departament d'Enginyeria Agroalimentària i Biotecnologia

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On-line tools for sprayer calibration

Online nozzle selector | iPhone apps | Android apps

HARDI Nozzle Selection Tool

This web-tool can help you to choose the right nozzles for the application you are planning. Fill in your desired spraying volume and driving speed and press SEARCH.

Spray Volume (l/ha)
 Speed (km/h)



www.hardi-nozzles.com

www.hardi-international.com

www.spray.com/services

Spraying Systems Co. Experts in Spray Technology

Spray Nozzle Selection

With more than 87,000 different spray nozzles and accessories from which to choose, spray nozzle selection can be challenging. Once you identify the performance you need and evaluate your operating environment, you will be able to narrow down your options. In some cases, you will find just a few nozzles that are suitable and, in other cases, you may find dozens of possible options.

We have a variety of tools available to assist you with nozzle selection. We encourage you to use them to learn more about the nozzles that will meet your needs. However, we recommend that you [contact your local sales associate](#) for selection assistance especially if your application requires high precision. Our sales engineers have the applications expertise to guide you to the best spray system solution.

Specification and Selection Tools

Flow rate calculator: Use this calculator to determine the flow rate of any nozzle at any operating pressure. Inputs to this calculator are the nozzle type, current operating pressure and flow, desired flow or desired pressure.

Spray Coverage: Determine the spray nozzle coverage at a known spray height and spray angle; determine the spray angle required to produce desired spray coverage at a known spray height or determine the spray height required to produce desired spray coverage at a known spray angle.

iSpray Selection Tools: iSpray is our online ordering offering. In iSpray, you will find tools that will assist with nozzle selection. You may use these tool even if you don't place an order. However, if you do find the exact nozzles you need, you can purchase them by using a major credit card.

iSpray Nozzle Selector: Enter your desired spray pressure and flow rate to start narrowing down the options. Then choose spray pattern and nozzle type to further refine your choice.




Spray Technology Reference Guide: Understanding Drop Size, Bulletin 4598
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ALBUZ Long Lasting Precision

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Choose your nozzle

ATR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR	TR

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 New : xDl range extends to Lilac size.
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 AGRO SHOW 2011

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- Importance and benefits
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Maintenance of the sprayer

- ✓ Damaged or wear nozzles
- ✓ Losses on hoses/pipes
- ✓ Correct functioning of the pump
- ✓ Check nozzle flow rate
- ✓ Filters
- ✓ PTO and fan
- ✓ General cleaning



Steps for sprayer's maintenance

Before initial use:

- Check all fluids, engine, and driveline.
- Grease boom.
- Grease steering, axle, and driveline.
- Tighten poly tank straps.
- Adjust boom.
- Check lighting and flashers.
- Record all field computer calibration values.



Daily maintenance:

- Check transmission oil level.
- Check hydraulic fluid level.
- Grease boom: grease flag pins, sway pivots, tip hinge, and boom fold pivots every eight hours
- Check lighting and flashers.
- Review field computer calibrations
- Clean boom strainers and main product strainer.
- Inspect machine for product or hydraulic leaks.





Thank you for your attention.

• ***Prof. Emilio Gil***

**Better Training for Safer Food
BTSF**

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