European Commission

Better Training for Safer Food

Initiative

Calibration, maintenance and operation

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

Consumers, Health And Food Executive Agency

Prof. EMILIO GIL
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- Importance and benefits
- Calibration procedure
- Tools for an easy calibration
- Sprayer maintenance

Consumers, Health And Food Executive Agency

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

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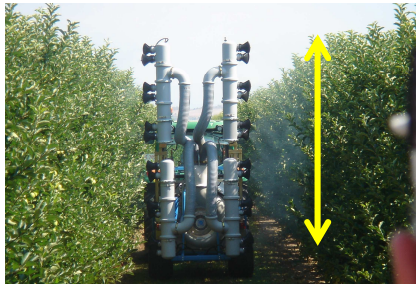
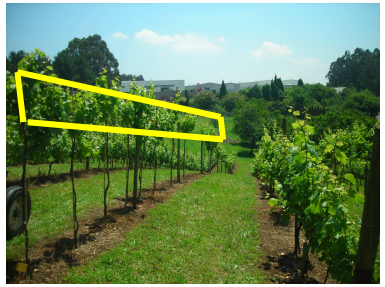
Calibration procedure, whatever method is chosen represents great benefits when it is developed prior the application task

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**

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Interest and benefits of calibration/adjustment of pesticide application equipment

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

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

\+

1) Calibration

\+

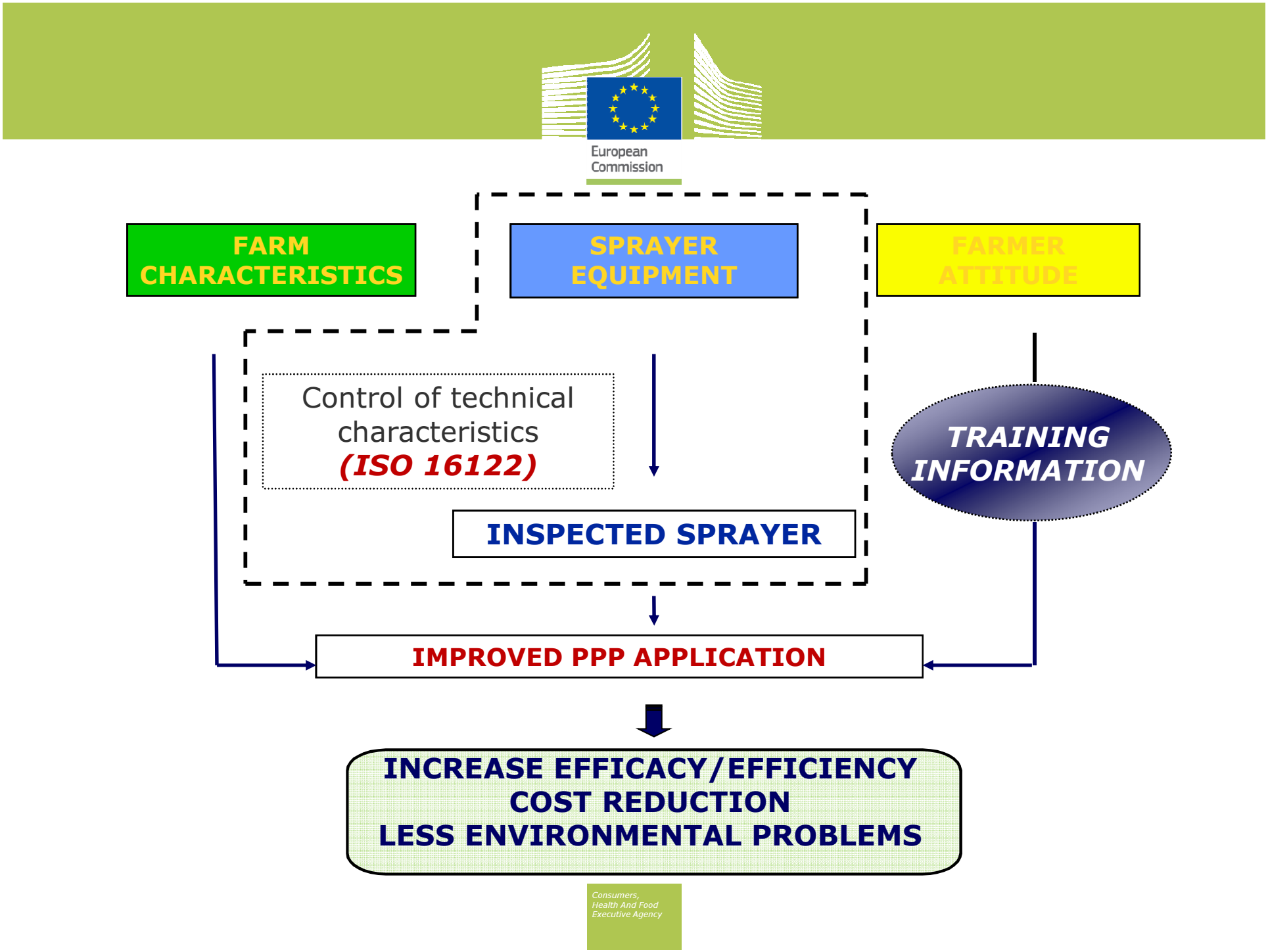
2) Adjustment related to the canopy structure

\+

3) Drift reducing Technology

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!


European Commission
FARM CHARACTERISTICS
SPRAYER EQUIPMENT
FARMER ATTITUDE
Control of technical characteristics
(ISO 16122)
TRAINING INFORMATION
INSPECTED SPRAYER
IMPROVED PPP APPLICATION
INCREASE EFFICACY/EFFICIENCY
COST REDUCTION
LESS ENVIRONMENTAL PROBLEMS
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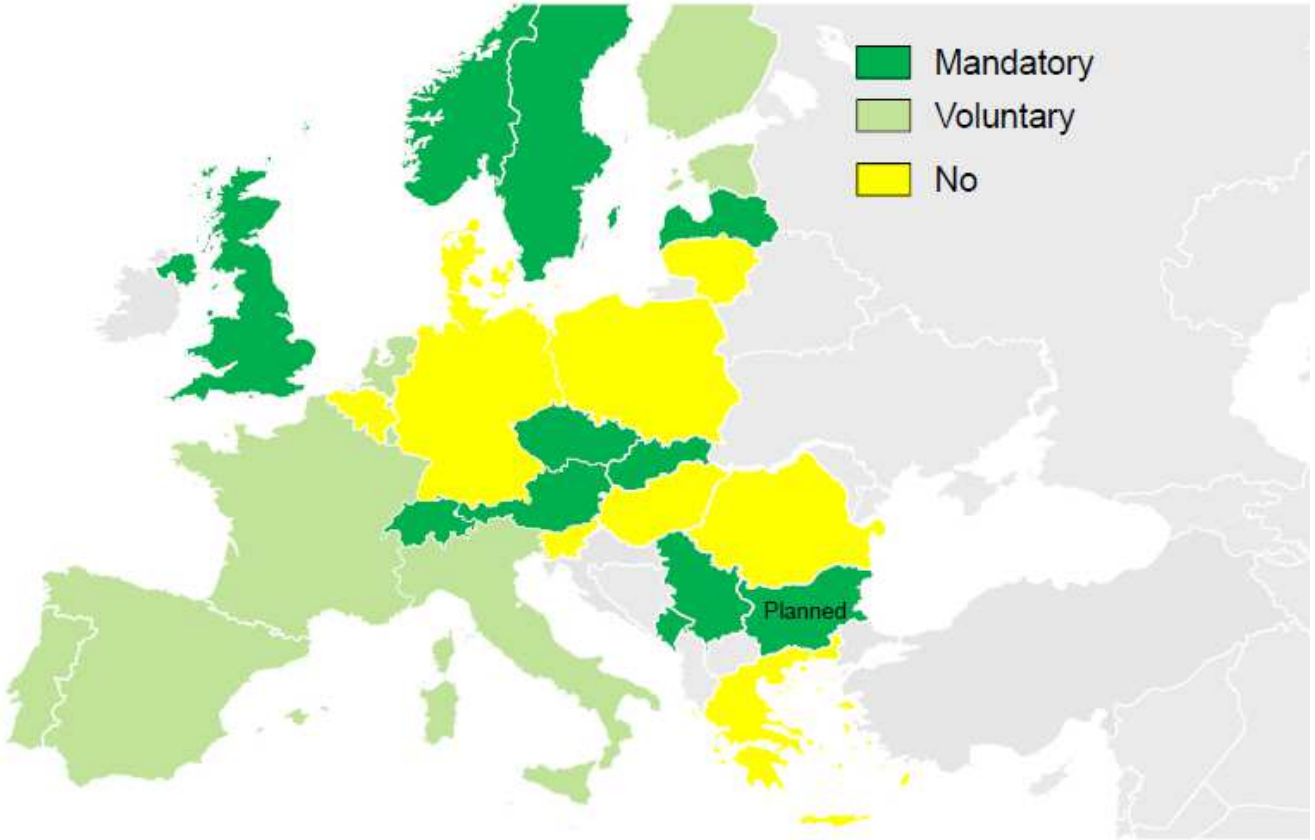
Calibration and training activities during inspection procedure



(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

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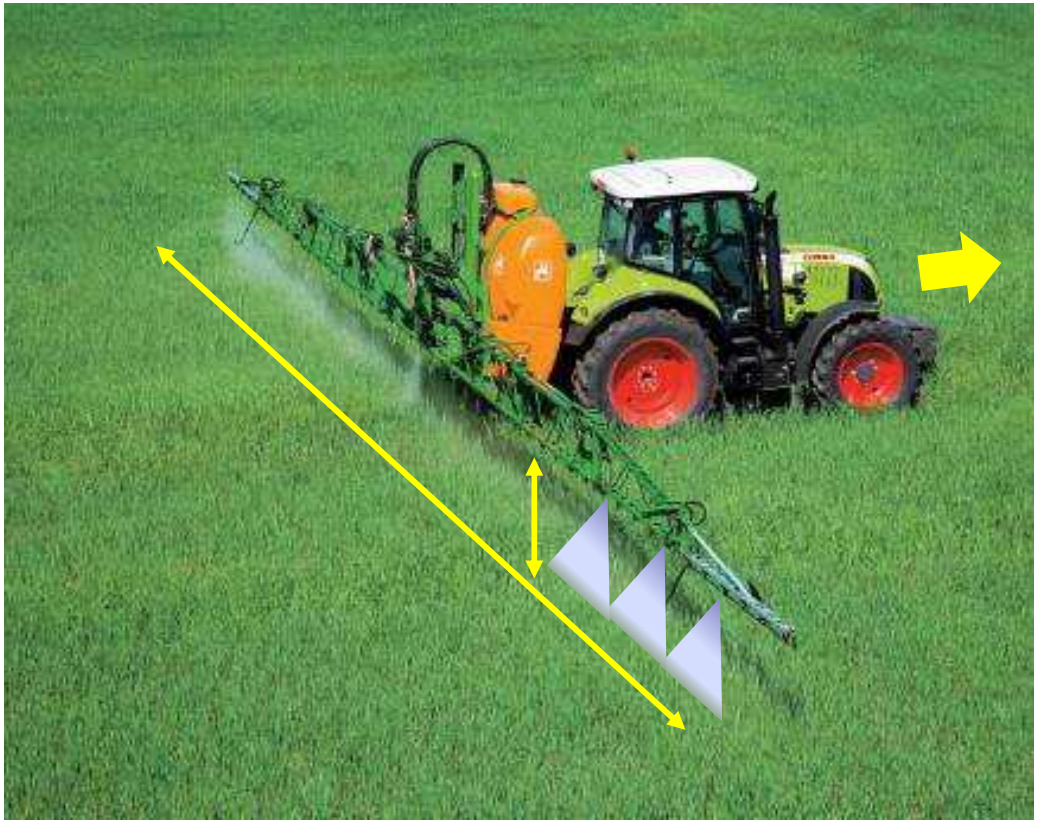
Field boom sprayer calibration process



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)***

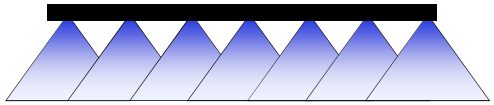
$$q\ (l/min) = \frac{V\ (l/ha) \times a\ (m) \times v\ (km/h)}{600}$$

Example:
Calibration of a field boom sprayer for **<u>200 l/ha</u>**

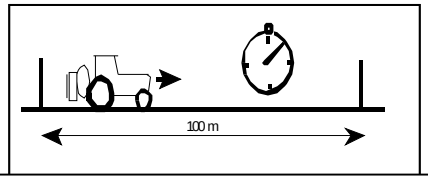
1. Determine nozzle flow rate and working pressure

Fwd. speed: 100 m in 52 s

Boom width: 24 m



Volume: **200 l/ha**



Recommended volume

200 l/ha

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

1,15 **l/min**

200 **6,9** **0,5**

$$\frac{\text{volume (l/ha)} \times \text{Fwd. speed (km/h)} \times \text{Nozzle distance (m)}}{600}$$

DROPLET SIZE

Product characteristics and environment conditions)

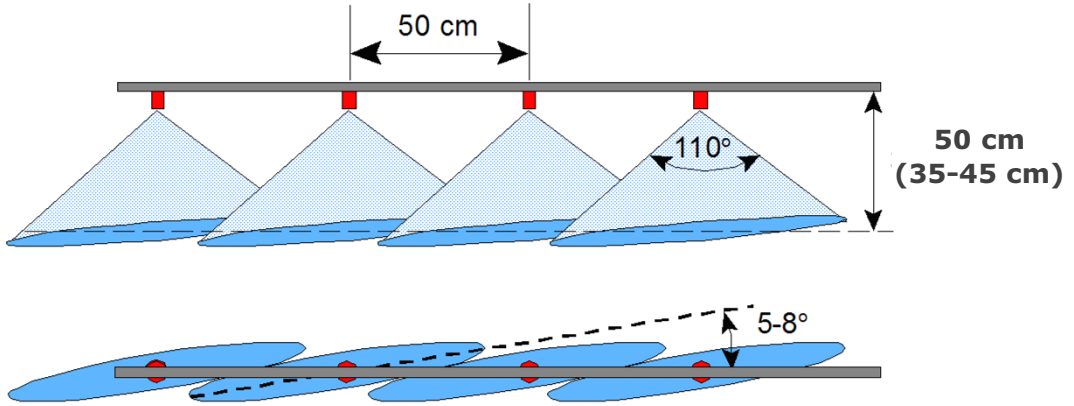
WORKING PRESSURE

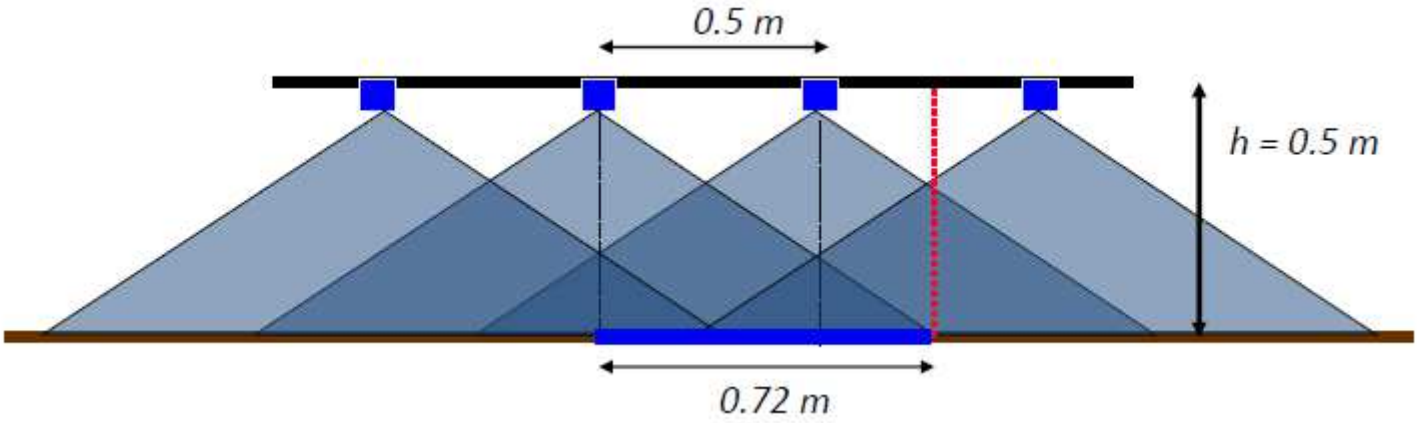
Select according droplets characteristics

CHECK

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

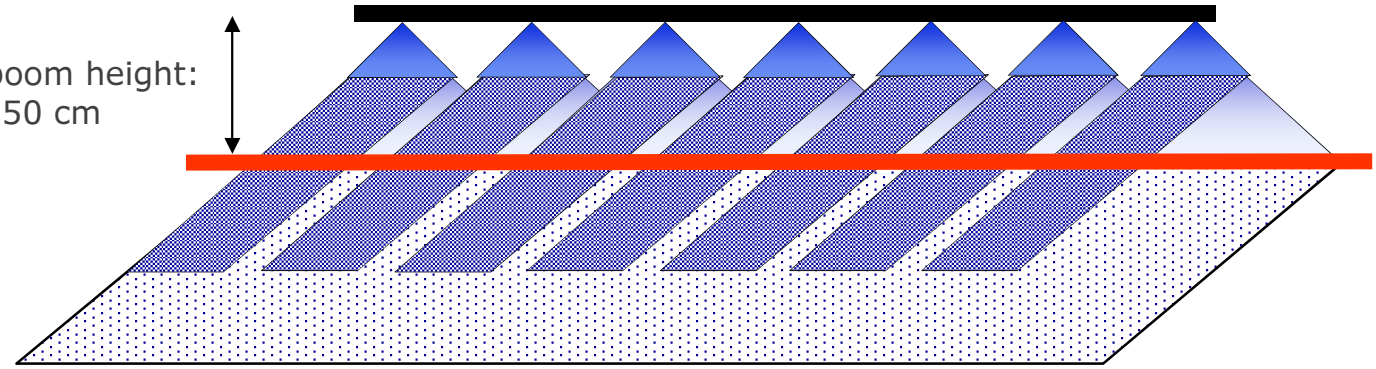
Boom height: distribution vs drift



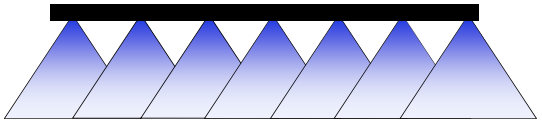


Effect of a boom too low

Optimal boom height:
35-50 cm



Uneven distribution



Volume: **200 l/ha**

3 bar

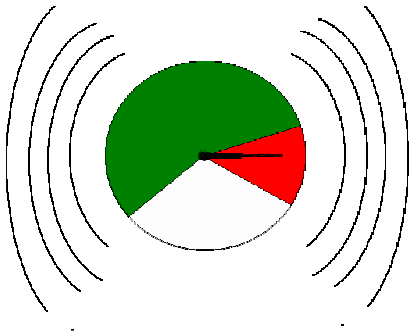
Search the intended flow rate on the adequate nozzle catalogue. In this case ISO nozzles

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**	**0,98**	**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

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

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

bar	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

X 4

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]** ***(m^3/h)***

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

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

Example for uniform orchard calibration

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

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

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

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

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	0.5[illegible]	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.[illegible]	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*

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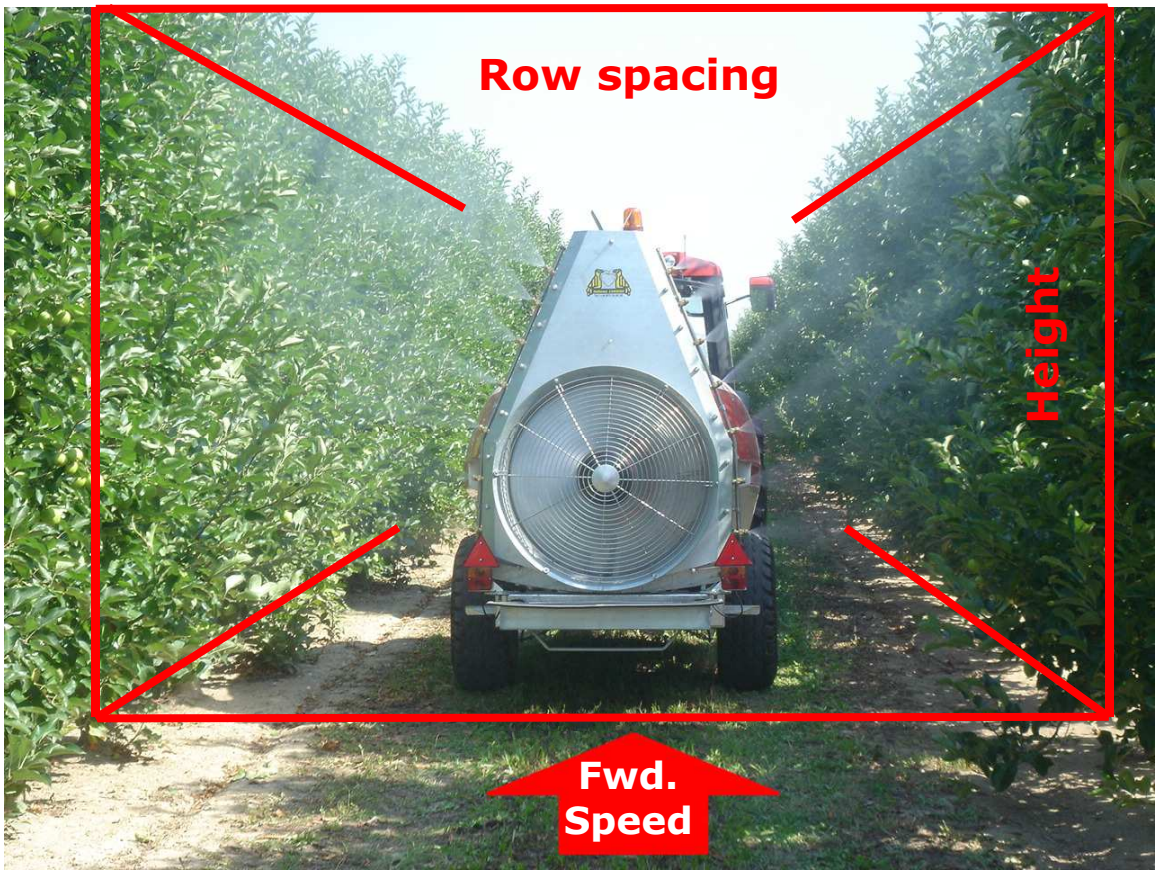
How to calculate the air needs

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



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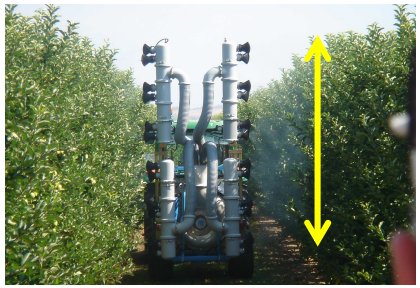
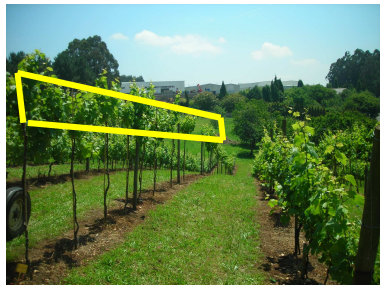
Adjustment according canopy structure implies:

Adequate selection of air flow characteristics (velocity, air flow rate,…)
Precise orientation of air outlets





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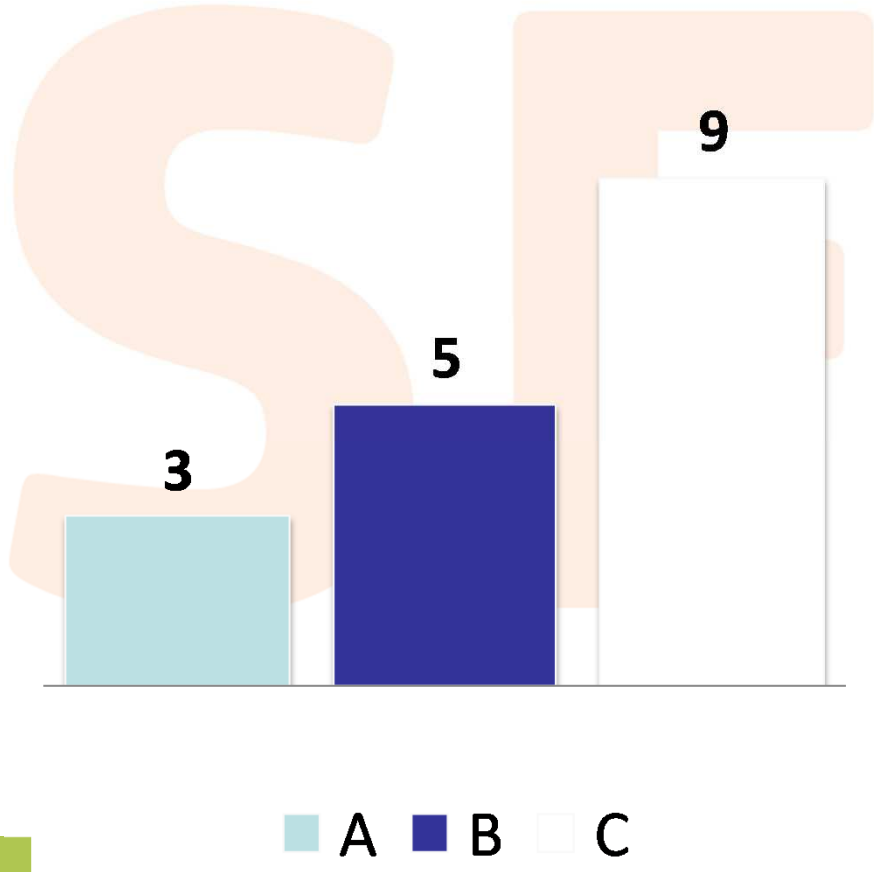
If the intended applied volume is 150 l/ha and forward speed is 8 km/h, the nozzle flow rate will be:

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



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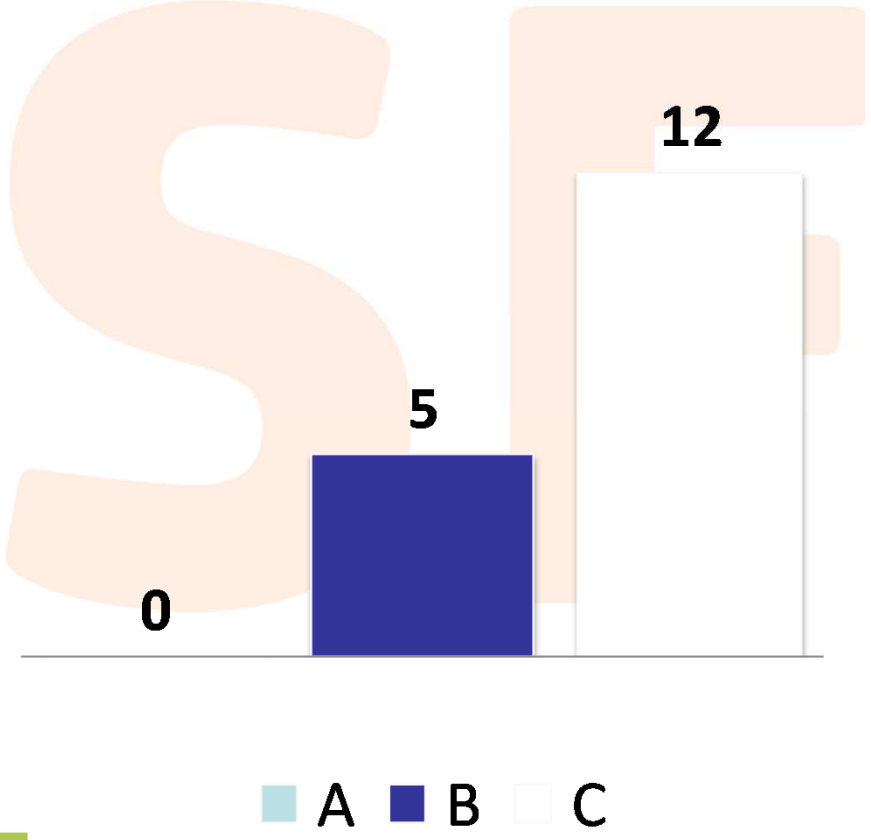
Nozzle flow rate is 0.5 L/min at 3 bar. What should be the new pressure to obtain 1 L/min?

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



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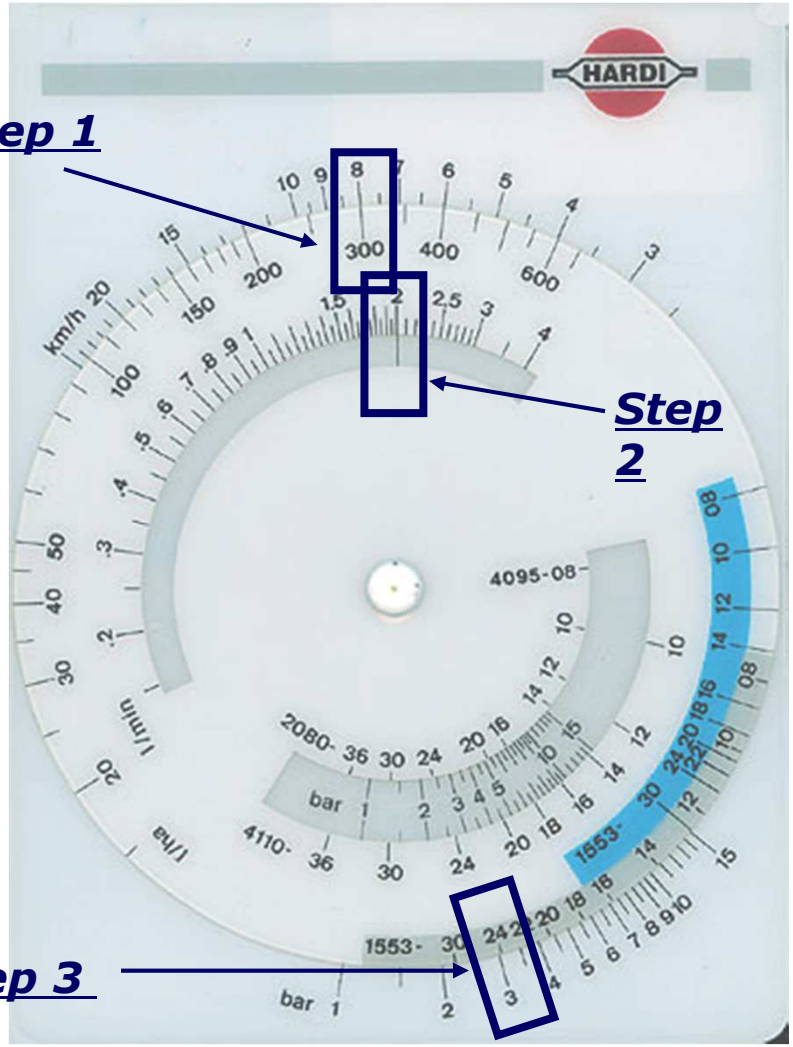
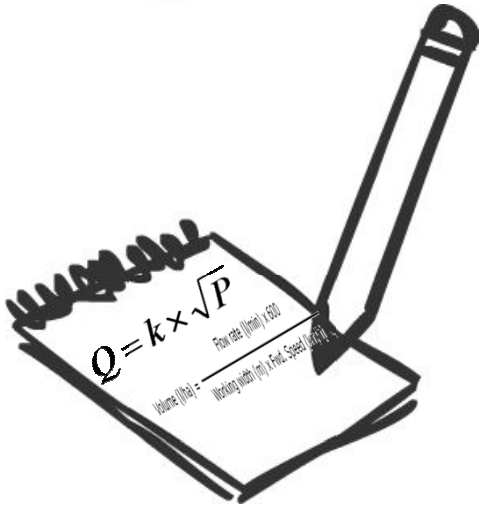
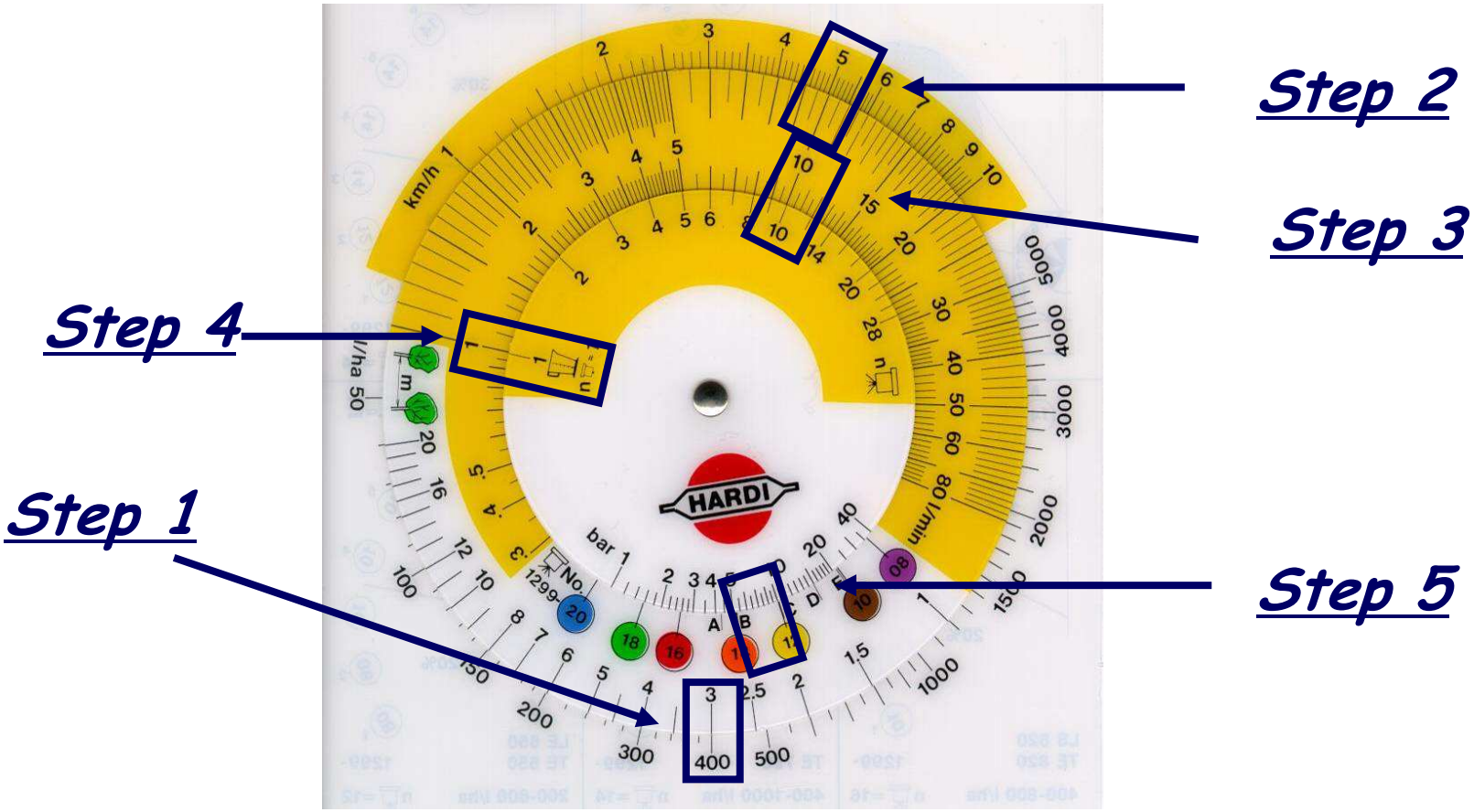
Calibration tools






Step 2
Step 3
Step 4
Step 1
Step 5
HARDI
km/h
bar
l/min
l/ha

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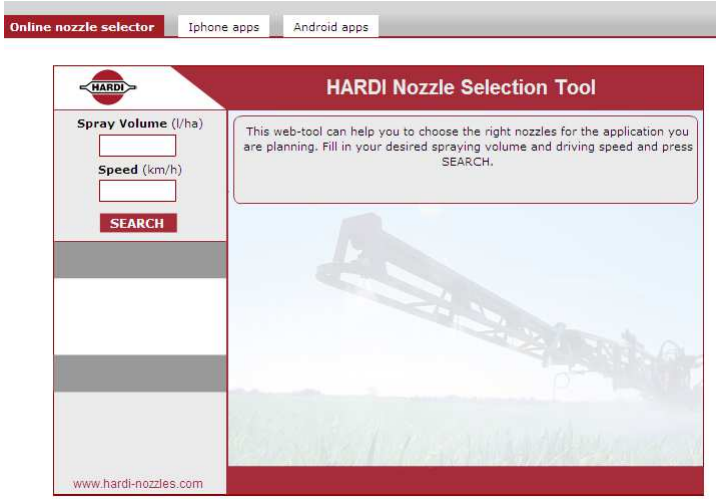
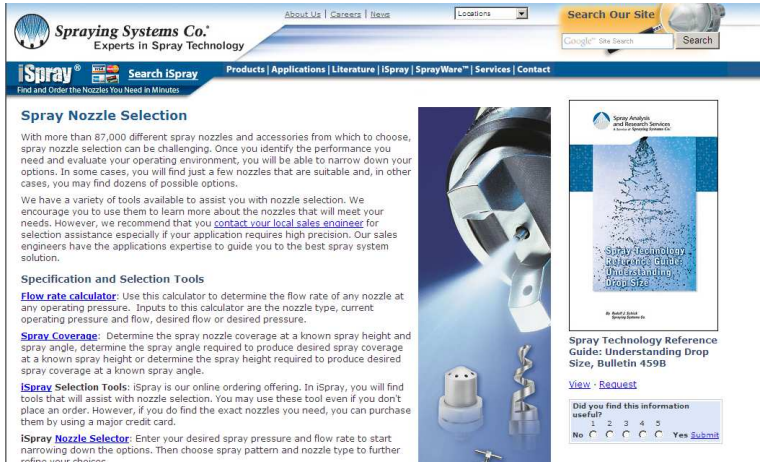
On-line tools for sprayer calibration

www.uma.deab.upc.edu

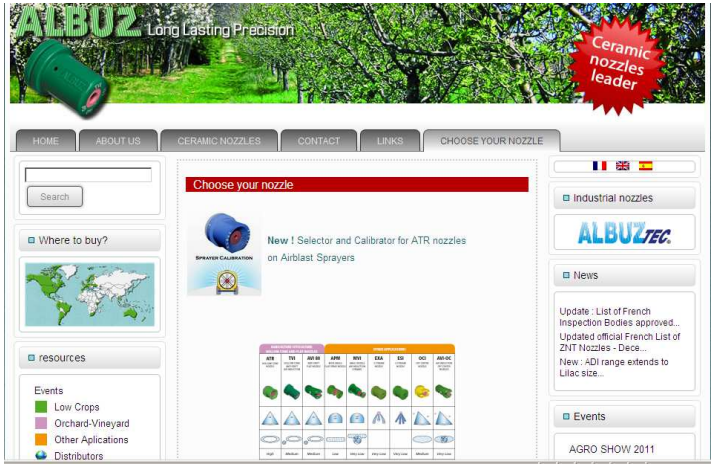
www.hardi-international.com



www.spray.com/services



www.albuz-spray.com



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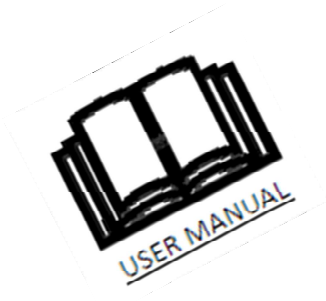

Maintenance of the sprayer

- ✓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

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