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Italian Agricultural Machinery Manufacturers Federation

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Mechanisation and Technologies for New Farmers Needs

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The challenges of EVOO production in new regions: the Australian and Californian experiences

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Pablo Canamasas is an Agriculture scientist and technician in the olive oil production and quality fields. He has been involved in the EVOO industry for over 29 years, and has worked for Boundary Bend Olives in Australia, the largest EVOO producer in the South hemisphere, for the past 21 years.

Pablo is also an independent consultant to EVOO and avocado private companies in USA, China, Japan, New Zealand, Chile, Israel, México, Italy, Argentina and others; he is frequently invited as a key speaker in national and international EVOO events. In the past, Pablo has undertaken research activities funded by the Australian government in the EVOO production field.

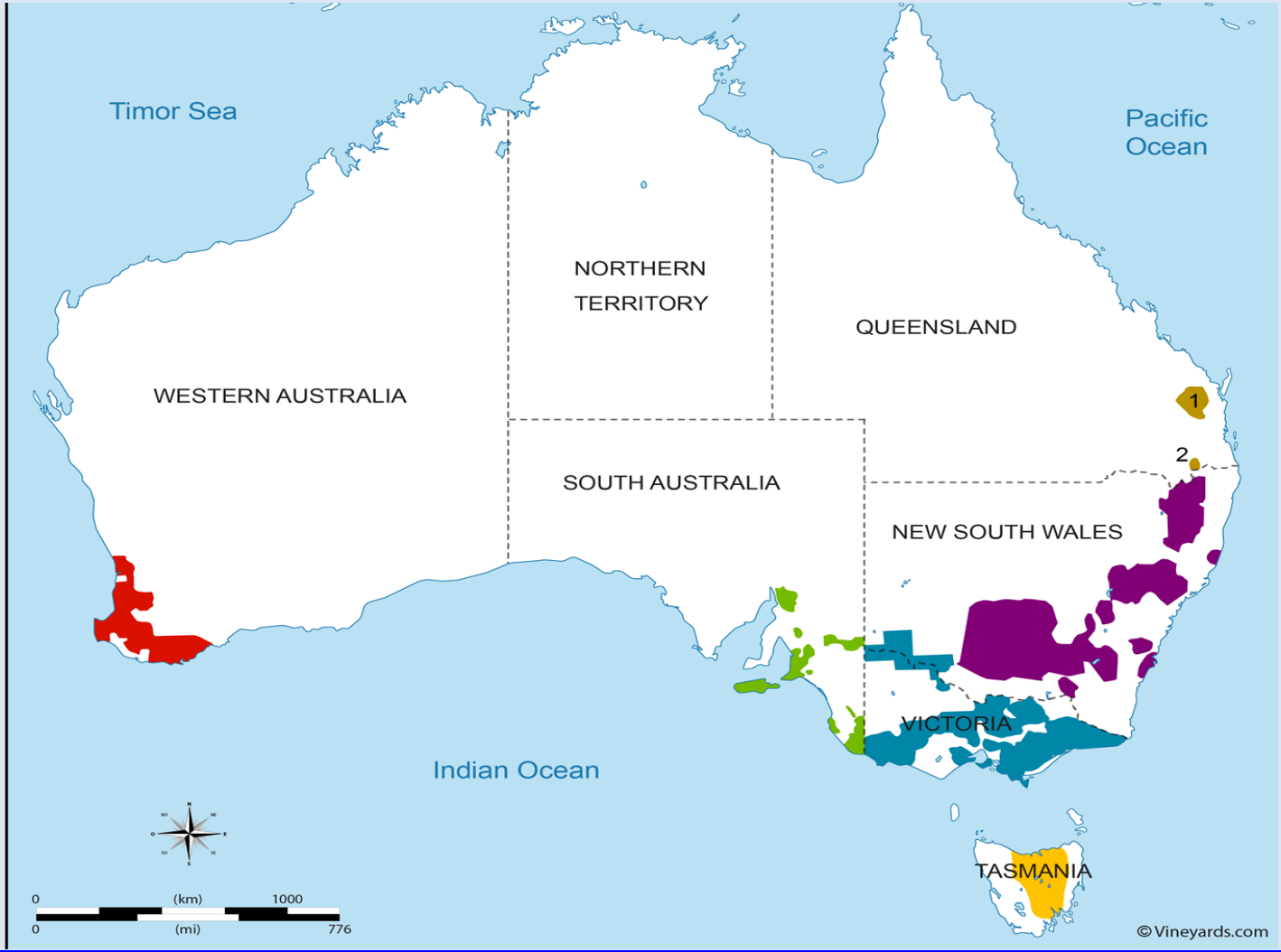
The challenges of EVOO production in new regions: the Australian and Californian experiences

Ing. Agr. Pablo Canamasas

Challenges in the new regions

- ✓ The trend in the new olive production areas of the world is towards **early harvests**, in order to obtain EVOO of **higher quality**, as well as to reduce the **tree annual bearing** and to minimise the risk of **frost events** and **diseases**.
- ✓ Early harvests also mean **low initial oil content** in fruit, **low maturity** fruit and **high ambient temperature**, making the industrial challenge more complex.
- ✓ Olive farms are **under irrigation**, which gives way to **high moisture** fruit (> 60%).
- ✓ The **mechanical harvest** can sometimes impact negatively on **% mummified fruit** in new loads, which eventually impacts significantly on oil quality
- ✓ There are problems associated to the **fruit size** in **super high density groves**
- ✓ The oil from some new areas of production have had problems in complying **analytically** with international oil standards

Australia


Timor Sea
Pacific Ocean
NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH AUSTRALIA
NEW SOUTH WALES
1
2
VICTORIA
Indian Ocean
TASMANIA
0
(km)
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0
(mi)
776
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California


SACRAMENTO VALLEY
NORTH COAST
SACRAMENTO
SAN FRANCISCO
SAN FRANCISCO BAY AREA
CENTRAL VALLEY
CENTRAL COAST
LOS ANGELES
INLAND EMPIRE

Plantation density

High Density 6 x 4 (417 trees/ha)

Super High Density 4 x 1,5 (1667 trees/ha)

Irrigation and yields

	100% riego aplicado	50% riego aplicado desde julio	50% riego aplicado desde julio
	Control	Parcela T-1	Parcela T-2
Tipo de suelo	Franco-Arcillo-Limosa	Franco-Arcillo-Limosa	Franco
kilos aceituna/ha	17.700	10.365	10.780
kg aceite /ha teórico	1.870	1.447	1.530
kilos aceite reales/ha	1.217	931	1.059
Índice de Madurez	1,3	2,0	2,0
Ác. Cítrico (mg/fruto)	6,9	8,4	8,4
Fenoles Totales (mg/kg aceituna; espectrofotometría)	2.799	3.257	3.326
Fenoles Totales (mg/kg aceite; HPLC)	102,3	223,7	494,7
Orto-Difenoles (mg/kg aceite; HPLC)	48,2	137,7	290,4
Derivados Secoiroideos (mg/kg aceite; HPLC)	75,2	180,5	411,6
Solubilización Fenoles Totales (%)	3,7	6,9	14,9
Clorofilas (mg/kg aceite)	3,5	4,6	6,3
Carotenoides (mg/kg aceite)	3,4	3,8	4,9
Pigmentos totales (mg/kg aceite)	6,9	8,4	11,2
Estabilidad Oxidativa (horas Rancimat®)	24,5	36,9	39,2

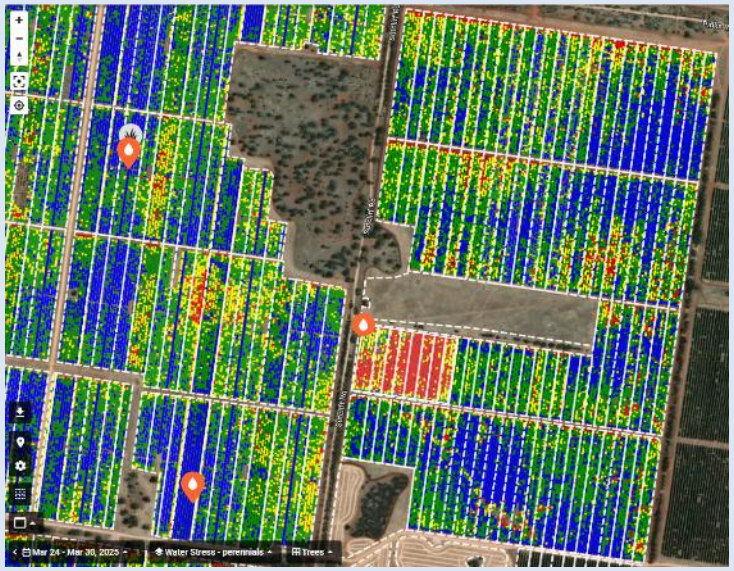
Source: Redondo-Redondo, S. et al

Water stress index (Airplane)

Water stress index: It provides a precise and accurate measure of **crop stress** in time for growers to make critical corrections.

Common uses:

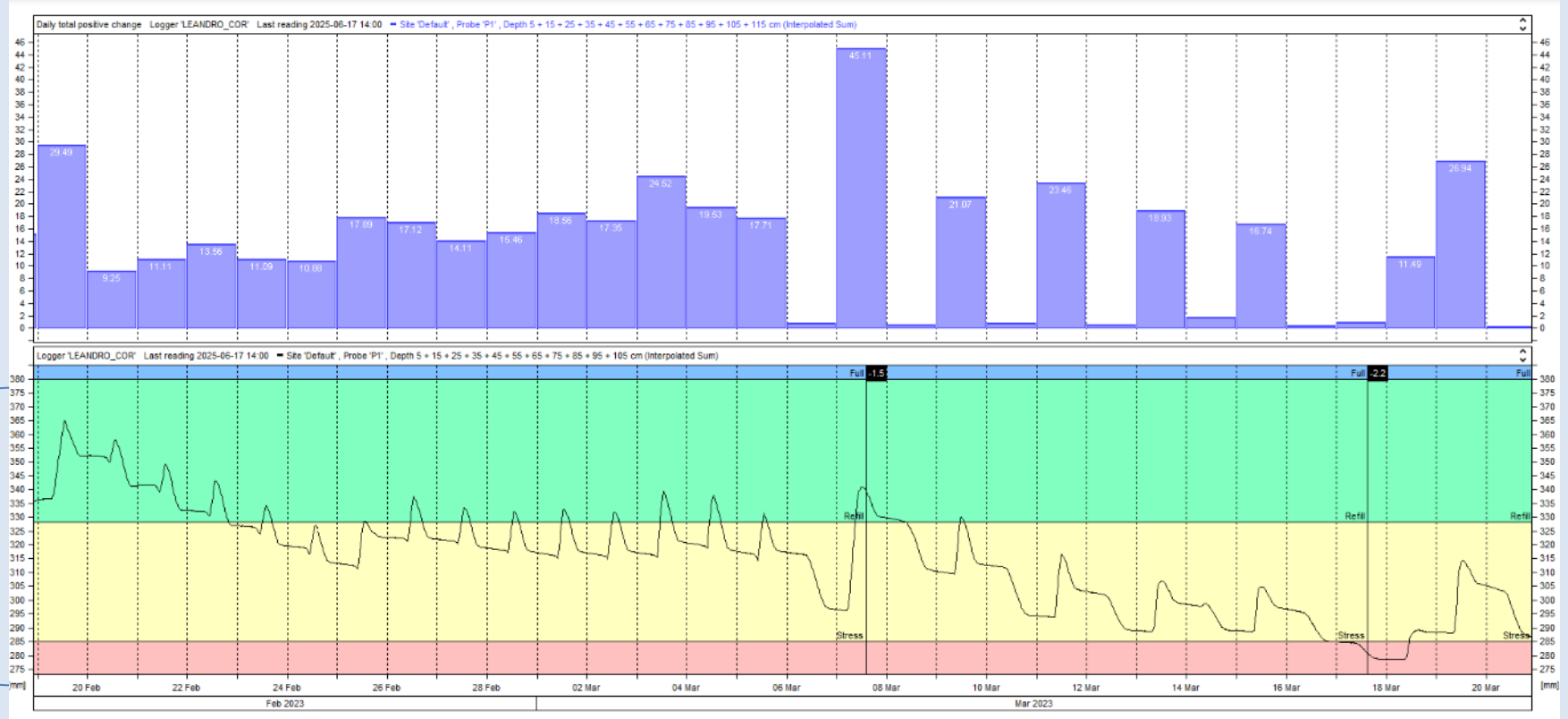
- ✓ Pinpointing common issues in the irrigation system, including **leaks**, **clogged emitters**, **pressure issues**.
- ✓ Optimizing **the irrigation system** design and **scheduling** for terrain and soil conditions
- ✓ Improving the water distribution **uniformity**
- ✓ Selecting the best locations for **moisture probes** and other point-source sensors



Land surface temperature

Irrigation equipment

Stationary Moisture probes

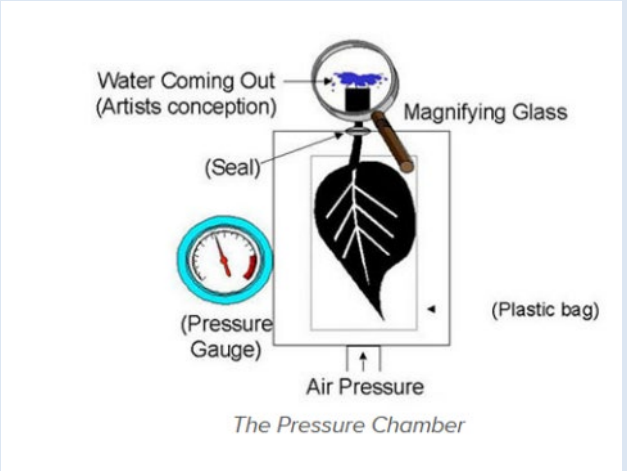


Available water content

Irrigation equipment

Pressure chamber (Stem water potential)

Indicates the tension or negative pressure of water within the xylem, which is affected by various factors including transpiration, root water pressure, soil moisture levels, and environmental conditions.



The Pressure Chamber

TDR (Time-Domain Reflectometry) = dielectric constant

Portable soil moisture meter. Obtains accurate soil moisture measurements at the ideal root zone.

Fertilization

LEAF ANALYSIS:

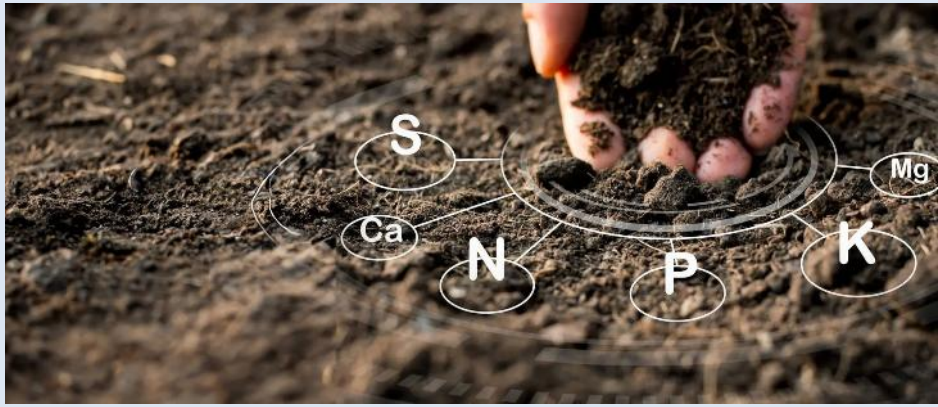
It provides an accurate diagnosis of the tree nutritional situation.

Summer testing: Ideal. It helps understanding the situation when the tree is fully active

Winter testing: It provides a stable situational picture when the olive tree is inactive

SOIL ANALYSIS:

Soil samples are typically taken in **winter time**. Information reported is combined with the leaf analysis to lay out the fertilization program



Fertilization

Dripline fertilization for major elements (N, P, K, Mg)

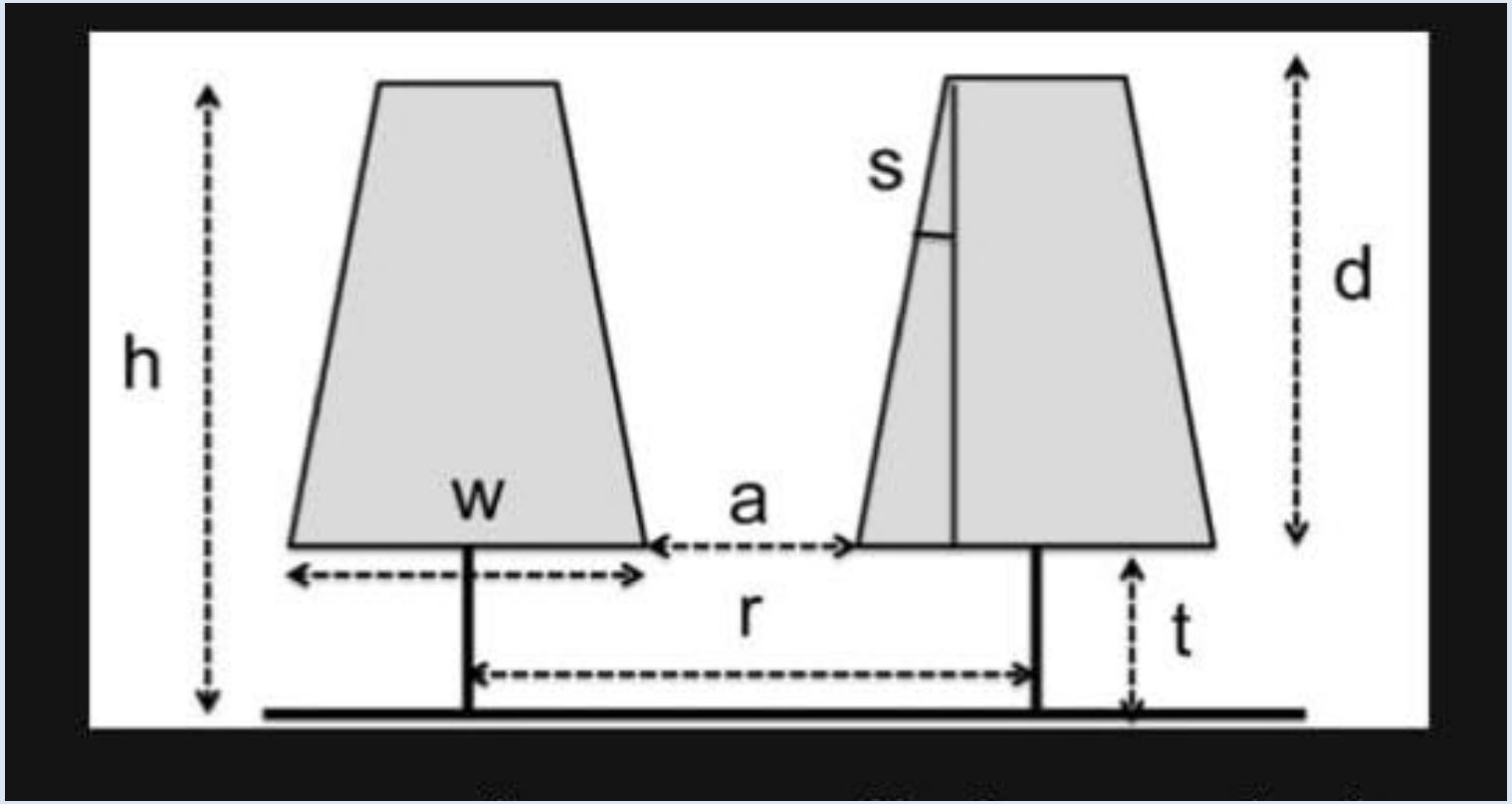
Low volume spraying for minor elements (B, Zn, Fe, etc)
Pre-flowering spraying for improvement of fruit set

Mechanical pruning

Mechanical Discs systems are mostly used for tree topping

Manual intervention with electrical cutters

Pruning



- ✓ Canopy structure for better light passage and shading avoidance
- ✓ More uniform oil accumulation in fruit at different heights of the canopy
- ✓ Slope (S) = 10-15 degrees
- ✓ Tree height (h) = 80% of row spacing (r)
- ✓ Good response in cultivars Arbequina and Picual

Pest Control

Peacock spot

Black scale

Soft nose/Anthracnose

Index evaluation (by Airplane)

Normalized Difference vegetation index

NDVI

Vegetation health and density: NIR reflected vs IR absorbed

Chlorophyll

Infrared

Thermal

High accuracy GPS

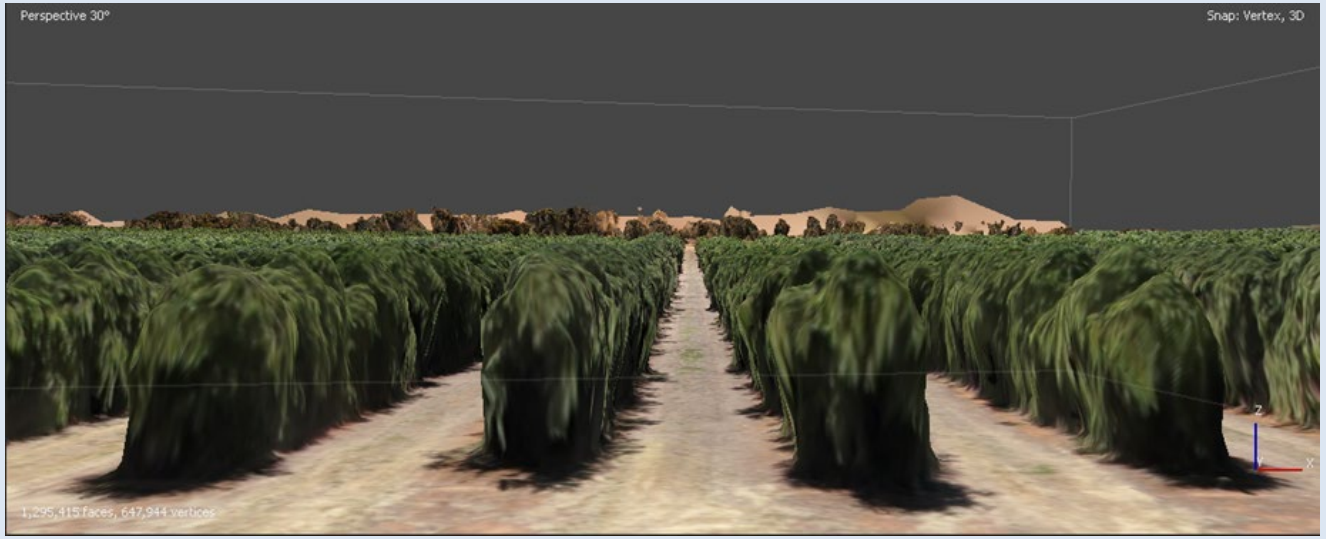
FROST FANS

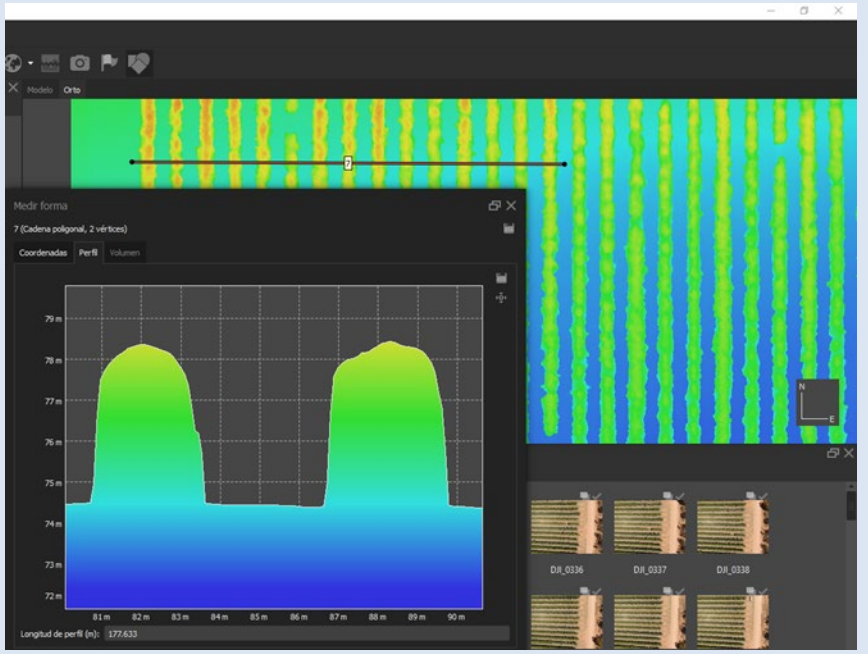
Intercepted radiation for pruning trials

- ✓ It is crucial to maintain the optimal balance between **radiation interception** and **canopy structure**.
- ✓ One of the microclimatic parameters affected by pruning is intercepted radiation, which is the **main limiting factor for photosynthesis**.
- ✓ If the canopy intercepts more **photosynthetically active radiation** (PAR), its photosynthetic potential increases exponentially.
- ✓ At low **leaf area index** (LAI) levels, increases in leaf area result in significant increases in intercepted PAR. However, at higher LAI levels, intercepted PAR tends to saturate, resulting in slight increases due to an increase in self-shading within the orchard.

Plant Canopy Analyzer

Canopy Volume models (by drone)





Very important in crop projections
Pest and diseases monitoring

Harvesting technology

DOWNTIME CONSIDERED

Colossus

4,2 metres canopy height

60 trees/hour

Pellenc

3,8 metres canopy height

180 trees/hour

Braud

3,5 metres canopy height

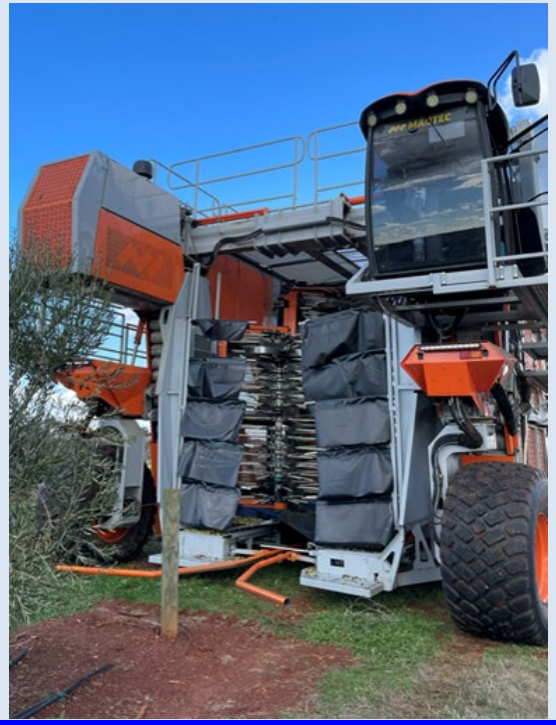
350 trees/hour

PICKING HEIGHT

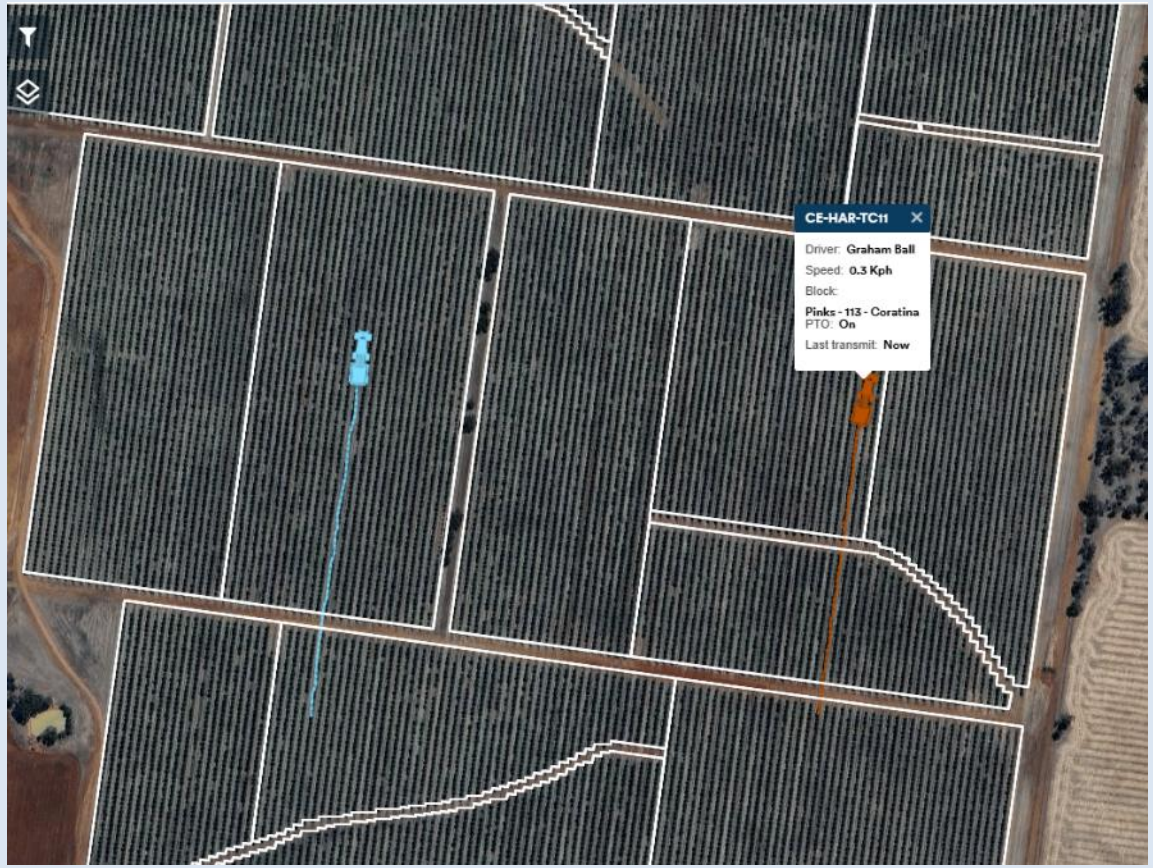
Optimus

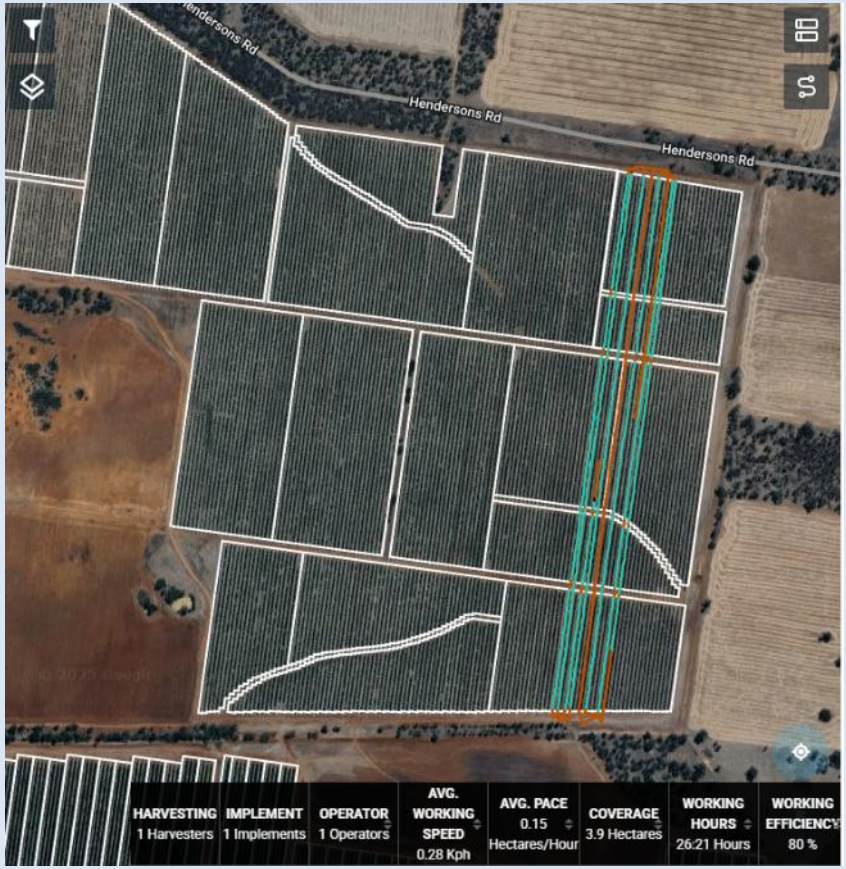
4,0 metres canopy height

80 trees/hour



Harvesters tracking system





Processing Plant technology

Boort, Australia

Fruit characterization

- ✓ Fruit characterization is key to **predict its industrial behaviour**
- ✓ All adjustments to the industrial process are based on the **fruit condition**
- ✓ The key parameters measured are:

  - Oil content
  - Moisture content
  - Average fruit weight (gr)
  - Maturity Index

- ✓ How these parameters combine in the fruit loads determines the **degree of difficulty of processing**
- ✓ The success in being industrially efficient lies on the appropriate assessment of the fruit condition

Fruit characterization

- ✓ The combined presence of certain fruit conditions gives way to changes in the industrial behaviour of the olive paste
- ✓ In California, a **paste viscosity increase** and a change in the industrial behaviour in cultivar Arbequina can be observed when some (or all) of the following conditions are detected:

1. Fruit weight < 1,3-1,4gr
2. Fruit moisture < 50,0%
3. Oil content < 14,5%
4. Maturity Index < 1,5

- ✓ In Australia, it is required to increase the crusher grid size, reduce the enzymes dosage and reduce the decanter plate number in cultivar Picual when the following conditions are detected:

1. Fruit weight > 5,5gr
2. Maturity Index > 3,0
3. Fruit moisture > 59,0%

Colour sorter technology

REMOVAL OF LOW QUALITY FRUIT

Colour sorter technology

WHY COLOUR SORTERS?

FROST DAMAGE

ANTHRACNOSE

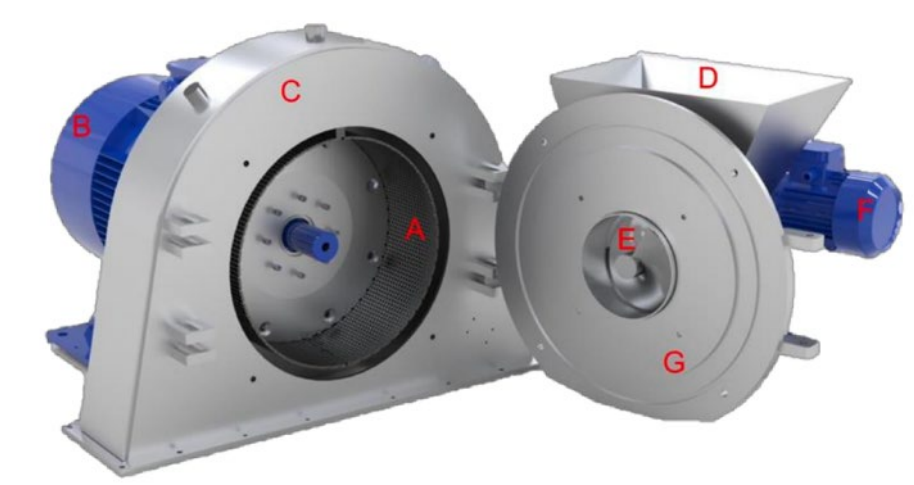
MUMMIFIED FRUIT

Colour sorter technology

ARBOSANA

	MI	Fruta momificada (%)	FFA	Defecto sensorial	Clasificación comercial	Precio por US$/KG
Control	0.5	0.0	0.17	0	Virgen Extra	4.05
Muestra 1	0.5	1.0	0.28	0	Virgen Extra	4.05
Muestra 2	0.6	3.0	0.60	1	Virgen	3.75
Muestra 3	0.4	7.5	2.20	5	Lampante	3.30

Crusher rotating speed



Variation of crusher rotating speed for **paste preparation**

Crusher rotating speed

3300 RPM				
Variety	Arbequina			
MI	2,9			
Temp Paste	29,4			
Crush time	37			
Malax Time	30			
Pump time	63			
Total	130			
Real Malax. Time	80			
Qtity Enzymes	5,24			
Enzymes dose (ml/t)	953			

PASTE :	Oil %	Moisture %	Dry Oil
	22,20%	51,9	46,15%
	21,00%	51,8	43,57%
	22,10%	51,3	45,38%
AVERAGE :	**21,77%**	**51,7%**	**45,03%**

POMACE :	Oil %	Moisture %	Dry Oil
	2,90%	59,0%	7,07%
	2,90%	59,0%	7,07%
AVERAGE :	**2,90%**	**59,00%**	**7,07%**

	Paste (kg)	Oil (kg)
Qtity Malaxer =	5500	1197,167
	Cm	Kg
Qtity Extracted =	38,7	885,9707

IE	**74,01%**
Yield	**16,11%**

2900 RPM				
Variety	Arbequina			
MI	2,9			
Temp Paste	31,2	Delta	1,8	
Crush time	40	Delta	3	
Malax Time	30	Delta	0	
Pump time	62	Delta	-1	
Total	132			
Real Malax. Time	81			
Qtity Enzymes	5,67	Delta	0,43	
Enzymes dose (ml/t)	1030			

PASTE :	Oil %	Moisture %	Dry Oil
	22,60%	51,9	46,99%
	21,30%	51,8	44,19%
	20,60%	51,3	42,30%
AVERAGE :	**21,50%**	**51,7%**	**44,49%**

POMACE :	Oil %	Moisture %	Dry Oil
	2,70%	57,80%	6,40%
	2,70%	56,90%	6,26%
AVERAGE :	**2,70%**	**57,35%**	**6,33%**

	Paste (kg)	Oil (kg)
Qtity Malaxer =	5500	1182,5
	Cm	Kg
Qtity Extracted =	39,1	895,128

IE	**75,70%**
Yield	**16,28%**

2500 RPM				
Variety	Arbequina			
MI	2,9			
Temp Paste	31,4	Delta	0,2	
Crush time	47	Delta	7	
Malax Time	30	Delta	0	
Pump time	62	Delta	0	
Total	139			
Real Malax. Time	85			
Qtity Enzymes	6,66	Delta	0,99	
Enzymes dose (ml/t)	1211			

PASTE :	Oil %	Moisture %	Dry Oil
	22,20%	50,5	44,85%
	19,60%	49,6	38,89%
	21,90%	49,9	43,71%
AVERAGE :	**21,23%**	**50,0%**	**42,48%**

POMACE :	Oil %	Moisture %	Dry Oil
	2,60%	56,40%	5,96%
	2,90%	57,20%	6,78%
AVERAGE :	**2,75%**	**56,80%**	**6,37%**

	Paste (kg)	Oil (kg)
Qtity Malaxer =	5500	1167,833
	Cm	Kg
Qtity Extracted =	39,7	908,864

IE	**77,82%**
Yield	**16,52%**

Australia, 2024

Processing aids

PNEUMATIC TALC POWDER MACHINES

ENZYMES DOSING PUMPS

Processing aids

WHY PROCESSING AIDS?

- ✓ They are essential to improve **paste preparation**
- ✓ **Talc powder** is extremely important as an **emulsion breaker** when fruit is high in moisture
- ✓ **Pectinase enzymes** are very cost efffective and help in degrading the cell walls of the pulp to improve oil release
- ✓ Enzymes are key in production strategies that contemplate **early harvests** in order to obtain high oil quality
- ✓ Enzymes and talc powder are key industrial tools to deal with wet and low maturity fruit that are so common in new olive groves under irrigation

Enzymes & malaxation time reduction

	Malaxation time			
	60 min	60 min + E	90 min	120 min
Variety	Picual	Picual	Picual	Picual
Grid size (mm)	6	6	6	6
Malaxing temperature (°C)	28,3	29,2	32,8	33,2
Malaxing time (min)	65	60	93	120
Enzymes dosage (ml/t)	0	650	0	0
Pump speed (kg/h)	5000	5000	5000	5000
Paste pump pressure (bar)	1,7	0,9	1,5	1,4
Oil loss dry (%) (NIR)	9,6	6,8	8,3	8,1
Fruit weight (kg)	5500	5500	5500	5500
Oil content in fruit (%)	16,3	17,3	17,6	17,9
Moisture content in fruit (%)	52,4	52,0	52,2	52,1
Maturity Index	2,5	2,4	2,5	2,8
Oil obtained (kg)	659	828	819	840
Yield (%)	11,98	15,05	14,89	15,27
Real oil loss (%)	4,32	2,25	2,71	2,63
Industrial efficiency (%)	73,5	87,0	84,6	85,3

Australia, 2024

Paste preparation evaluation

PASTE VISCOSITY

Paste preparation evaluation

Producto	Tiempo batido (min)	Temp. batido (*C)	Presion bomba pasta (bar)	Amperaje Batido (A)	Viscosidad pasta (Cps)	Aceite obtenido (kg)	RI	IE
Control	61	30.1	1.5	10.7	10000	555	10.1%	71.6%
1 (350)	60	31.0	1.2	10.5	5200	598	10.9%	74.8%
1 + 4	59	30.4	1.1	10.4	4400	613	11.1%	**77.1%**
1 + 5	60	30.7	1.2	10.5	5100	610	11.1%	76.3%
1 (500)	61	31.1	1.1	10.5	5500	590	10.7%	72.8%
1 + 2	60	30.6	1.1	10.4	4800	604	11.0%	74.1%
2 + 3	59	32.9	1.1	10.4	3700	639	11.6%	**76.1%**
Control	61	30.5	1.4	10.0	8100	463	8.4%	60.9%
6	60	29.8	1.1	9.7	5000	516	9.4%	68.8%
7	59	29.9	1.0	9.7	4200	531	9.7%	69.4%
8	60	30.8	1.1	9.8	4600	514	9.3%	67.6%
1	60	31.0	1.0	9.8	4200	526	9.6%	69.7%
2	60	29.8	0.9	9.7	3500	535	9.7%	**72.8%**
Control	60	29.9	1.50	10.9	8700	486	8.8%	62.7%
9	60	30.1	1.20	10.6	5400	569	10.3%	72.9%
10	60	30.8	1.25	10.6	6500	571	10.4%	71.8%
11	60	30.9	1.40	10.8	7900	555	10.1%	73.0%
12	60	31.7	1.40	10.8	7400	554	10.1%	72.4%

California, 2018

CORRELACIÓN vs IE = -44%
CORRELACIÓN vs RI = -39%

✓ Paste temperature, fruit moisture and maturity index are the parameters that most significantly impact on paste viscosity

✓ When MI < 2,0, the lower the viscosity, the higher the oil recovery

Heat Exchange systems

Tubular heat exchanger

Auger heat exchanger

Heat Exchange systems

WHY HEAT EXCHANGERS?

- ✓ Their use is quite extended due to their versatility and simplicity
- ✓ They help in **reducing paste temperature** when ambient temperature is high (early harvest during warm autumns)
- ✓ They **increase paste temperature** when fruit arrives too cold to the processing plant.
- ✓ They help in **reducing malaxation time** without compromising yields
- ✓ This leads to better quality oils, both sensorially and chemically

Heat Exchange systems

Australia 2024

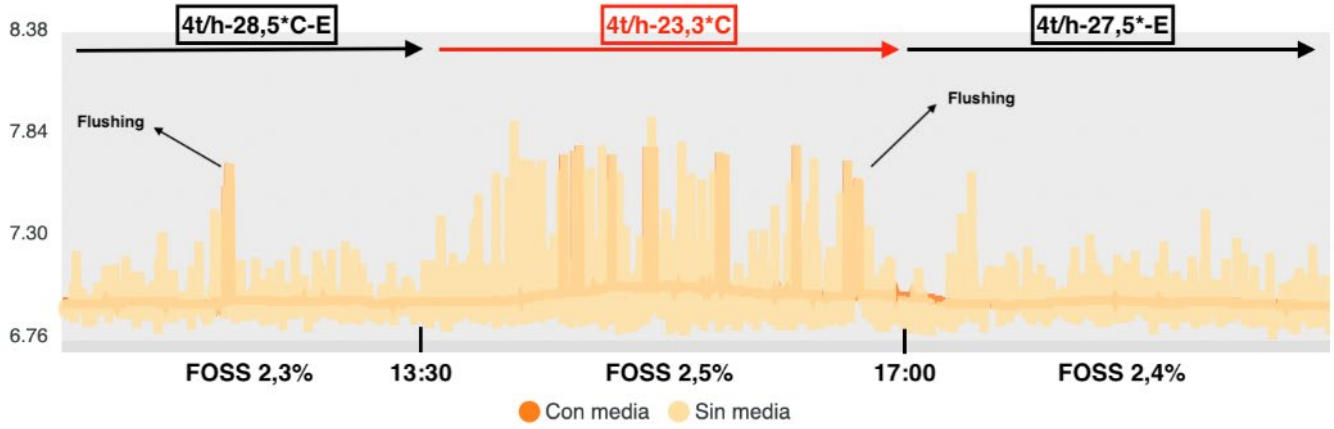
	ARBEQUINA		
	Heatex ON + 2V	Heatex OFF + 3V	Heatex OFF + 2V
Malaxation time (min)	120	155	120
Paste temp (°C)	31,0	28,2	31,0
Pump speed (kg/h)	5000	5000	5000
Enzymes dosage (ml/t)	505	469	491
Auger speed (Hz)	25	30	70
Heatex temp. (°C)	70,0	15,0	22,0
Diff. temp Heatex (°C)	N/M	N/M	N/M
Diff. speed (rpm)	23,2	23,2	23,5
Pump pressure (bar)	0,7	0,8	0,8
Decanter Ampere (A)	77,4	80,8	78,3
Screw Ampere (A)	50,3	52,8	53,2
Pomace oil (%)	3,4	3,3	3,4
Pomace moisture (%)	59,7	62,4	61,4
Oil loss dry (%)	8,4	8,8	8,7
Oil obtained (kg)	1797	2553	1717
Total fruit (kg)	11000	16000	11000
Fruit oil (%)	20,88	21,95	21,60
Fruit moisture (%)	51,6	53,0	52,7
Weight (gr)	1,6	1,6	1,4
MI	2,5	3,1	2,3
Yield (%)	16,34	15,95	15,61
IE (%)	78,26	72,68	72,26

On line Moisture & FFA measurement

US sensor to measure oil moisture

- ✓ Possibility of adjusting the process in order to obtain a cleaner oil
- ✓ NIR sensors for FFA measurement would allow for a more consistent consolidation of the oils produced based on their quality

On-line measurement of pomace



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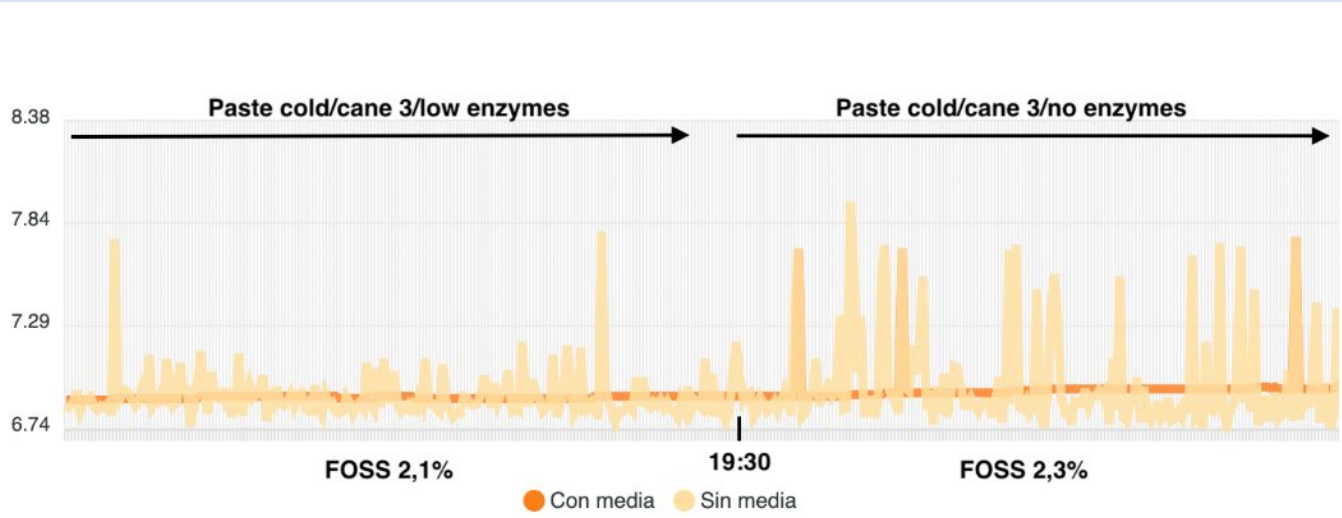

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Tank you!