



Crop characterization by Lidar sensor in different French orchards: preliminary results at early vegetation stages.

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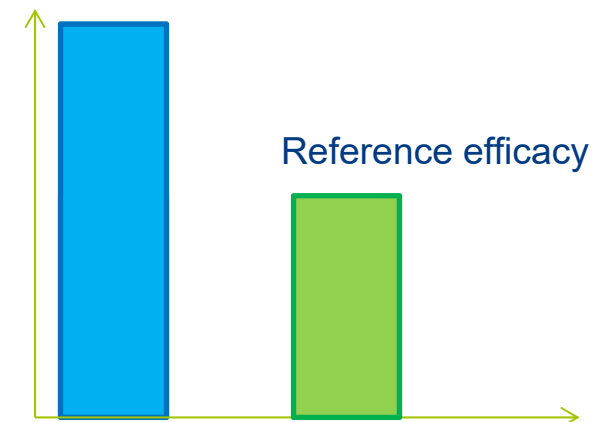
Context

National Action Plan Ecophyto aims at reducing pesticide use

In France the dosage expression of chemical for bush and tree crops is fixed in l/ha or kg/ha whatever the crop plantation, the training, and the crop stage

Few incentives are developed to adapt the dosage (Optidose) but based on visual observation of the vigor

There is still a disconnection between the evaluation of sprayer capability (deposit/drift), the vegetation structure and the potential for dosage adjustment





Typologies of Orchards

POME FRUITS



Fruit Crop	Training system	Crop characteristics			Number of rows scanned
		Inter-row	Height (sd)*	Thickness (sd)	
Pome fruits	Fruit wall, axis; drilling	3.3 - 4m	2.75m (± 0.30)	1.84 (± 0.61)	60



Typologies of Orchards

STONE FRUITS (GOBELET)



Fruit Crop	Training system	Crop characteristics			Number of rows scanned
		Inter-row	Height (sd)*	Thickness (sd)	
Stone fruits	Gobelet	4 - 6m	2.08m (± 0.47)	2.30 (± 0.93)	15

Typologies of Orchards

CIDER APPLE



Fruit Crop	Training system	Crop characteristics			Number of rows scanned
		Inter-row	Height (sd)*	Thickness (sd)	
Cider apple	Free axle	4.7 - 5.5m	2.60m (± 0.80)	2.26 (± 0.43)	8



Typologies of Orchards

WALLNUTS – CHESNUTS



Fruit Crop	Training system	Crop characteristics			Number of rows scanned
		Inter-row	Height (sd)*	Thickness (sd)	
Nuts	Free axis	8 - 10m	5.33m (±1.80)	5.33(±1.34)	7

Objectives

Provide information on the crop structure and the evolution during the growing season ?

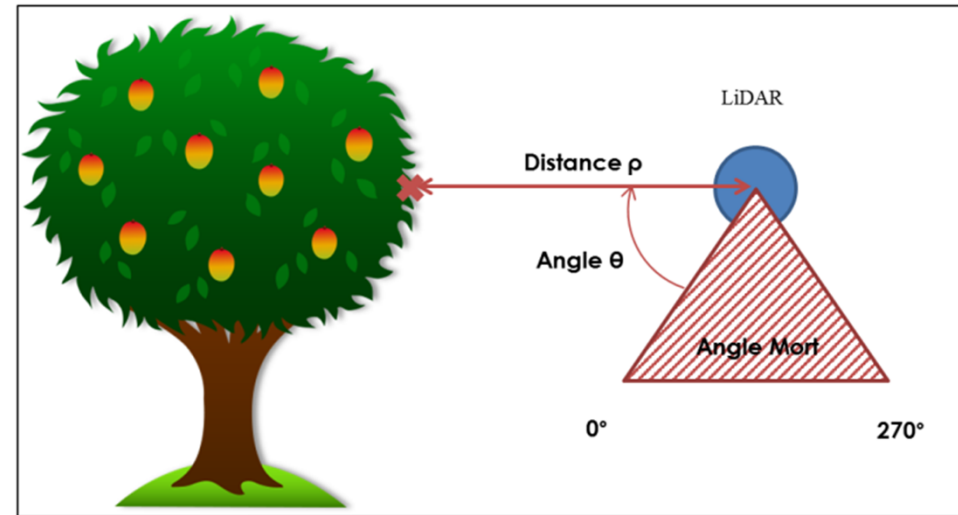
To be compared with manual measurements of LWA and TRV



Compare crop trainings for a uniform practical dosage expression

Materials and methods

8



Lidar SICK LMS 100
Laser Class 1

DESCRIPTION

Wavelength : 905 nm

50 scans/s (0.5° resolution)

Distance 50m/10m à 10% réflectivity

Forward speed 5 km/h

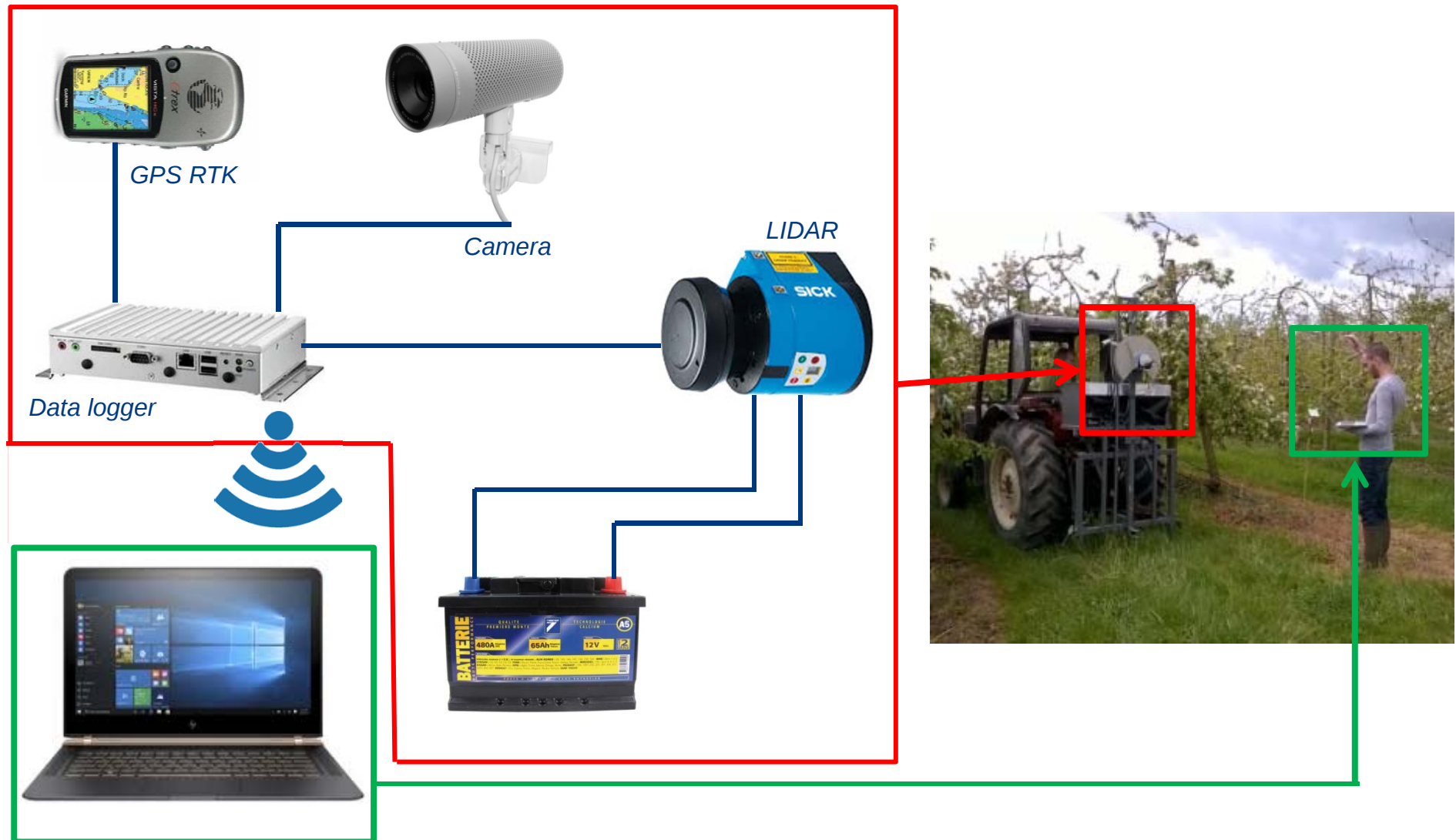
Spatial resolution :

x : 2.5 – 3.5 cm / y : 1.1-1.3 cm

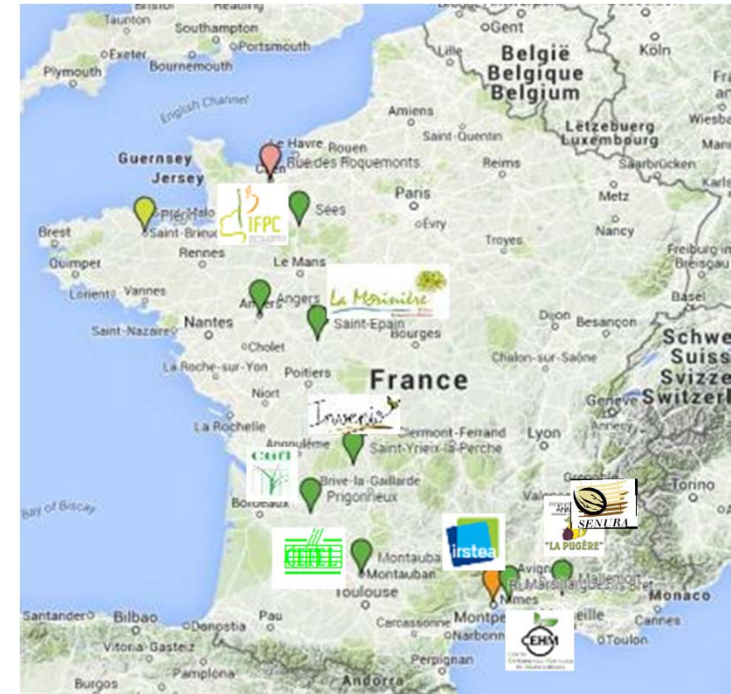
→ **Pixel :** 2,7 – 4,5 cm²

Materials and methods

9



10



Materials and methods

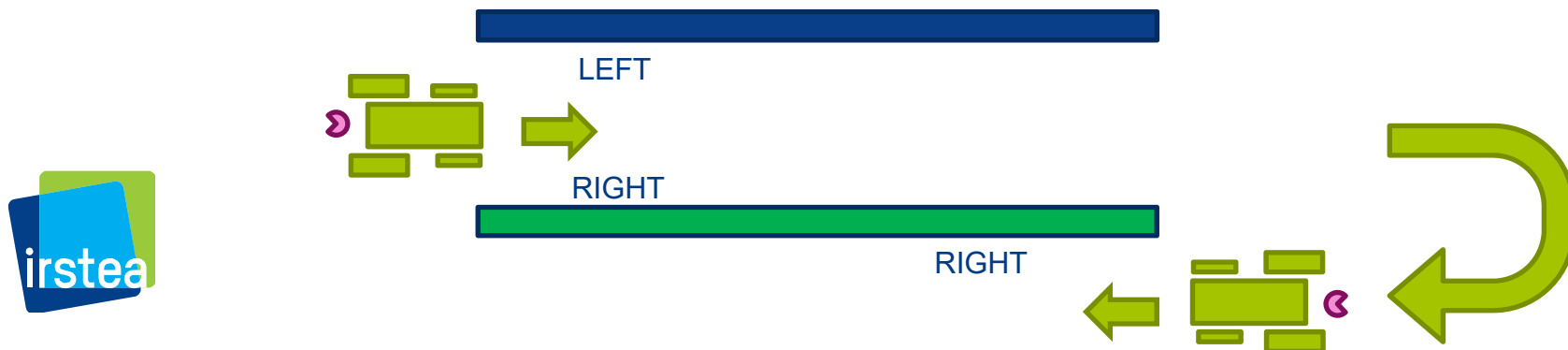
DATA PROCESSING

Conversion of polar to cartesian coordinates

-> Lidar center height

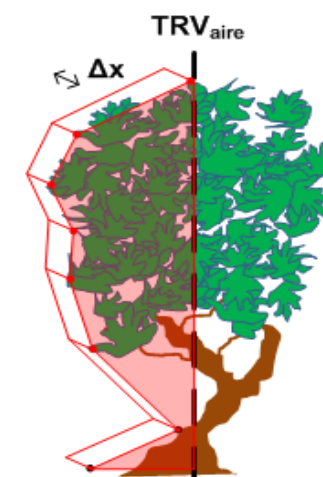
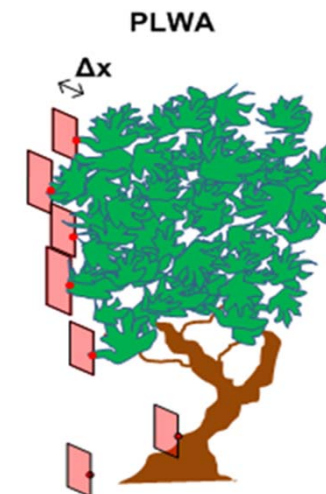
-> Threshold distance : center of the trunk (1/2 the inter-row distance)

Identification and computing of left and right side independently



Definition of crop indicators

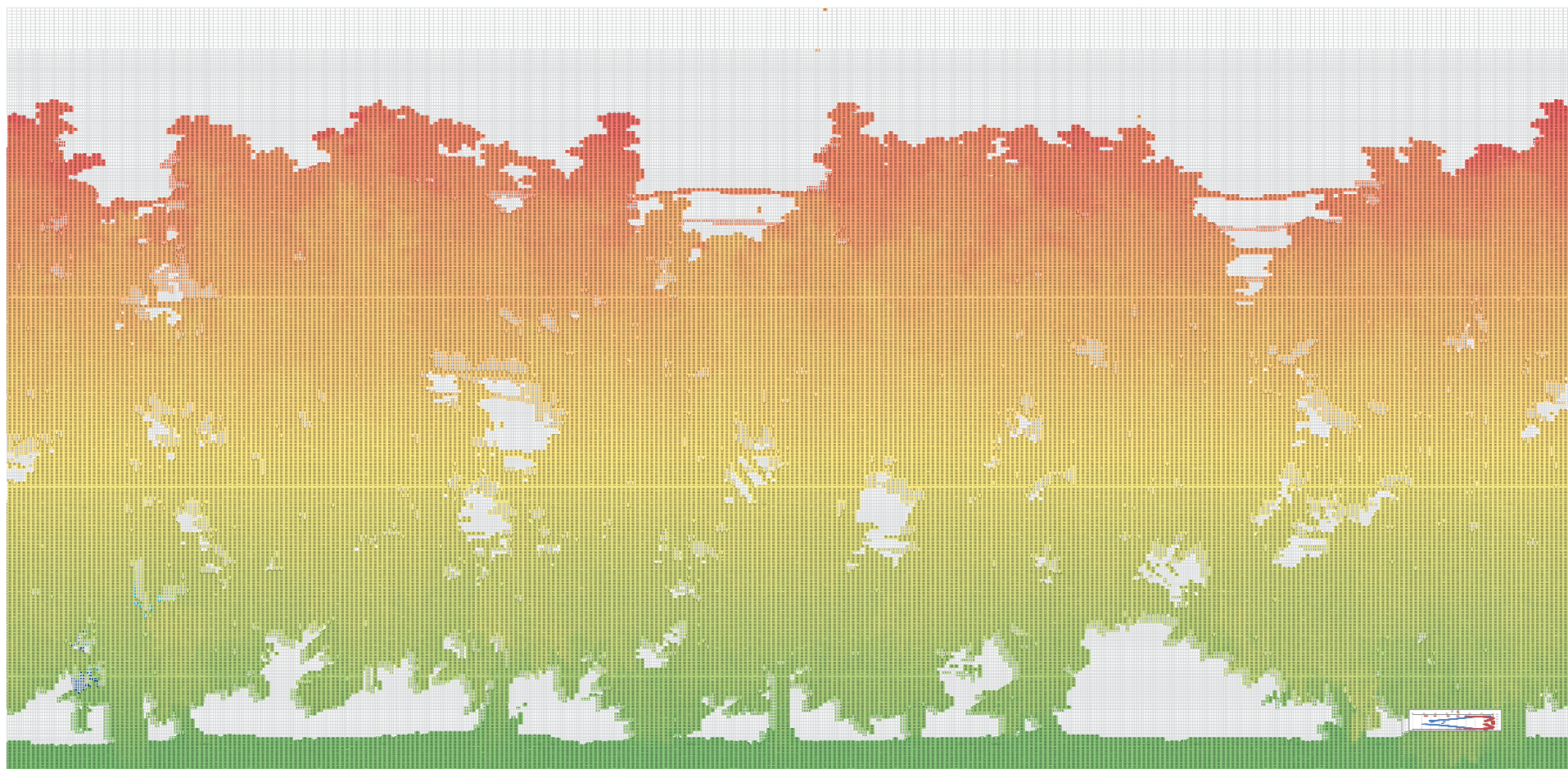
- **LWA Av** : close to manual measurement, a LWA is calculated for each scan and then averaged for the overall row.
- **PLWA** : each target point is associated to an elementary surface area (by discretization)
- **TRV** according to the 95th percentile of depth : closest to the manual measurement.
- **TRV Area 95th percentile** : Every point of the profile are linked to generate a volumetric pattern.



Results

FRONT VIEW OF THE ROW

ex. extract of the sampled row



Example P42 – La Morinière

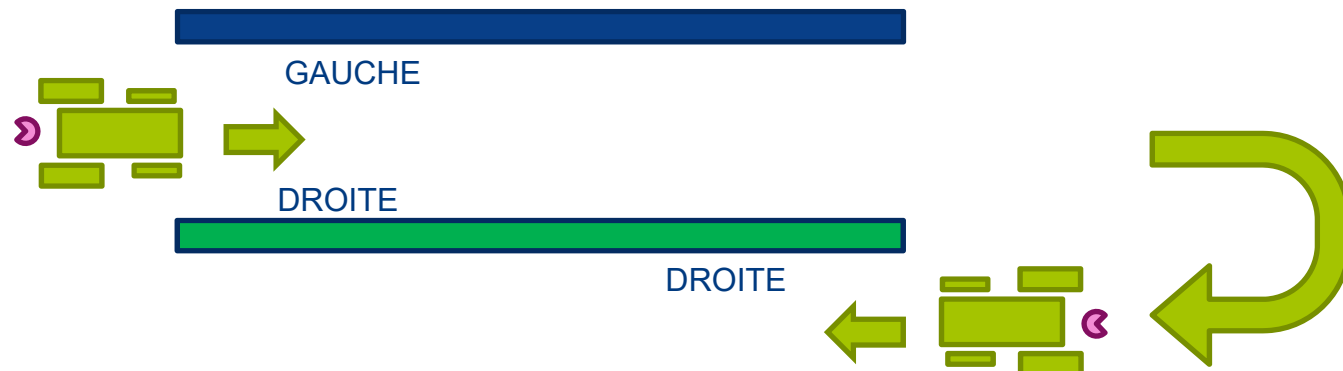
14

Crop Height

Crop Depth

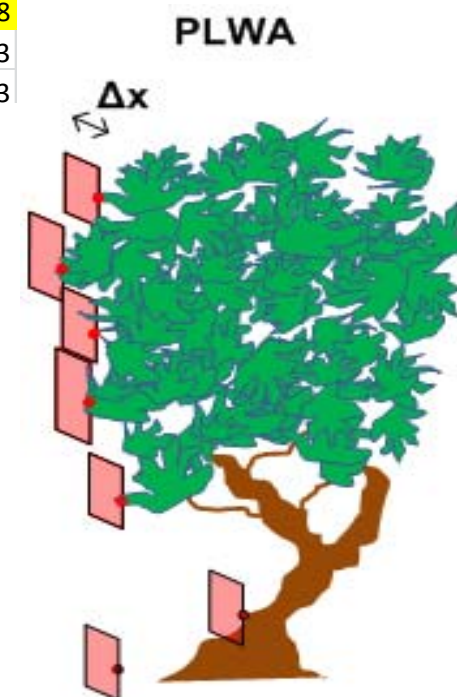
Methode de F Cible	H moy	H 0.8%	H 90%	H95%	H Max	EP moy	EP 80%	EP 90%	EP 95%	EP Max	Max EP moy	Max EP 80%	Max EP 90%	Max EP 95%	Max EP max
Moyenne par Moyenne gauche droite	3.12937695	3.312	3.378	3.428	3.873	1.236	1.725	2.170	2.503	2.836	2.129	2.847	3.192	3.357	3.536
Moyenne par Rang gauche	3.17124898	3.363	3.444	3.503	4.050	1.260	1.737	2.182	2.511	2.844	2.321	3.043	3.319	3.494	3.574
Moyenne par Rang droite	3.08750492	3.261	3.313	3.353	3.695	1.212	1.713	2.158	2.495	2.828	1.938	2.651	3.064	3.220	3.498
Sans moyenn Moyenne gauche droite	3.12937966	3.312	3.378	3.428	3.873	1.239	1.727	2.171	2.504	2.836	2.153	2.865	3.135	3.320	3.497
Sans moyenn Rang gauche	3.1712544	3.363	3.444	3.503	4.050	1.256	1.731	2.175	2.503	2.835	2.273	2.983	3.230	3.434	3.514
Sans moyenn Rang droite	3.08750492	3.261	3.313	3.353	3.695	1.222	1.723	2.167	2.505	2.837	2.033	2.747	3.040	3.206	3.479

Travel 1



Exemple P42 – La Morinière

fichier Lidar	Correction GP	Cible	H moy	EP 95%	LWA Moyen (m2, PLwa (m2/ha))	
2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12937695	2.503	15647	10064
2016.06.20_P	Avec correctio	Rang gauche	3.17124898	2.511	15856	10109
2016.06.20_P	Avec correctio	Rang droite	3.08750492	2.495	15438	10018
2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12937966	2.504	15647	10063
2016.06.20_P	Avec correctio	Rang gauche	3.1712544	2.503	15856	10113

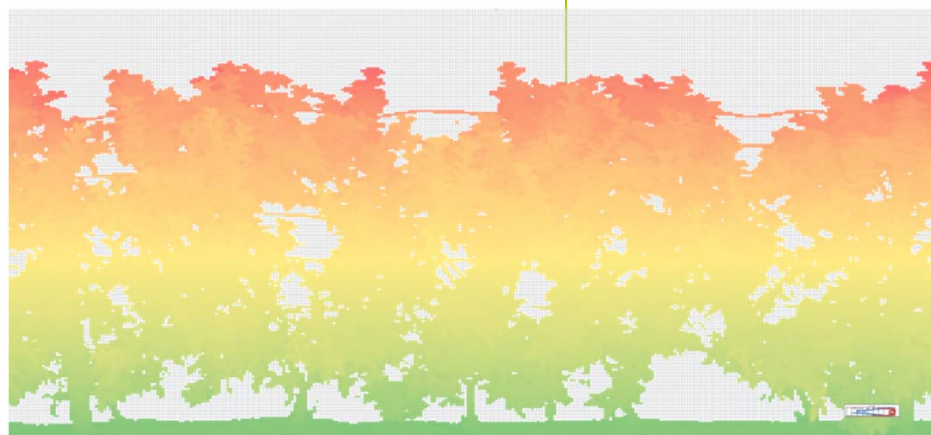


LWA Average : 15029 m²/ha **PLwa** : 9993 m²/ha (discretised $\subset$ porosité)

Results

crop – training	LWA_{man}	$LWA_{(L)}$	$LWA_{(\text{opt})}$	2D Porosity
Apple (young)	12840	10800	5790	46%
Apple	17295	18080	8140	42%
Stone fruits	13080	7680	5540	27%
Nuts	19060	11410	5870	47%
Cider apples	11670	9800	5890	38%

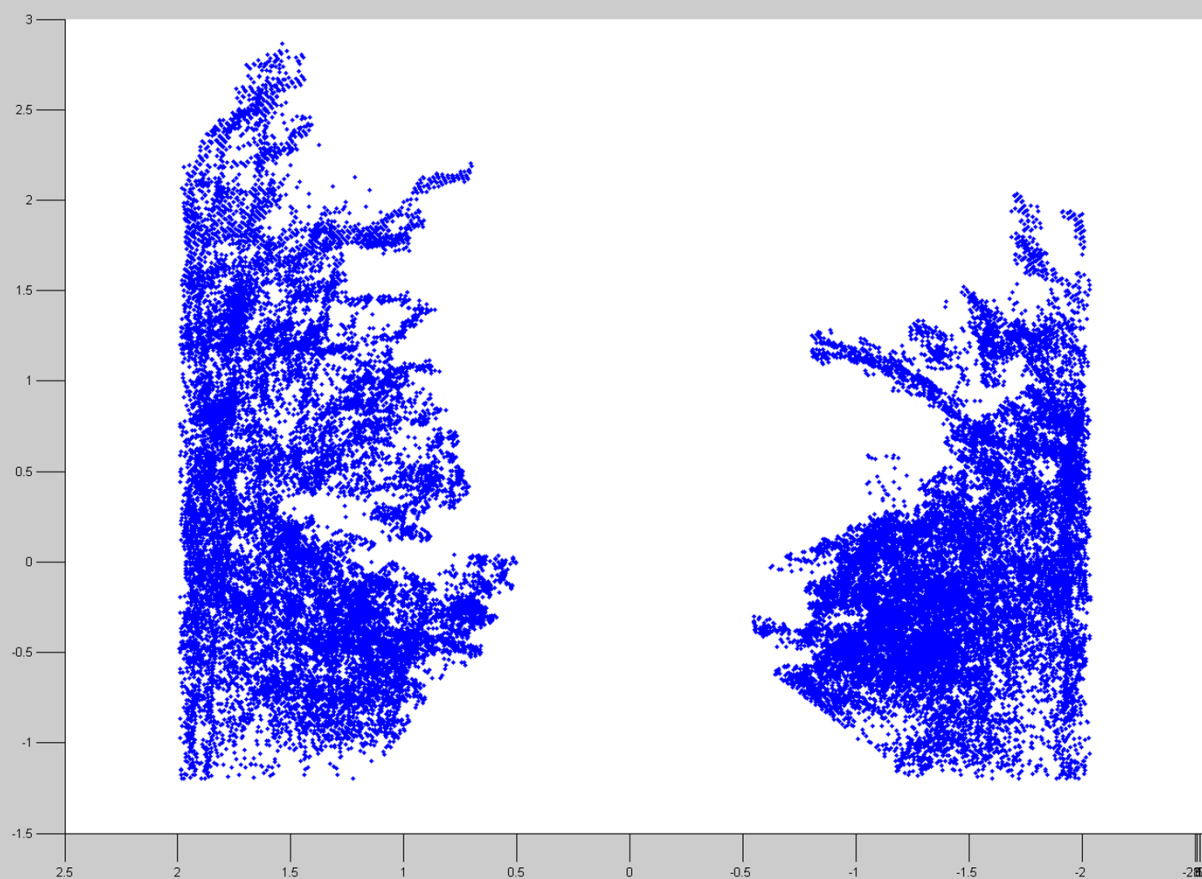
In m² leaves per ha



Results

CROSS SECTION OF THE ROW

Based on a 10m extract of the sampled row



Exemple P42 – La Morinière

18

Essai	fichier Lidar	Correction GP Cible	H moy	EP 95%	Trv EP 95% (m3/l	Trv Aire EP 95% (	
1	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12937695	2.503	19651	10860
1	2016.06.20_P	Avec correctio	Rang gauche	3.17124898	2.511	19955	11749
1	2016.06.20_P	Avec correctio	Rang droite	3.08750492	2.495	19346	9971
1	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12937966	2.504	19658	10902
1	2016.06.20_P	Avec correctio	Rang gauche	3.1712544	2.503	19893	11806
1	2016.06.20_P	Avec correctio	Rang droite	3.08750492	2.505	19423	9998
2	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.04449153	2.715	20756	11801
2	2016.06.20_P	Avec correctio	Rang gauche	3.18042028	2.812	22409	13059
2	2016.06.20_P	Avec correctio	Rang droite	2.90856278	2.618	19103	10543
2	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.04443666	2.716	20717	11629
2	2016.06.20_P	Avec correctio	Rang gauche	3.18028916	2.685	21385	11948
2	2016.06.20_P	Avec correctio	Rang droite	2.90858415	2.748	20049	11309
3	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12234358	2.496	19601	10624
3	2016.06.20_P	Avec correctio	Rang gauche	3.18651232	2.533	20238	11368
3	2016.06.20_P	Avec correctio	Rang droite	3.05817484	2.460	18963	9881
3	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.12234457	2.497	19609	10781
3	2016.06.20_P	Avec correctio	Rang gauche	3.1865143	2.520	20122	11486
3	2016.06.20_P	Avec correctio	Rang droite	3.05817484	2.475	19096	10077
4	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.04561086	2.745	20945	11682
4	2016.06.20_P	Avec correctio	Rang gauche	3.11643159	2.859	22329	13218
4	2016.06.20_P	Avec correctio	Rang droite	2.97479013	2.630	19561	10147
4	2016.06.20_P	Avec correctio	Moyenne gauche droite	3.04542445	2.745	20923	11647
4	2016.06.20_P	Avec correctio	Rang gauche	3.11604649	2.732	21329	12306
4	2016.06.20_P	Avec correctio	Rang droite	2.9748024	2.758	20517	10988
						19243	10135

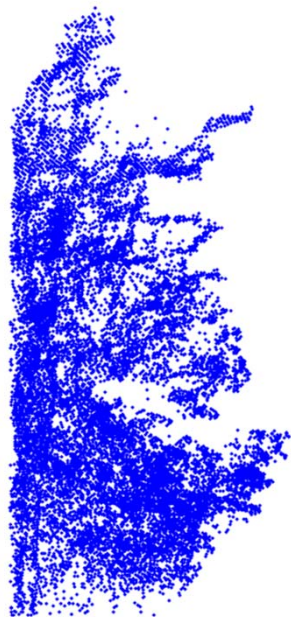


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TRV EP 95% : 19243 m³/ha

TRV area 95% EP: 10135 m³/ha

Results

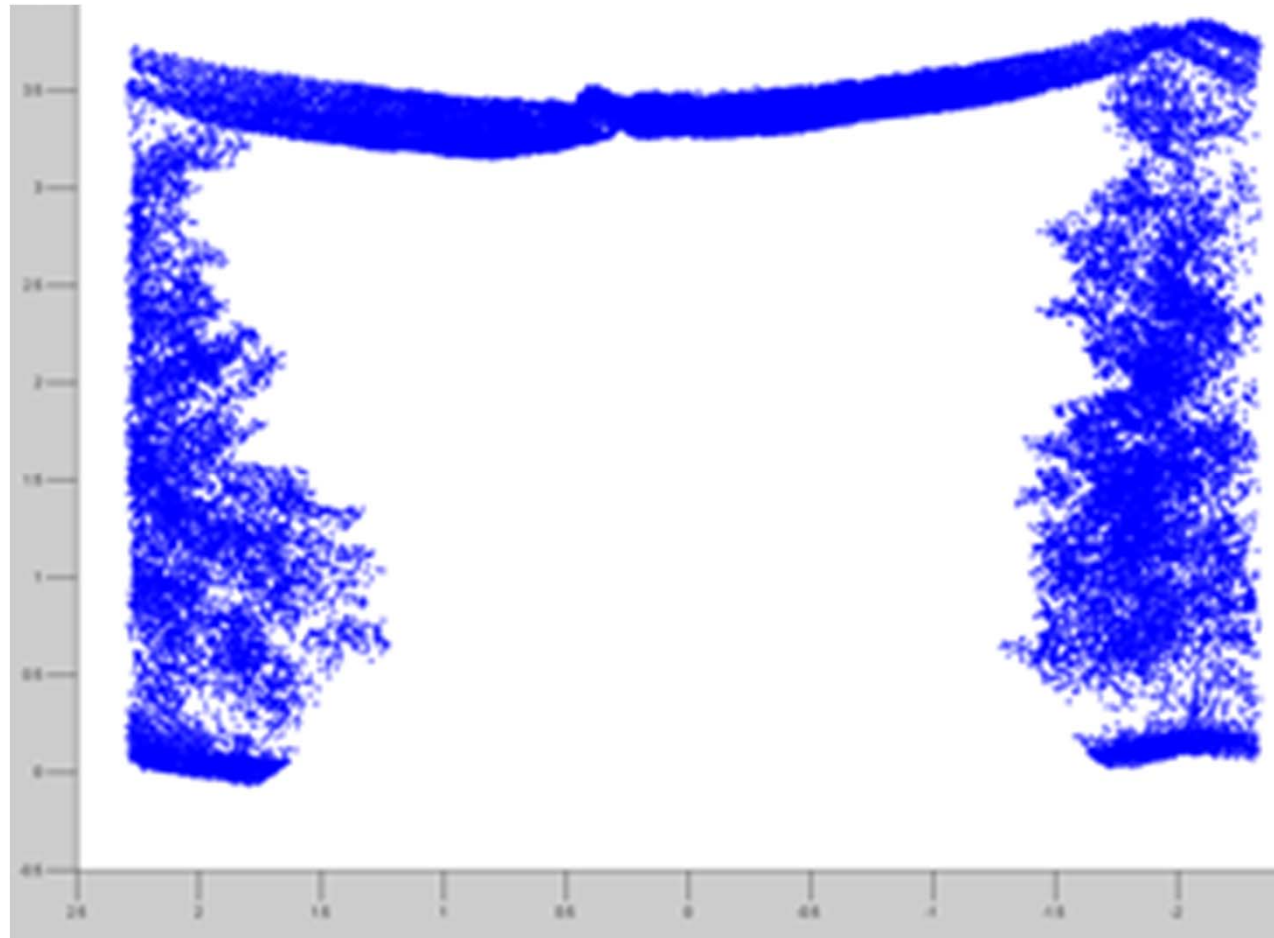


crop – training	TRV _{man}	TRV _(L)	TRV _(opt)	3D porosity
Apple (young)	5849	6750	3640	54%
Apple	12880	12800	7750	60%
Stone fruits	11550	8650	7310	8%
Nuts	55620	31950	20030	26%
Cider apples	12090	11120	9850	13%

In m³ leaves per ha

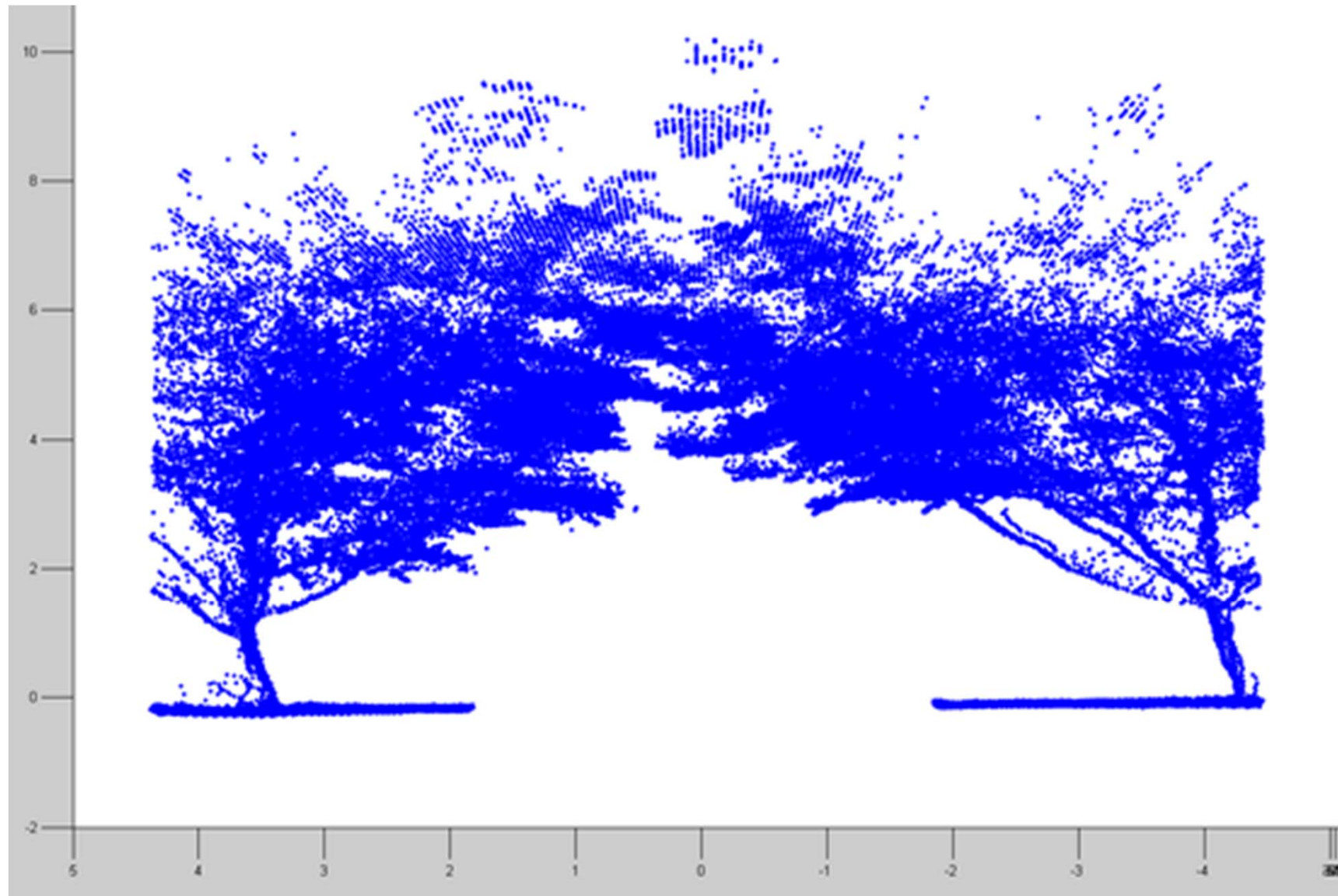
Practical issues : Hail nets

20



Practical issues : Tall trees

21





Conclusions

Lidar measurements may provide profitable results compared to manual measurements :

- Take into account the heterogeneity on the 2D or 3D profiles
- Will be a basis for practical dosage adjustments combined with spray deposit assessment (capability of sprayers)
- Compare reference orchards and training systems to local situations



Thank you for your attention !



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