Tillage system effect on maize seed depth placement and fuel consumption

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1.Background

In Portugal:

- Maize is one of the main irrigated crops - 150.000ha
- Is Alentejo, Alqueva, one of the largest dams in western Europe
- Estimated yields up to 18 ton/ha

STRENGTH

- Koppen-Geijer Csa Mediterranean climate with hot and dry summers
- In the recent past a very traditional till technology - 76% C.tillage (Census, 2009)
- Risk of soil erodibility (european soil portal)

WEAKNESS

- The Europe 2020 strategy - smart & sustainable, towards a low-carbon economy
- United Nations declared 2015 International Year of Soils

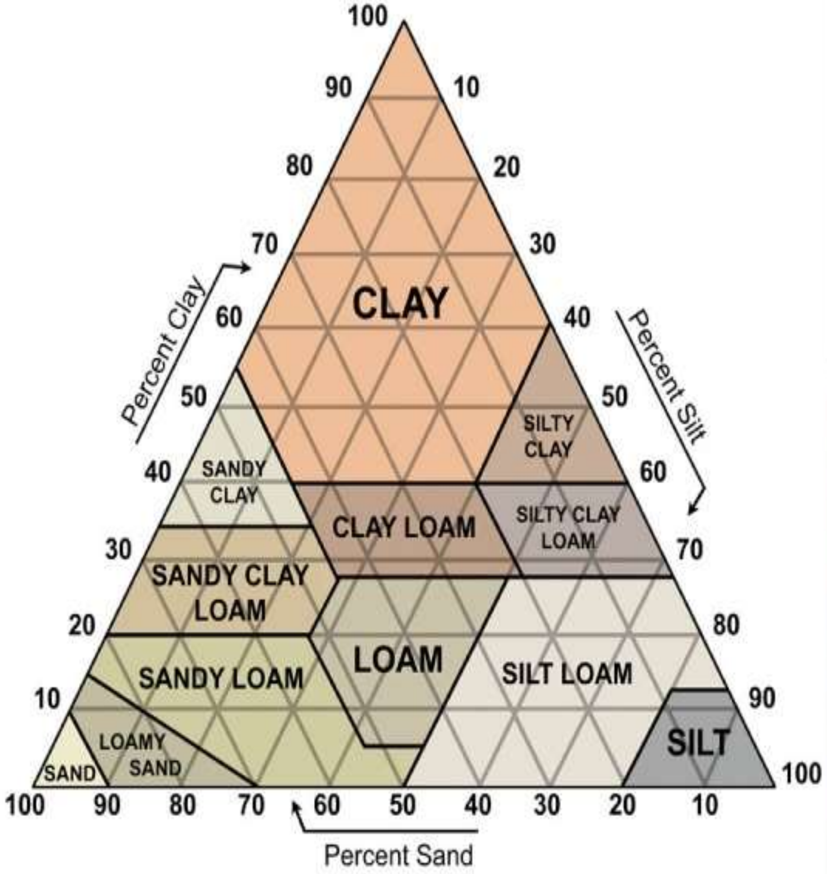
OPPORTUNITY

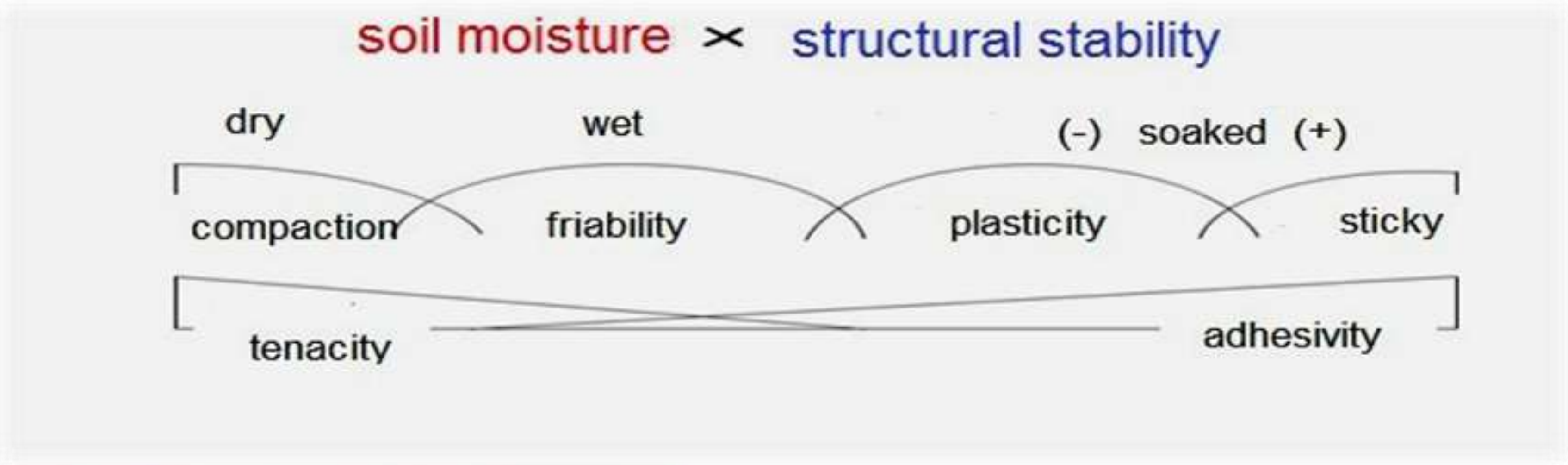
- Energy price
- Average age of the farmer – 50 years old
- Lower commodity prices for cereals

THREAT

Precision farming-conservation agriculture-energy trilogy is determinant to a sustainable crop production!

Seeders performance depends on several factors as soil properties, residues and….





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Although no tillage sowers are prepared to work in untilled soils……………………..

Type of opener	Capacity of handling with crop residues	Performance in dry soil condition	Performance in wet soil condition	Ability to handle with stony ground	Preferred soil texture	Line seeder weight	Machinery running costs
Shoe	Good or low	Good	Good	Good	All	Low	Low
Single disc	Weak	Weak	Weak	Susceptible	Sandy to clay loam	Heavy	Media to high
Double disc	Good or high	Reasonable	Good	Susceptible	All	Heavy	Media

Most common depth control is a passive mechanism !

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Why is important seed depth control?

Uniformity of seeder vertical distribution

Uniformity of crop emergence;

Consistency of vegetative growth stages & yield

2. Objetives

Without interfering in the calibrations made by the farmers the aim of this study using PA technology :

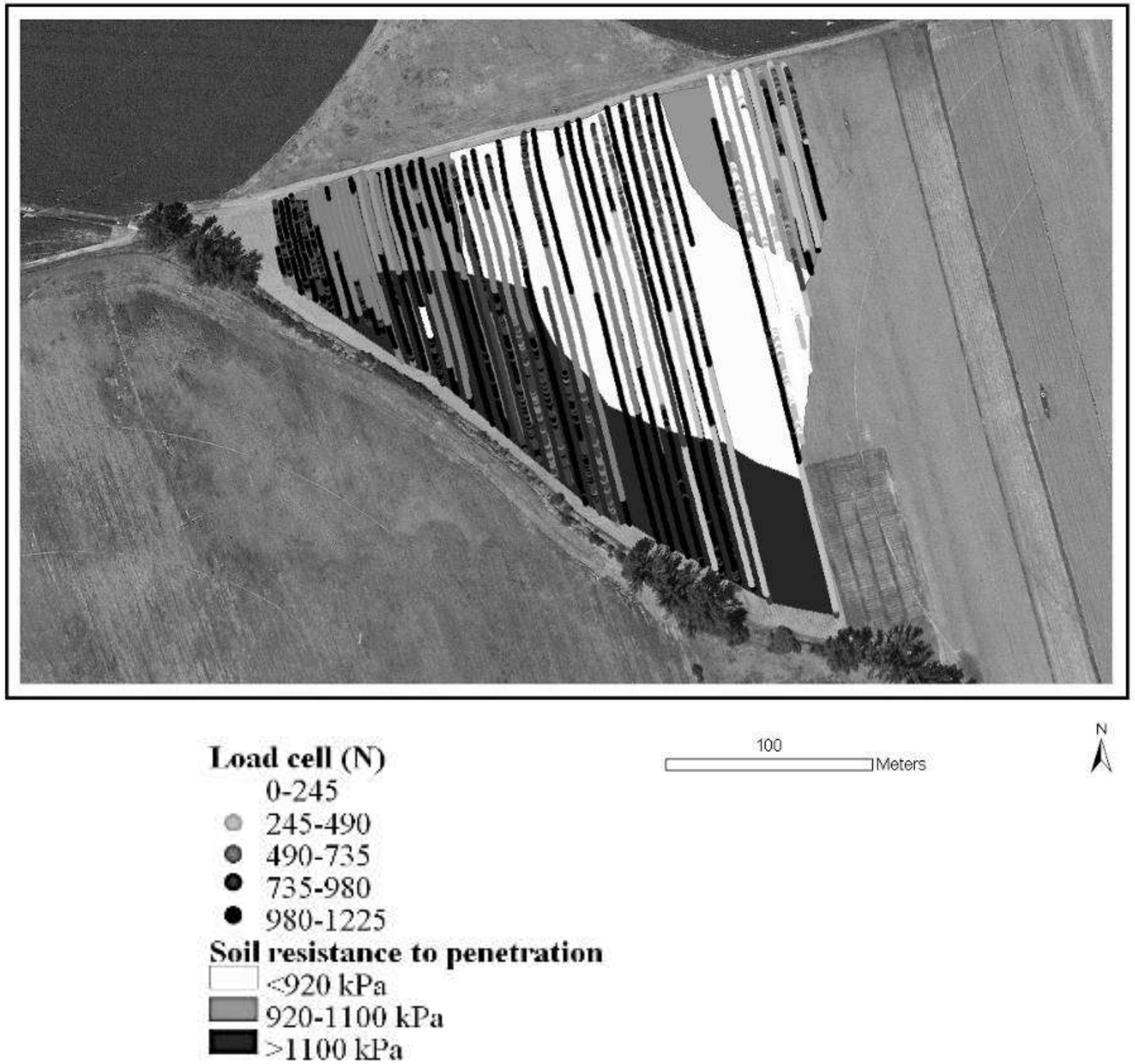
- to carry out a field assessment of the effect of tillage system on maize (*Zea mays*) seed depth placement;
- to understand correlations between seed depth placement and some vegetative and growth parameters of the maize crop;
- to carry out a field assessment of fuel consumption for the different tillage systems.

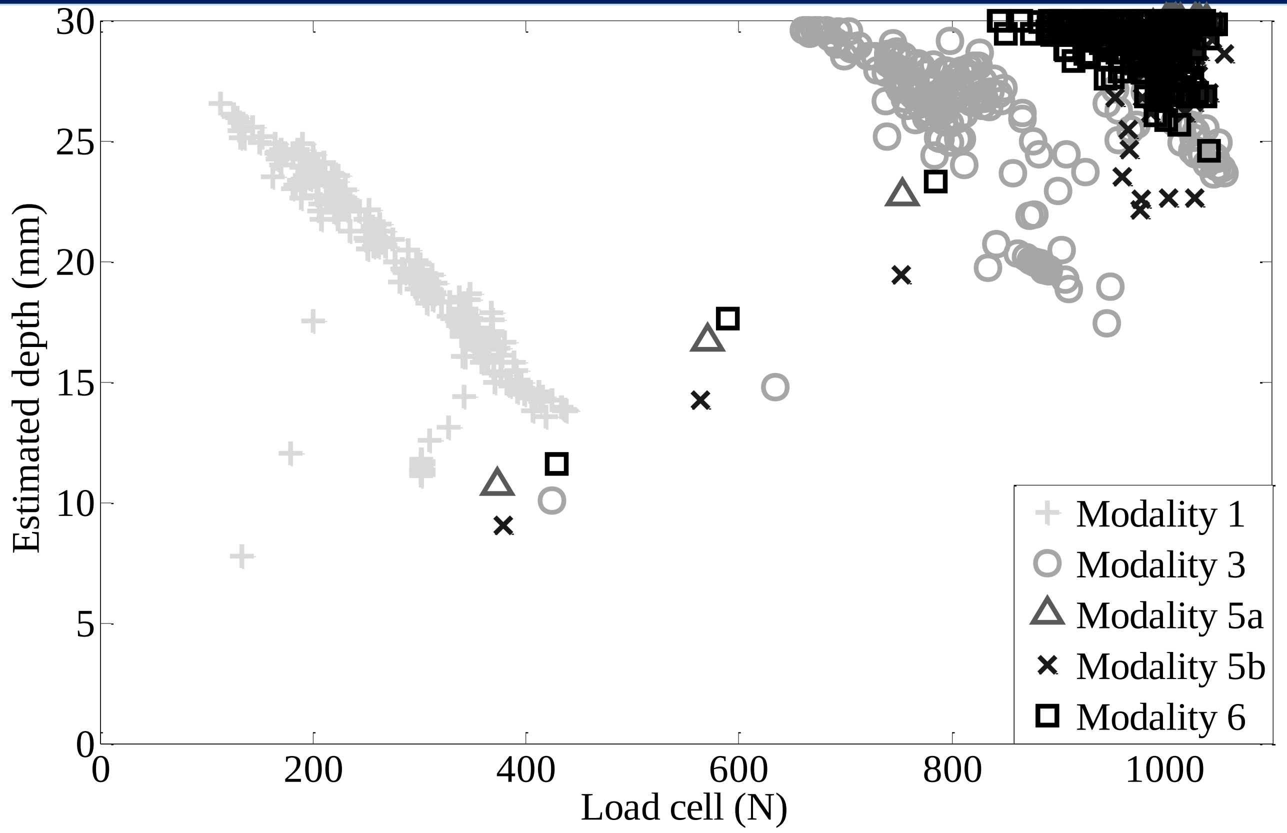
3. Material & Methods

Preliminary trial….2010

In a 4,16 ha area seed depth placement and linear seedling down force were measured with a LVDT sensor a load cell, a datalogger and a GPS receiver installed in the tractor cab in order to georeference the sensor data and measure the forward speed. Pos-processing data were taken by Matlab 7.0 and ArcView 9.0 software

Preliminary trial....2010





Estimated depth measured by the LVDT (mm) and spring force by the load cell (N) for different modalities.Each modality refers to increasing spring stress offset under manual adjustment

over 2011 and 2012....tillage system

Conventional tillage


Minimum tillage

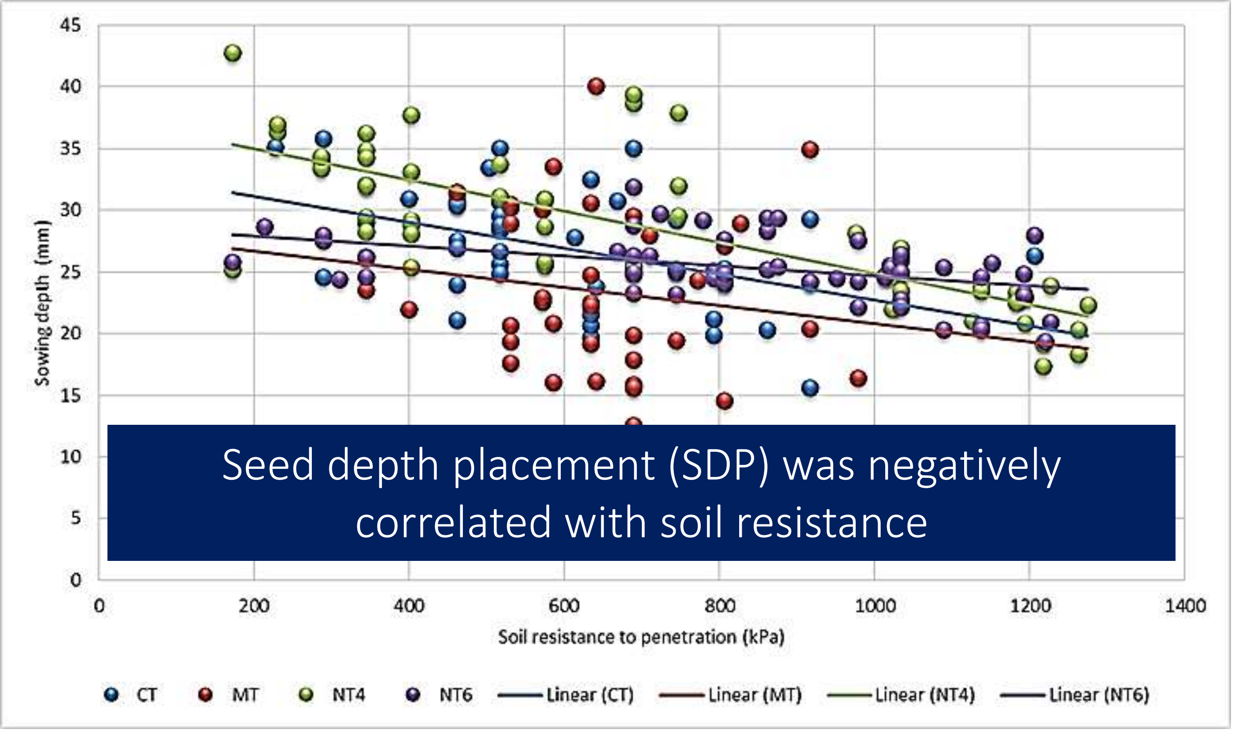
No tillage/4-6kmh^{-1}


Soil samples and Greferenced values soil resistance


Mesocotyl lenght


UAV Aerial images

4. Results tillage system on maiz seed depth



Seed depth placement (SDP) was negatively correlated with soil resistance

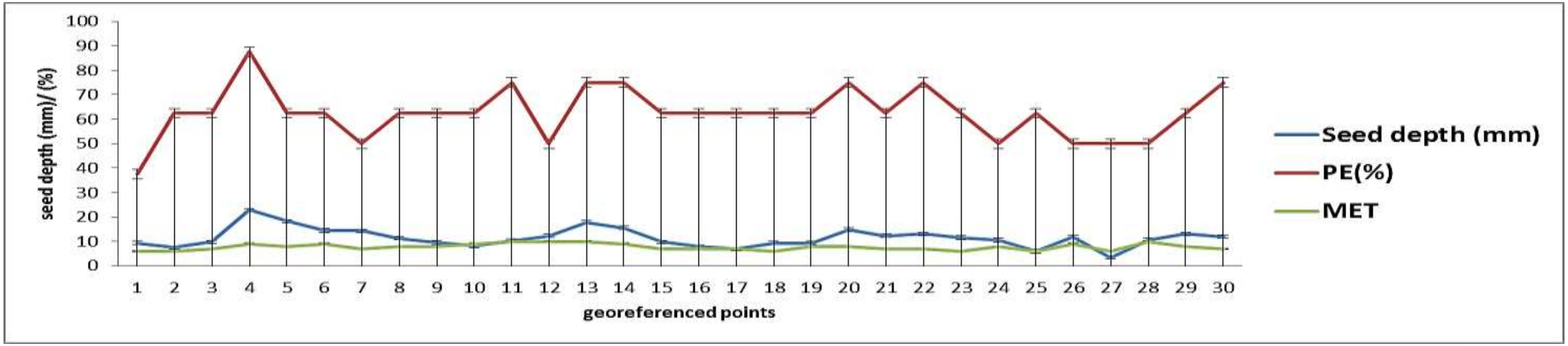
Tillage system affected significantly sowing depth, particularly when comparing Conventional Tillage (CT) to No Tillage (NT)

Tillage system	CT n = 42	MT n = 40	NT4 n = 56	NT6 N = 56	Significance
Sowing depth (mm)	27,01 ± 4,74[ab]	23,43 ± 6,75[a]	28,49 ± 6,07[c]	25,27 ± 2,56[ab]	***

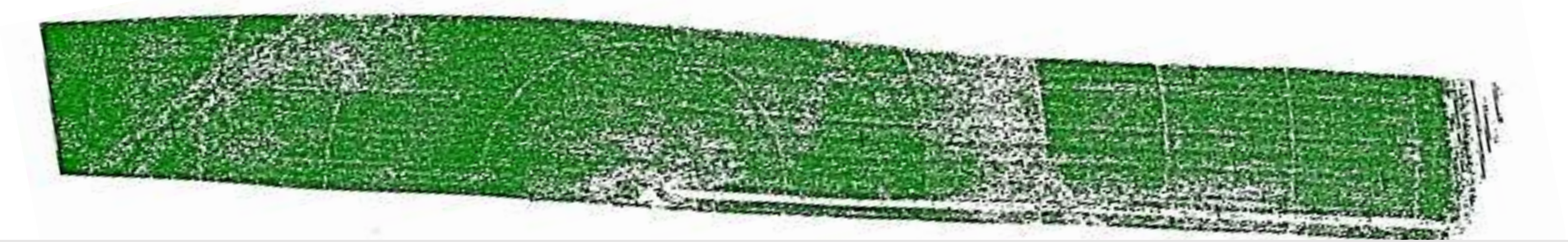
Except for NT4, shallow mean values of SDP and high CV were observed probably due to the relationship soil texture/gravimetric moisture of the plots

Tillage system	Foward speed (kmh^{-1})	Soil resistance (kPa) $\bar{X}$ ±sd	CV	Sowing depth (mm) $\bar{X}$ ±sd	CV	MET (days) $\bar{X}$ ±sd	CV	PE (%) $\bar{X}$ ±sd	CV
2011CT	4	642,66±207,11	32,22	27,01±4,74	17,5	6,04±0,88	14,56	78,27±9,90	12,64
2011MT	4	619,14±149,20	24,08	23,43±6,75	28,8	6,77±0,91	13,29	70,93±12,78	18,01
2011NT	4	713,59±371,92	52,12	28,49±6,07	21,25	9,78±1,40	15,18	61,83±13,77	22,28
2011NT	6	852,14±273,53	32,1	25,27±2,56	10,13	9,33±0,76	8,23	68,75±11,67	16,9
2012NT	4	1286,33±191,47	18,52	11,71±3,96	39,6	7,60±1,57	18,11	61,49±13,43	21,85

Vegetatitive crop consistency



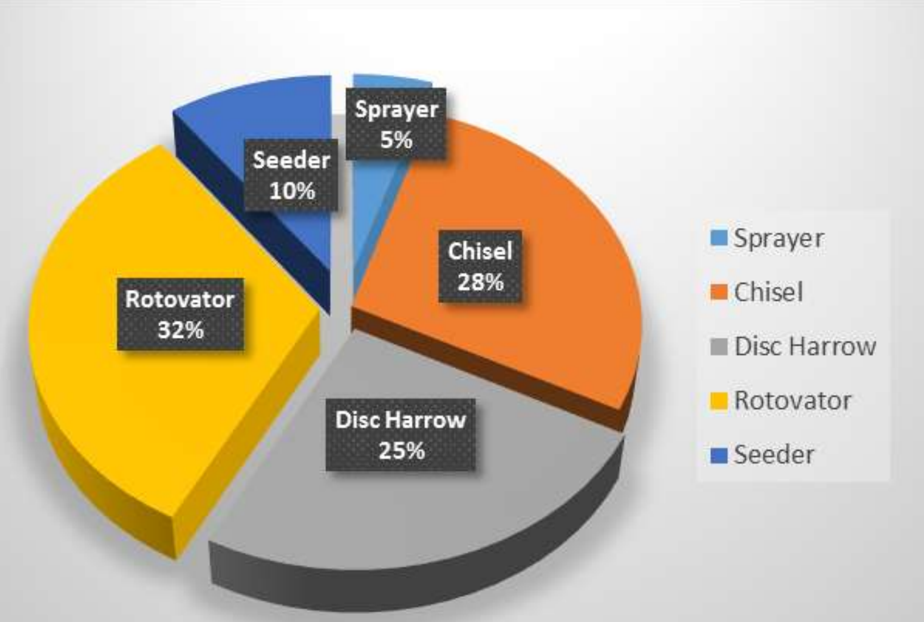
Along the plots SDP led to significant differences in the crop mean time (MET) and percentage of emergence (PE) and was positively correlated with PE and MET.



After crop emergence green spectral band image as a tool to evaluate the need of crop reseeding…!

About fuel consumption

Diesel fuel required was measured by filling the fuel tank of the tractors before and after each field operation, noting the number of hectares covered and…



Percentage of tractor fuel consumption/hectare operation

In no tillage conditions, to evaluate the effect in fuel consumption due to the interaction of sowing depth calibration and seeders load, using the Semeato seeder model SSE and a MF 3060 Datatronic tractor, four modalities were tried.

Interaction	M1 n=59	M2 n=59	M3 n=59	M4 n=59	Significance
Fuel ($l\ ha^{-1}$)	$4{,}30 \pm 0{,}32^{a}$	$4{,}30 \pm 0{,}19^{a}$	$4{,}17 \pm 0{,}17^{b}$	$4{,}04 \pm 0{,}16^{c}$	***

M1 - minimum sowing depth/ loaded seeder **M2** - maximum sowing depth/ loaded seeder **M3** - maximum sowing depth/ unloaded seeder **M4** - minimum sowing depth/ unloaded seeder

Fuel consumption/hectare was significantly affected by the interaction of sowing depth calibration and seeders load

5. Conclusions

Because of the cost of mechanized tillage operations and the importance of conservation far
no tillage in improving soil quality and fuel saving has led to its adoption by f

PA technology monitoring seeding operations and after crop emergence rates may contribute o
help the farmer decide about the need of a crop reseeding

The high coefficients of variation of SDP observed and significant differences in fuel consumption under no tillage conditions, suggest the need for innovative solutions in controlling the seeders' sowing depth mechanism or more accurate calibration by operators in the field

merci beaucoup!

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