AGRO-TRANSFERT RESSOURCES ET TERRITOIRES

ARVALIS Institut du végétal

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Impact of potato planting and harvesting on soil compaction and plant development for potato and next crops

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Context

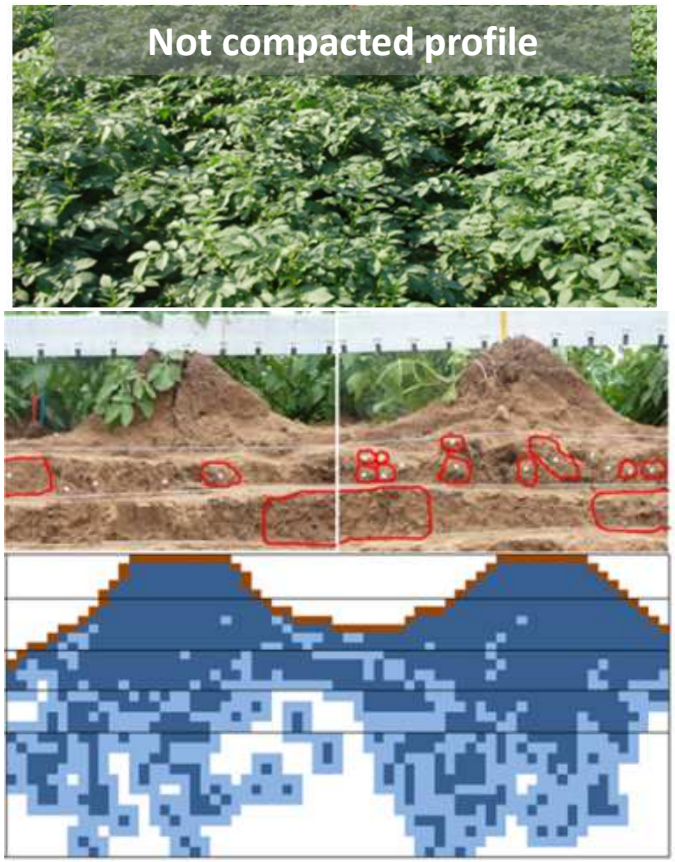
- Northern France : loess soils / oceanic climate
- Cropping systems with high proportions of root crops : sugar beet, potato and irrigated vegetables
- Heavy machineries at sowing/planting and harvesting
- Lack of flexibility to choose the harvest date : agro-industries requests, external supply for operations…

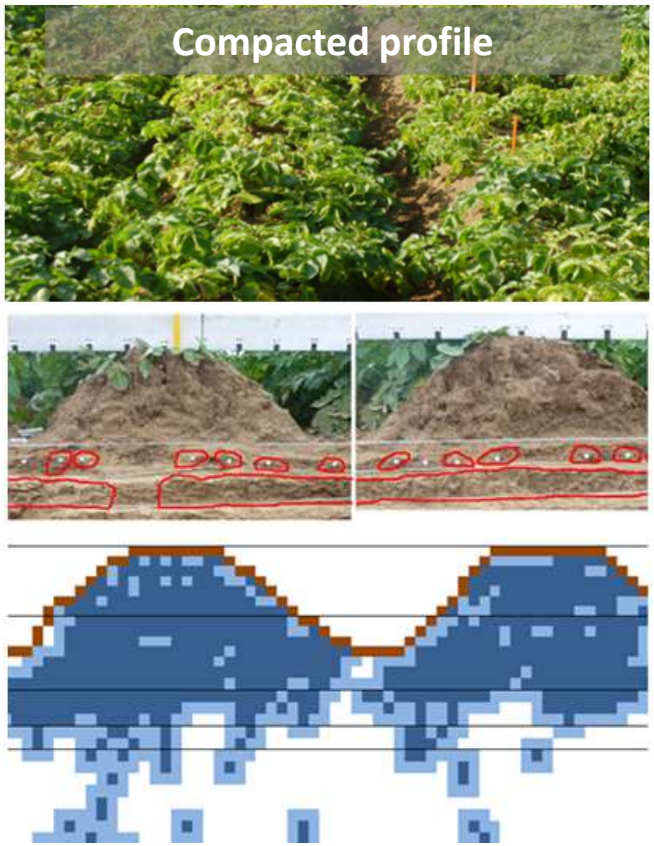
→ Field operations sometimes performed in wet conditions

→ High risk of severe and deep soil compaction

Context

Potato may suffer from the effects of deep compaction realized during the previous crops : a deteriorated soil structure can severely limit plant development, root growth and potato yield





Project Sol-D'Phy and EauptionPlus, 2012, Agro-Transfert-RT

However, potato planting and harvesting can also create soil compaction

Context

Search for more performance in farming operations to limit manpower needs :

- For planting, developpment of combine methods, integrating soil preparation, plantation and direct ridging within one passage

- For harvesting, the 2-row trailed elevator harvester with trailers now opens up a growing place to the 4-row self-propelled bunker harvester

These evolutions require powerful traction equipment and heavier machines, raising the question of compaction risk

Objectives of the study

- To quantify the impact of potato planting and harvesting operations on soil physical properties, plant development and yield for potato itself or next crops

- To characterize the flexibility for farmers to prevent soil compaction during potato operations

Methodology (1/4)

Experimental research has been conducted in 2015 and 2016, in farmers' fields

In each site, several experimental modalities were carried on, with variants on planting equipment, loading level of bunker or trailer, tire inflation pressure, and number of wheel passes

Methodology (2/4)

Contact area

Wheel load for each axle

→ **Assess soil stress :**

$$\frac{\text{Wheel load}}{\text{Contact area}}$$

Methodology (3/4)

Measurements of soil physical properties :

‘Profil cultural’ method

Main indicator used to assess soil structure :

% Δ zones (without visible macropores) in each layer

Δ zone

Bulk density

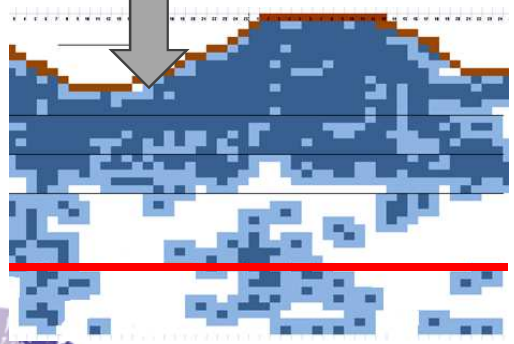
Penetration resistance

Measured with a cone penetrometer at soil field capacity

Methodology (4/4)

Root maps to evaluate root growth

- Grid with a mesh of 2 cm
- The presence / absence of root in each cell of the grid was recorded up to 120 cm depth



Indicators for root growth:

- Root density : % of colonised cells
- Roots exploration : area affected by roots
- ‘‘Effective’’ rooting depth

Method used : depth below which horizontal roots exploration falls below 50% (O. Scheurer)

Potato yield and quality

Yield of the following crop

Results (1/6)

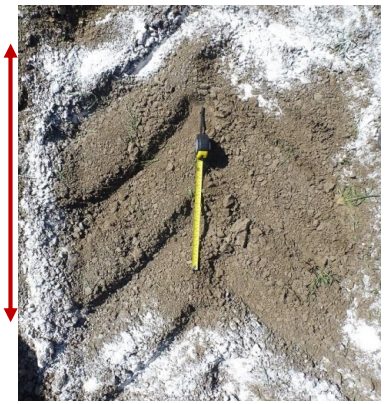
Potato planting

Effect of tire inflation pressure on a combined planting on one passage

High inflation pressure

90 cm

88 cm



900/60 R38

1,5 bar

670 g/cm²

Low inflation pressure

90 cm

115 cm

900/60 R38

0,8 bar

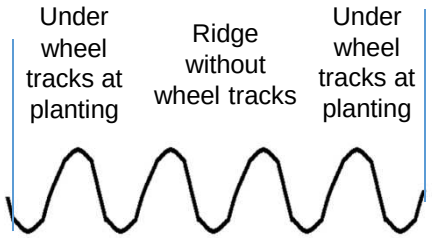
580 g/cm²

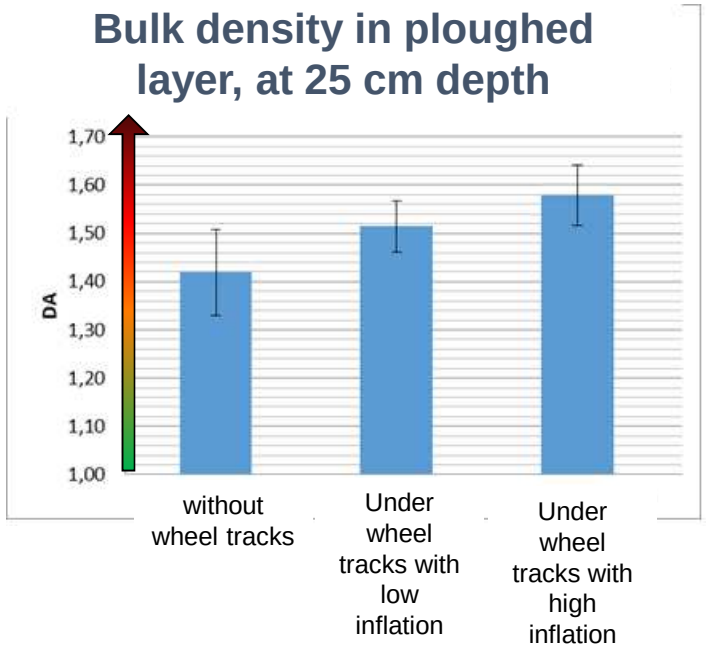
Soil stress

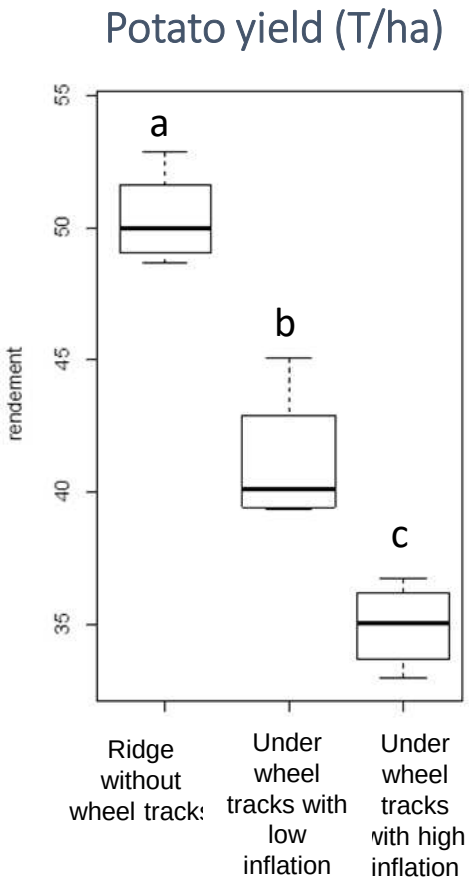
Results (2/6)

Potato planting

Effect of tire pressure on a combined planting in one passage







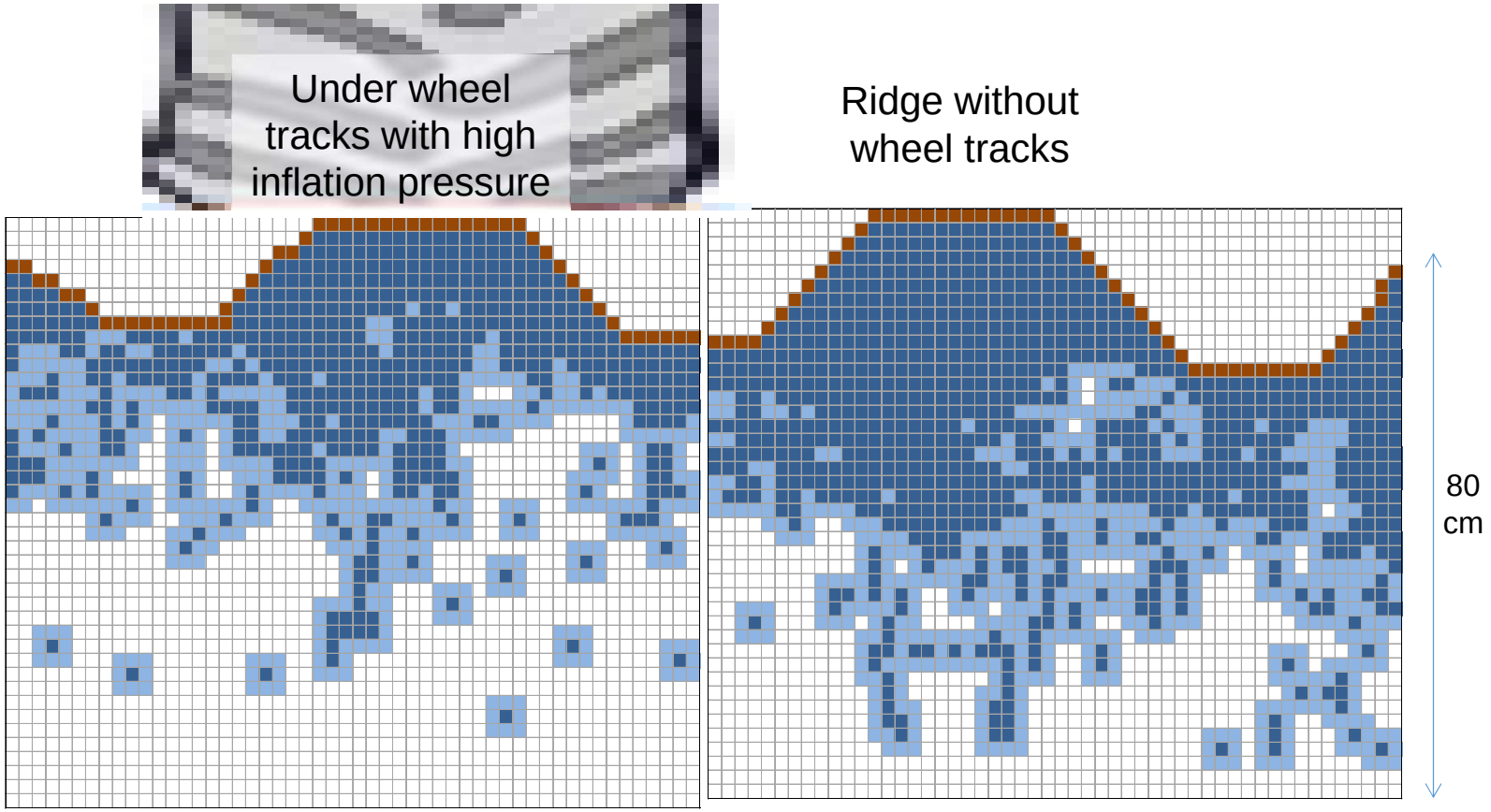
→ Decrease productivity of 15% in the wheeled ridge with low inflation pressure and 30% in the wheeled ridge with high inflation pressure compared to the unwheeled ridge

Results (3/6)

Potato planting

Effect of tire pressure on a combined planting in one passage

Effect on root map

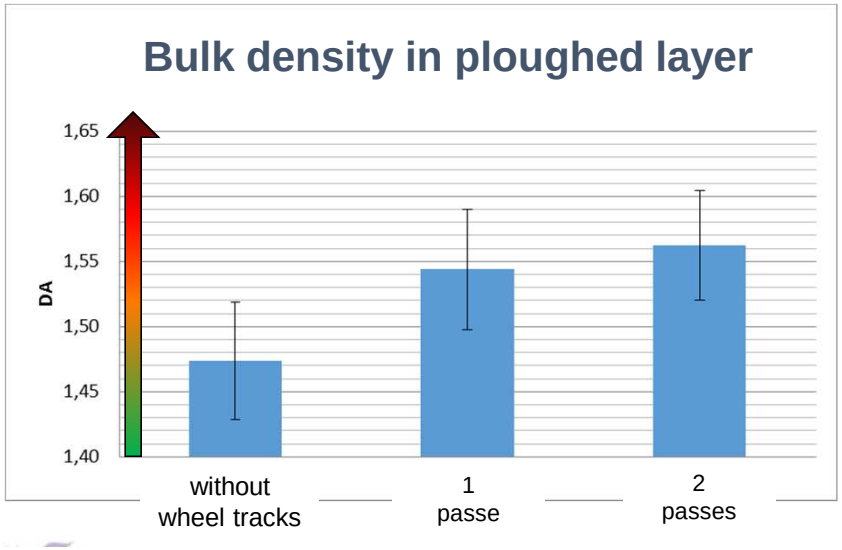


Reduced exploration of subsoil by roots under wheel tracks at planting

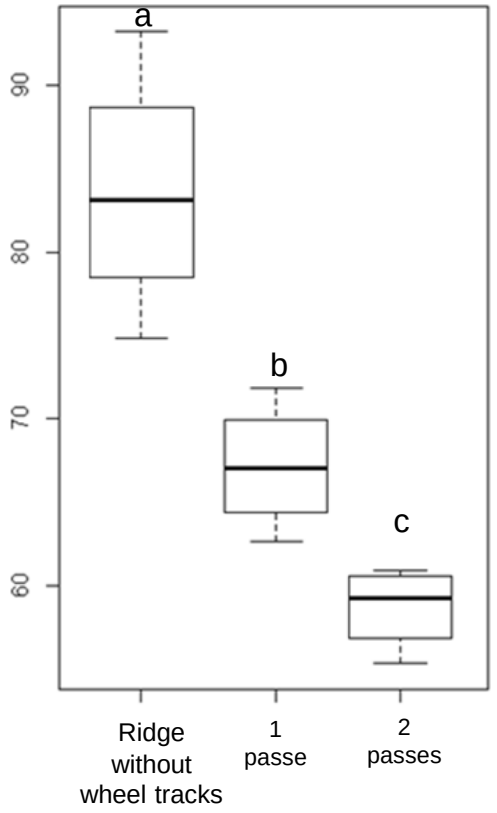
Results (4/6)
Potato planting

Effect of number of wheel passes for soil preparation

1 or 2 passes of rotary tillage



Potato yield at 17 % starch (T/ha)



→ **Decrease productivity of 15% in the ridge with 1 passe** of rotary tillage during the preparation compared to the unwheeled ridge

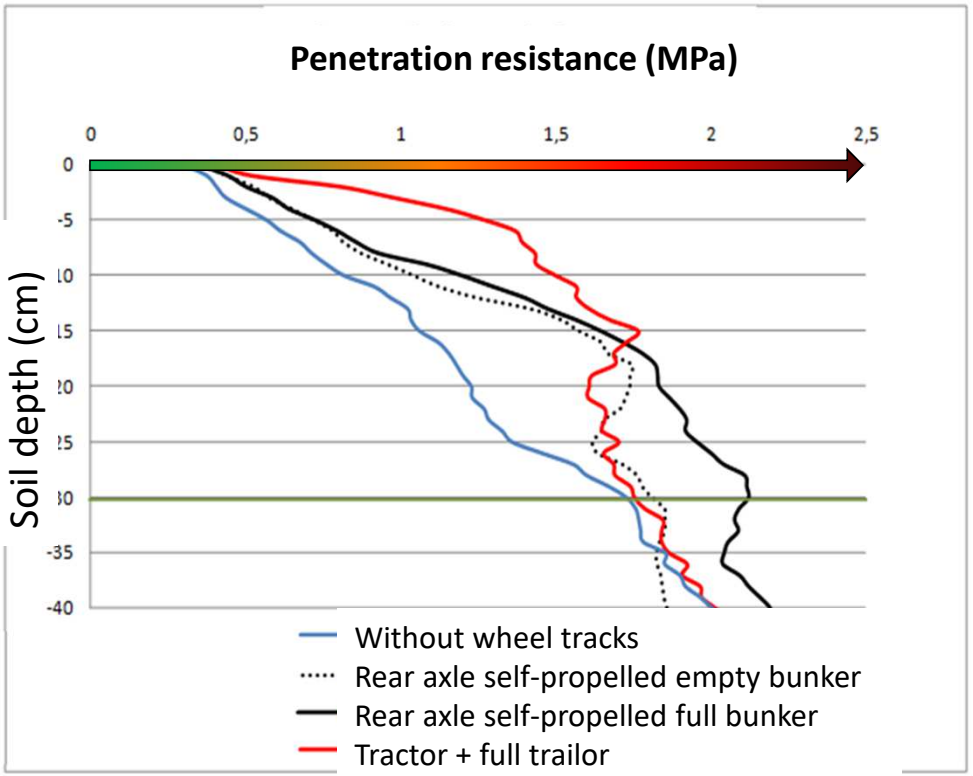
→ **Decrease productivity of 25% in the ridge with 2 passes** of rotary tillage during the preparation compared to the unwheeled ridge

→ The second passe induces a higher compaction in the ploughed layer

2nd passage performs on a loosened soil by the first passage

Results (5/6) Effect of number of wheel passes and axle load for harvesting

Potato harvesting



Soil moisture : near field capacity

In top layer :
Trailers, with multiple passes of wheels, increased compaction intensity
(5 passes of wheels at 9 T/axle)

In deep layer :
The self-propelled bunker harvester caused deeper compaction than trailors
(1 passe of wheel but at 24 T/axle)

→ **Effect of multiple passes of wheels on top layer**
→ **Effect of axle load in depth : for the deeper soil layers, the higher impact is expected from the higher wheel load**

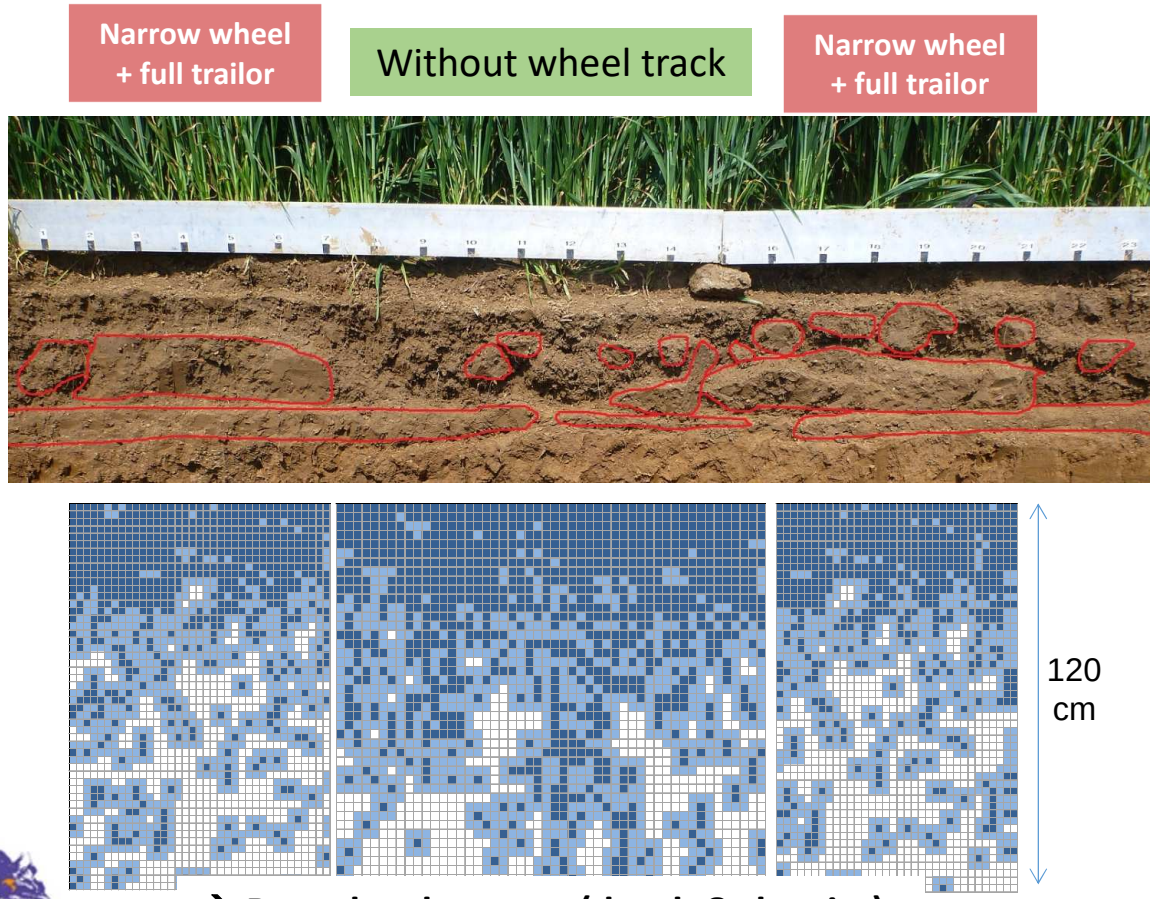
The self-propelled bunker harvester caused deeper compaction than the 2-row trailed elevator harvester

Results (6/6) **Effect of number of wheel passes and of axle load** for harvesting

Potato harvesting

Impact on the next crops

« Profil cultural » and root map on wheat after a 2-row trailed elevator harvester



→ **Root development (depth & density) decreases under compacted zones**

Productivity of next crop (wheat, corn)

- 5 to 24 % less productivity under wheel tracks compared to area w/o wheel track during potato harvesting
- In 2016, with the very wet conditions in spring, soil compaction in the ploughed layer was the most damaging on crops yield when no deep tillage was performed after potato harvesting

Conclusion

- During potato planting, increasing the tire inflation pressure or the number of passes for soil preparation, induces a high compaction risk in the ploughed layer, which can severely decrease potato yield

- During potato harvesting operation, the axle load and soil moisture seem to determine the depth of soil compaction

→ Importance to develop decision support tools and advisory to help farmers to better choose their machineries and the working days available to prevent or limit soil compaction

Thank you for your kind attention