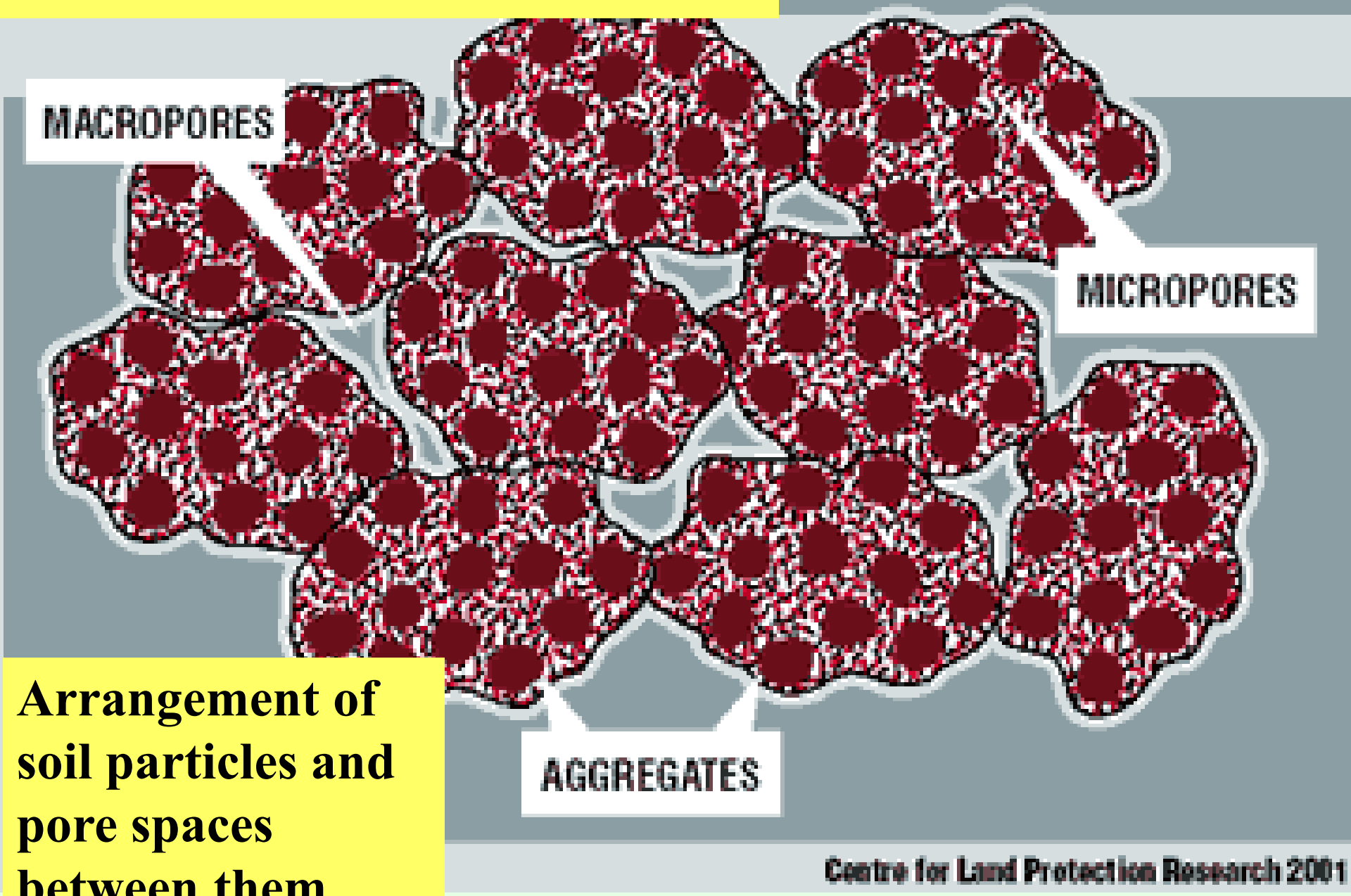
Mechanisation/cultivation Impact on soil structure

Dermot Forristal

Soil Structure



Arrangement of soil particles and pore spaces between them

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Soil Structure Damage

Compaction / Pans

- Reduces pore space
- Impedes root growth
- Impedes water movement
- Restricts oxygen availability
- Restricts nutrient uptake
- Reduces growth and yield - 50%
- Increases power demand

Other

- Smearing / Slaking / Puddling
- Drainage system damage
- Subsoiling: not full answer

Impact of compaction on VESS Scores

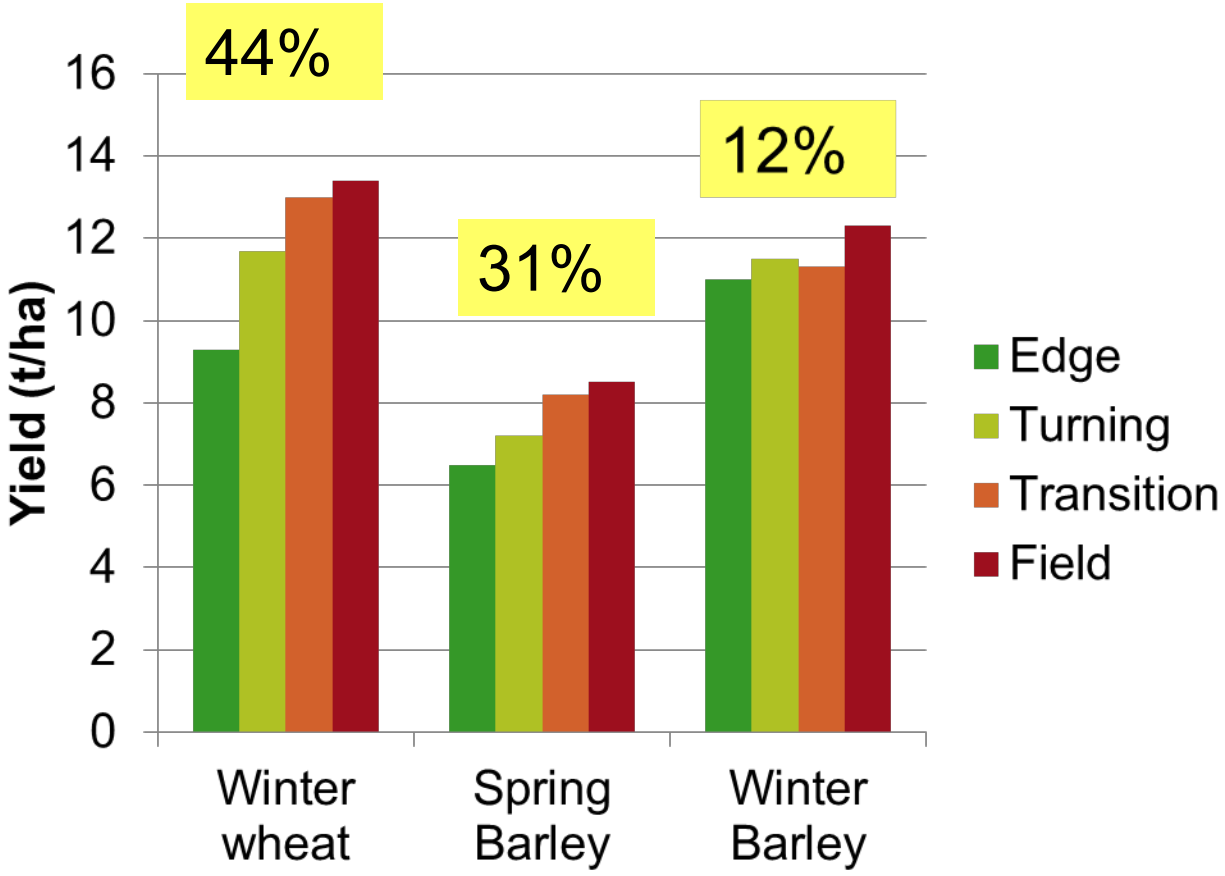
Control **T3** **Control** **T3**

‘Heavy’ soil

‘Light’ soil

Teagasc
Agriculture and Food Development Authority

Headland Yield Results: All Crops



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Damage Factors

- Soil type (including OM)
- Presence or absence of vegetation
- **Extent of cultivation**
- **Soil Moisture Content**
- Machine weight, Ground pressure
- Traffic density
- Animal weight + Traffic density

Veg challenges - 1

- **Often Intense cultivation**
  - Depth
  - Intensity – multiple passes. Tools, tilling speed, forward speed
  - Severe aggregate breakdown
  - De-stoning?
- **Traffic associated with all operations**
  - Weight / Axle Load / Tyre pressure
  - Lots of operations
- **Bulky crops, lots of transport**
  - Often transferring on headlands

Veg challenge - 2

- **Weather and Soil moisture: machinery operations**
  - Sowing / planting
  - Spraying / Weeding / Other
  - Harvest: Partic for Fresh market.

- **Huge challenge: Risk permanent damage.**
- **Contracts are problematic?**
  - Scope to discuss soil management contract clauses that might avoid permanent soil damage?

Soil management Options

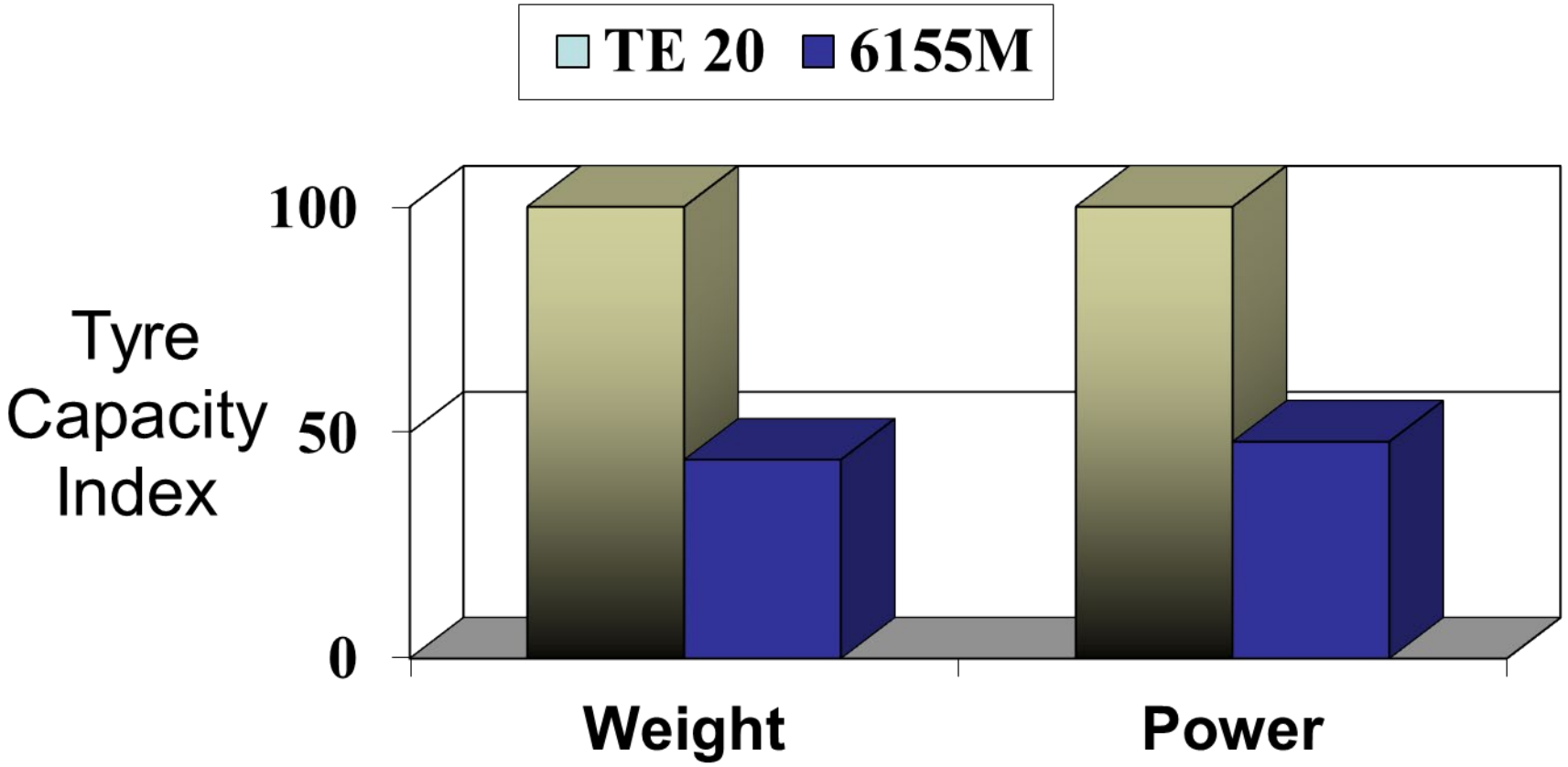
- **Prevent the damage**
  - Pick suitable soils
  - Drainage
  - Timing of operation (Engage the industry in soil protection)
  - Axle loads and tyres
- **Alternative cultivation**
  - Reduce tillage – crop dependent
- **Controlled traffic**
  - Permanent or seasonal
  - Headland management
- **Alleviating damage**
  - Have you a problem: examine and dig
  - Decide on management
  - Subsoiling – tricky

Axle Loads, Tyres and Ground Pressure

Ferguson 20
19 kW
1.2 t
10-28 tyres

JD 6155M
115 kW
6.8 t
20.8R 38 tyres

Tyre capacity: Weight; Power



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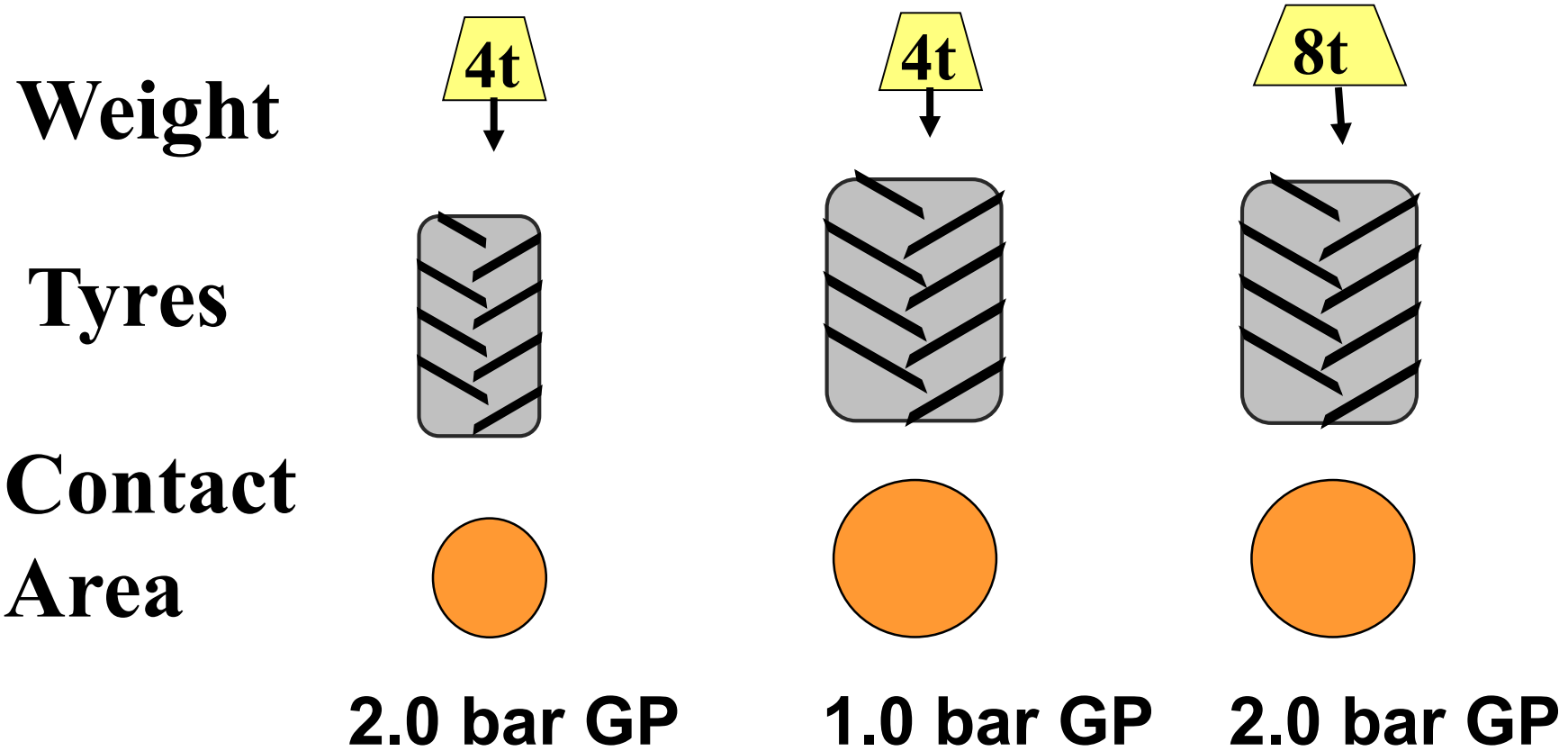
Reduce soil pressure?

- Reduce Load
- **Spread the load**
- **Reduce Ground pressure**
- **Weight / contact area**
- **Can be physically measured**



Air in tyre supports load

Inflation pressure = ground pressure

Large tyres - big volume - low pressure

Select tyres large enough to run at low pressure

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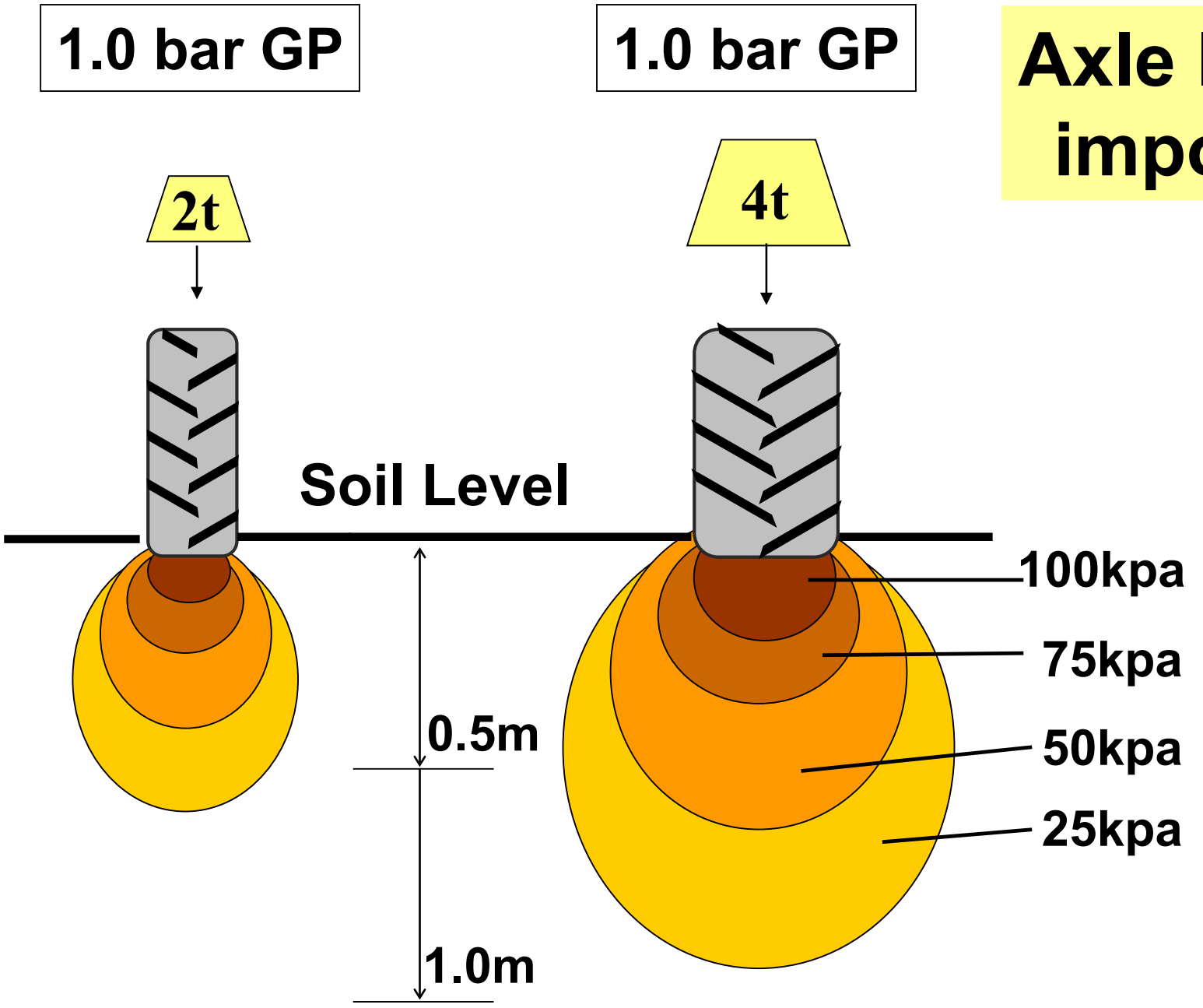
Tyre sizes and Pressure

7.0 t Axle or 3.5t Wheel load

	Inf. press (bar)
420/85 R 38 (16.9R38)	**1.8++**
650/65 R 38	**1.0**
IF 650/65 R 38	**0.9**
VF 650/65 R38	**0.7**


1.0 bar GP
1.0 bar GP
Axle load is important
2t
4t
Soil Level
100kpa
75kpa
50kpa
25kpa
0.5m
1.0m

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What Ground Pressure ?

Depends on conditions

Moisture, Looseness, Machine load and traffic

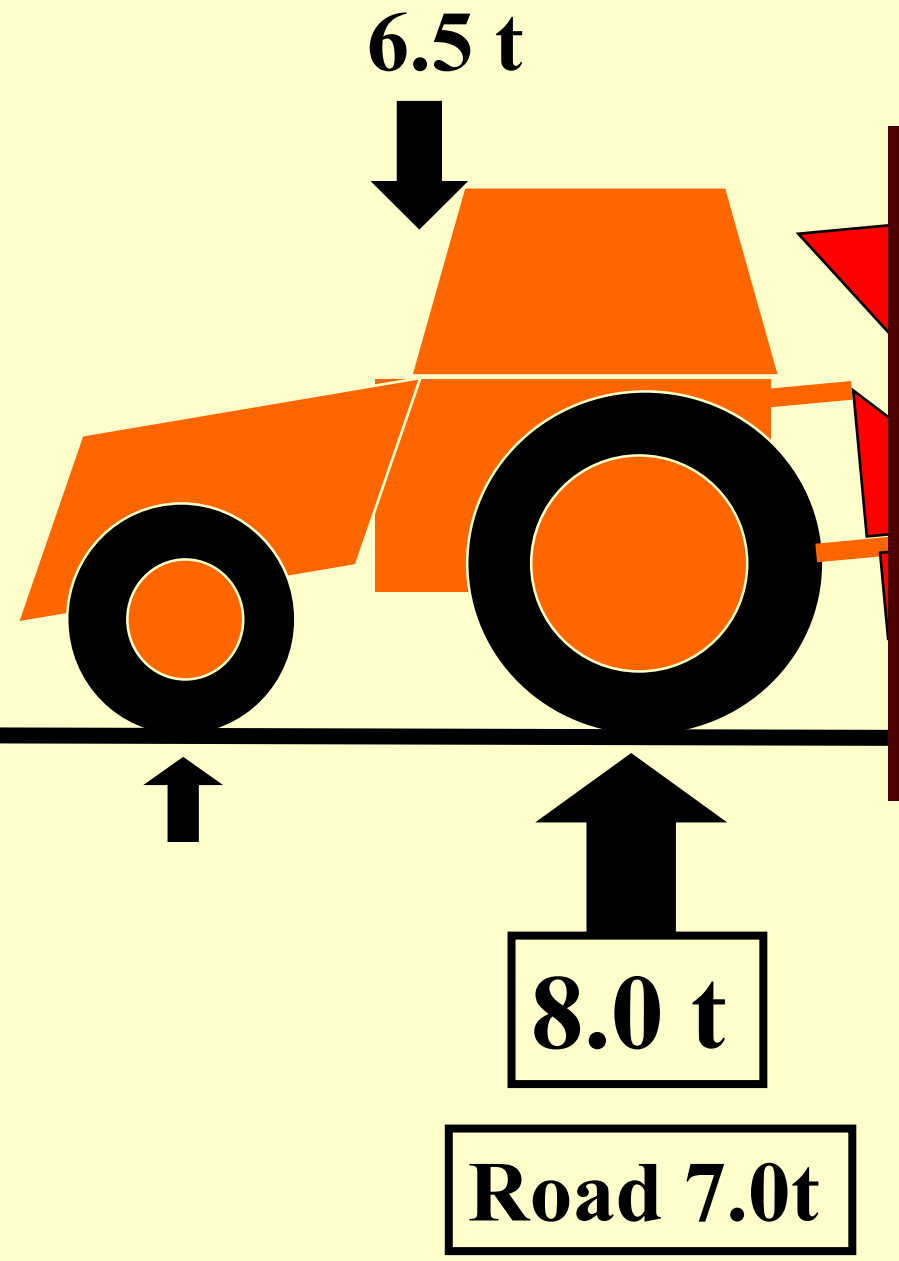
<0.5 bar: Very weak soils: LGP work

0.5 -0.8 bar: Work on cultivated soils

0.8 – 1.0 bar: Ploughing

1.0 – 1.5 bar: Combines and general equip

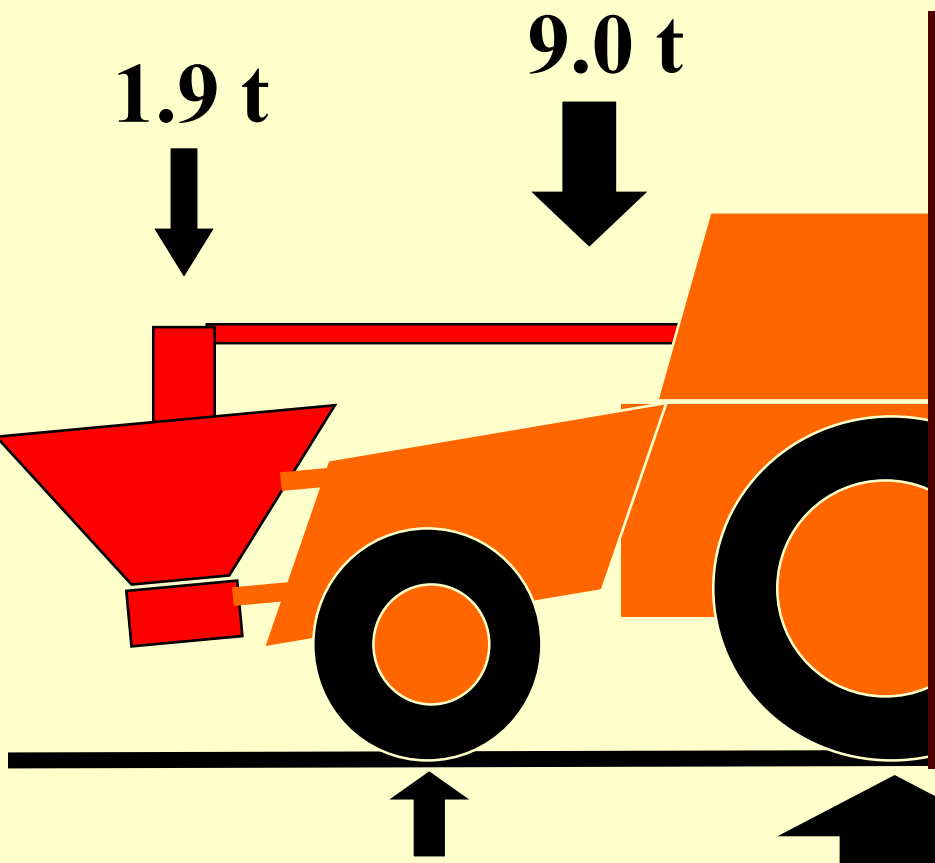
>1.5 bar: Restrict access



Options (30km/h)

520/85 R 38	1.6 bar
600/ 65R 38	1.5 bar
650/ 65R 38	1.3 bar
VF 650/65R38	0.9 bar
VF 710/70R38	0.7 bar

100 kW Tractor + 3m One-pass



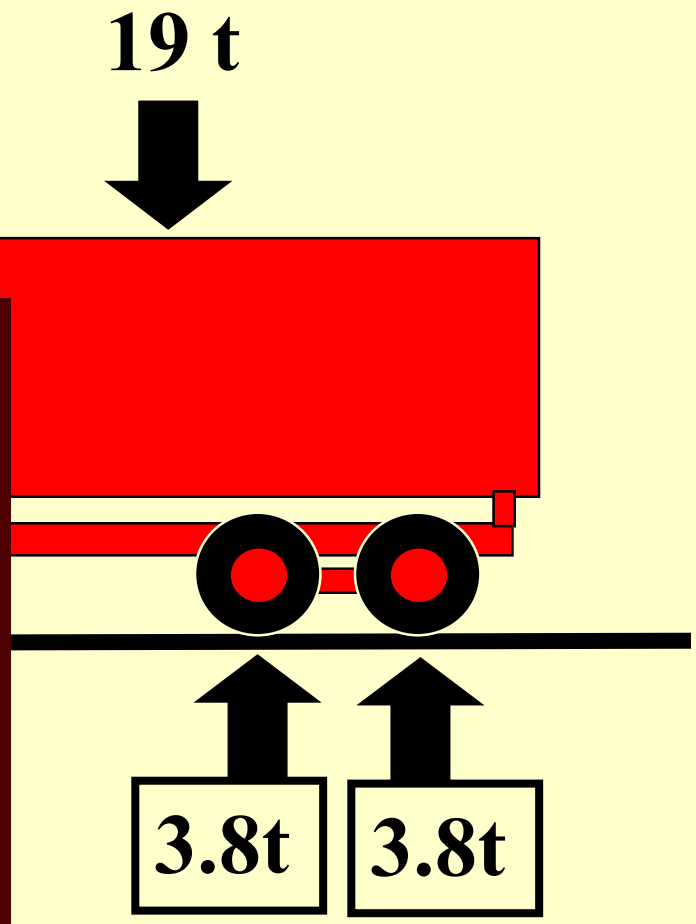
Options (40km/h)

710/ 70R 42	2.0 bar
900/ 50R 42	1.8 bar
1050/50R 32	1.4 bar
710/ 70R 42D	0.7 bar

180 kW Tractor + 6m One-pass


STEYR
UNIBED

5t Tandem Trailer + 14t load



Options (40km/h)	
15 R 22.5	4.0 bar
18 R 22.5	3.3 bar
560/ 40R 22.5	2.8 bar
600/ 50R 22.5	2.0 bar
600/ 55R 26.5	1.6 bar

Soil cultivation

♦Conventional Tillage: Deep Inversion

♦CT : Secondary tillage

♦Minimum Tillage : Shallow non-nversion

Why Cultivate

- **Facilitate seed /plant placement – depth and spacing**
- **Provide soil conditions for plant growth**
  - Seed / soil contact
  - Aggregate size / pore space / density
  - Expose it to dry. Retain moisture. Drain excess water.
- **Weed control**

BUT

- Break down aggregates - Weaken the soil
- Very easily damaged by machinery
- Depth and intensity increases risk!

Alternatives challenging in Hort/ Veg

Less intensive cultivation

- **Increases soil strength and bearing capacity**
- Min-till or Direct drill
  - Challenging for fast development of annual crops
  - May not be suitable for roots
  - Unrealistic to build up permanent structure for these crops
- Strip tillage
  - Maybe one third of the soil loosened to depth
  - Does not weaken the whole structure
  - Good compromise for some crops – practical info to follow.

Strip Tillage: Cultivate strip

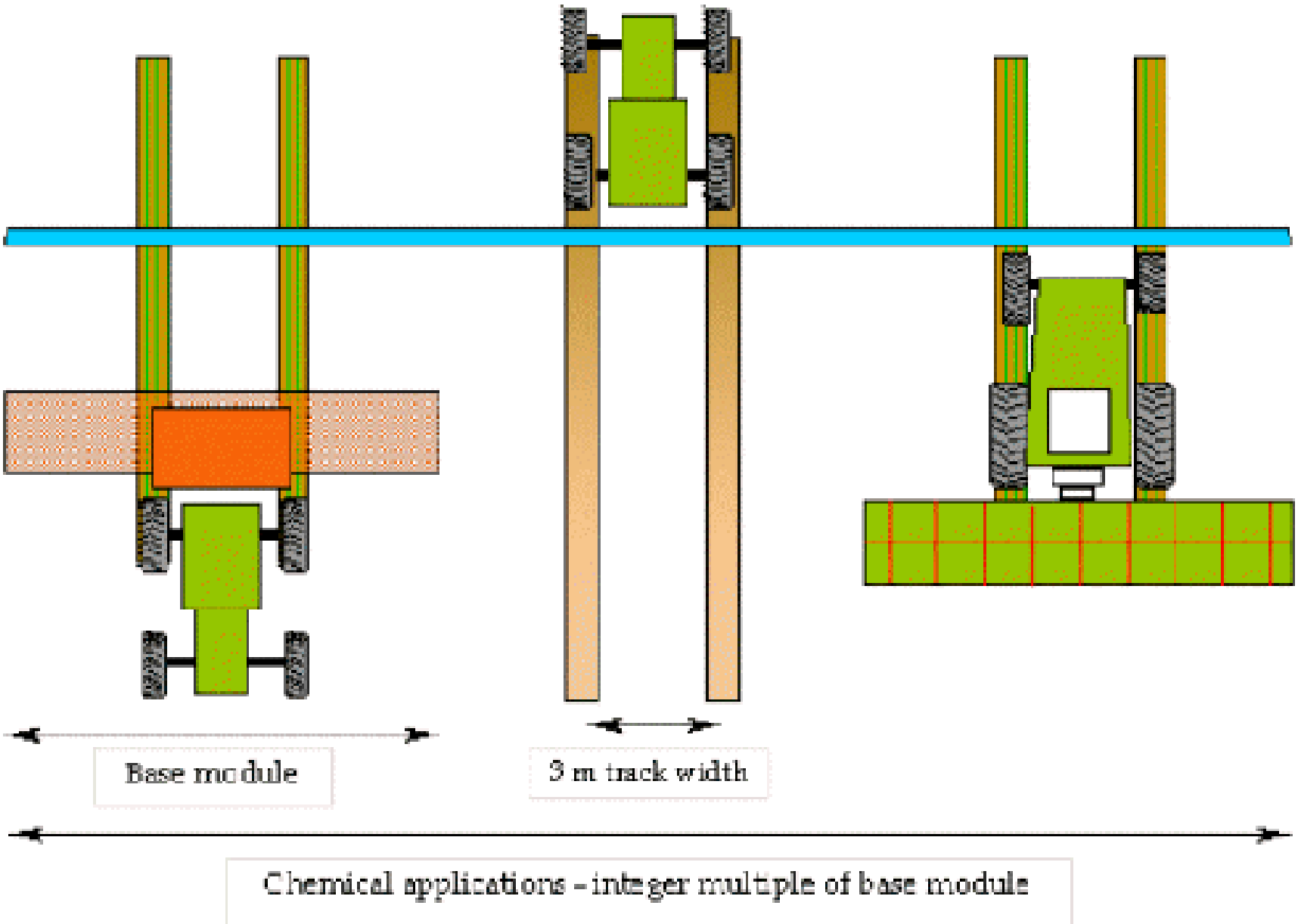
Controlled traffic

Controlled Traffic using GPS

- **Permanent pathways or seasonal (beds)**
  - Large areas without traffic
  - Less compaction
  - Reduced draught / cultivation power
  - Controls exact position of wheelings

    E.g. 6m base: cultivator, drill, combine
- **Can we adopt for Hort / Veg?**

Controlling traffic in field and headlands?


Base module
3 m track width
Chemical applications – integer multiple of base module

Alleviating problems


BLAZER

Sub-soiling / Deep Loosening

Consider how its going to be managed after loosening

- **Only use if needed and in dry conditions (examine)**
- **Use at correct depth and correct spacing**

- **Real re-compaction risk**
- **Avoid transferring problems deeper into profile**
- **Never in wet/plastic conditions – be patient!**

Conclusions

- **Adapt a soil management approach: Prevent damage**
  - Pick suitable soils /sites.
  - Avoid the need to work in wet conditions
  - Suitable machinery, tyres and ground pressures
  - Consider reducing cultivation
  - Control traffic
  - Only subsoil if necessary

  - Get **all stakeholders** to support soil protection