Advantages and potential drawbacks of tine tillage

Benefits	Considerations
1. modest clod and dust forming = **soil structure preserving** 2. **no 'tillage pan compaction'** 3. effective loosening crumbling and mixing 4. good quality work **in dry and humid soils** **5. in wet soils (possible to drive on the field) it causes less damage than other tools** 6. **reduced surface raising = reduced loss of moisture and C** **7. low risk = indirect economic benefit** 8. high area-capacity **9. energy saving** 10. suitability for a variety of purposes	**1. lower efficiency in wet soils** **2. carefully adapted if the soil is compacted and desiccated** 3. deep-working structures are suitable for controlling perennial weeds **4. use with due expertise if potential benefits are to be achieved** 5. mixing effect may be detrimental if crop residues are not chopped or if they are green and unripe **6. A non-inversion process!**

Cultivator/ tine use for winter/spring crops

Humid soil	Wet soil
1) Stalk/straw chopping at harvest and/or by flat plate disk	1) Stalk/straw chopping at harvest
2) Primary tillage by cultivator	2) Primary tillage by cultivator
3) Secondary tillage (if needed) by cross-board harrow and roll	Weed spraying (if needed – in early spring)
4) Seedbed preparation by compactor…	3) Seedbed preparation by combinator
5) Sowing, press, surface finishing	4) Sowing and surface finishing
Result: Soil state and water conservation (recommended)	**Result**: Soil state and cost saving (a extreme condition)

Practical benefits offered by tillage using cultivators

- Mulching – less water loss in hot days
- Good water storing in winter (35 cm depth, no pan)
- Direct weed control, if…..
- Indirect weed control: good germination – chance to control

- Better soil condition (related to ploughing) better chance to control

- Multi-effects: loosening, crumbling, mixing, pressing
- Surface press in the same pass (no recompaction risk)
- Working speed (6-12 km/h)
- Good area capacity – advantageous in any season
- Demand of tractive force – related to construction
- Preserving soil culture condition in any season

Rationalisation of ploughing

Training farmers to use ploughing rationally; prevention possible defects and decrease risks

- no clodding, no smearing
- inverting (for plant protection?)
- surface levelling
- well timing
- less damages
- less traffic after ploughing, before sowing
- less / moderated cost

Advantages of ploughing and other considerations

Advantages	Considerations
1. inverting - exchange between different soil layers - incorporating crop residues /manures - weed control (burying weed seeds ?) - a method for soil improvement **2. suitable for humid soils as well** 3. effective loosening to ploughing depth 4. a widely known tillage method 5. simple application (conventional plough) 6. loyalty to plough and to ploughing as an age-old tool and tillage technique 7. structure preserving and good workability if the soil is humid	1. high energy requirement of inverting and then surface forming 2. loss of soil moisture and carbon (if large surface area is left) 3. limitation of working depth depending on type of plough and the energy requirement of ploughing 4. working depth is limited by the depth to which the soil can be inverted 5. plough pan forming 6. forming large clumps of soil with smeared surfaces if soil is wet 7. clod forming if the soil is too dry 8. soil structure damage when clods are broken up 9. soil over-compacting by traffic (e.g. in case of conventional ploughing) 10. burying weed seeds! 11. environmental risks

Comparisons of conventional and rationalised ploughing systems

1st variant	2nd variant	
Stubble disking (+)	Stubble tine cultivation (-)	
↓	↓	
PLOUGHING: conv. pl. (+)	PLOUGHING: c. pl. + rolling tool (-)	
↓	↓	
Surface prep.: c. disk 1-2x (+)	Surface levelling: cross-board tool (-)	
↓	↓	↓
Seedbed preparation: heavy compactor (+)	Seedbed preparation: compactor (-)	Seedbed preparation and sowing in one pass (-)
↓	↓	
Sowing	Sowing	
Impacts on soil: unfavourable	Impacts on soil: favourable	favourable
Legend: possible damage (+); minimised damage (-)		

Sowing w. rape / w. wheat in humid soil

Whether ploughing is beneficial?

1) Does the farm apply this primary tillage mode with high standard?

a) having up-to-date ploughs and packers or surface preparing tools,
b) apply the ploughing at soil water content adaptable to invert and prepare,
c) no create clods (no plough on dry soil),
d) no create bacon-like furrows, and no smear compact pan layer below the ploughed layer,
e) no invert light soils promoting wind erosion

2) Plough the soils to invert great mass of stubble residues aiming at C content improvement in soil

3) Between two crops having similar diseases, and pests, when level of the crop protection is less adequate, or reducing costs of the chemical protection

Examining traditional ideas

1. Plough changes the original soil layers: this is strange from soil original character. Ploughing is a human decision to create clean surface (cleaning the surface from residues, weeds etc.)

2. Does invert FYM? FYM mixing with soil particles is better practice. Remaining 5-10 % of FYM on the surface is less damage compared to 15-45 % of C loss causing a bad ploughing (promoting C flux)

3. Due to frost effect great mass of dust form in the smeared surface created by ploughing in wet soil. Dust may remove by spring winds or leach into the deeper layers by strong rains …extending former compact layer

4. A cloddy ploughed surface promotes water and C loss till the frosts, and it causes water loss during mild winter

5. Out of the slopes, a levelled surface is good for wintering in flat areas: soil will conserve water and C; less dust will form in the minimised surface, however soil remains its water infiltration capacity

6. A cloddy surface my catch the snow, but the water loss will greater after snow melting

7. Ploughing inverts the weed seeds which survive this procedure and accumulate in the soil (seed bank)

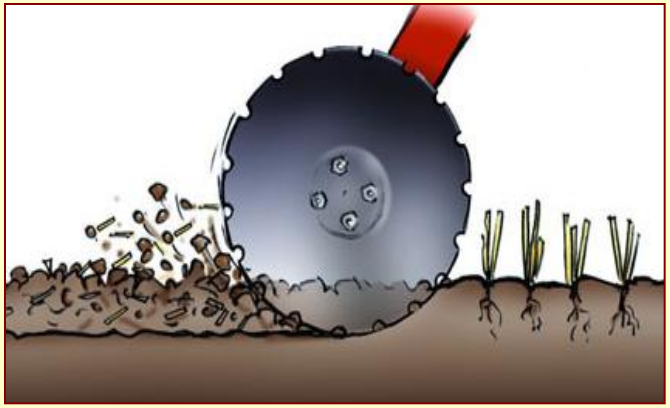
Rationalisation of the ploughing:

use this tillage mode with less soil structure deterioration (no clods!) and less water and OM / C release from soil.

Disking system

Considerations

- to decrease applying risk (attention to root zone state and soil moisture)
- do not use on soil compacted below 10-12 cm
- function change (use conventional disc rarely for primary and secondary tillage)
- use flat plate disk – results less compaction and dust



Disk pan compaction independent from soil types!

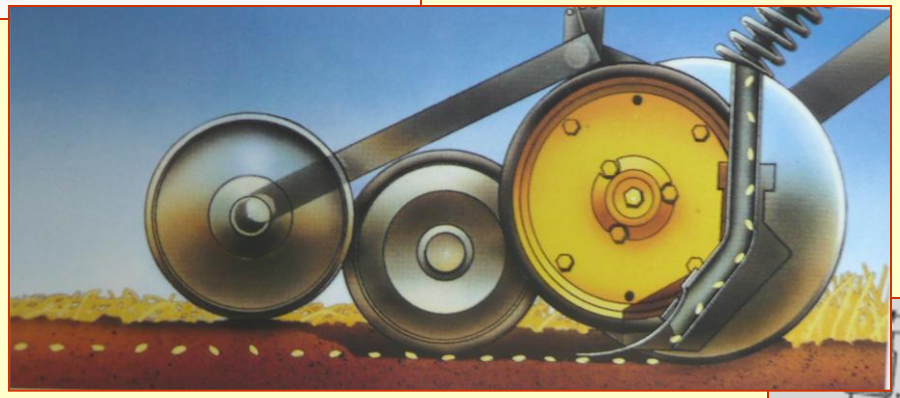
Environmental impacts of primary tillage variants

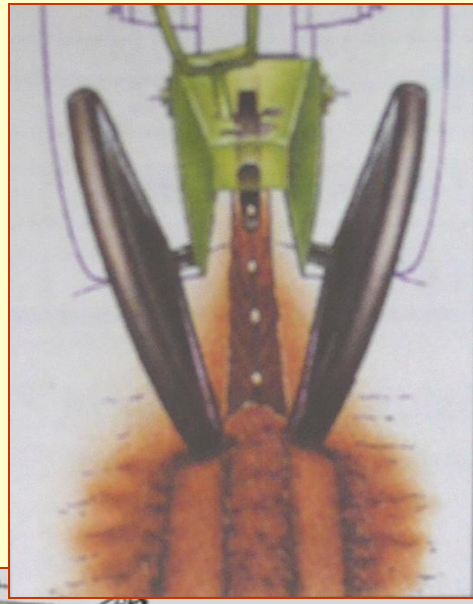
Soil state	Environmental risk at the given moisture state						
	Flat plate disk	Conv. disk	Tine	Plough		Loosener - ripper	Roto-tiller
				Conv.	Revers.		
Humid	less	moderate	no	great	less	less	less
Dry	less	great	no	great	less	less	mod.
Wet	moderate	great	less	great	great	moderate	less
	Grade of the soil conservation						
	good	poor	good	poor	moderate	good	good

Seedbed preparation

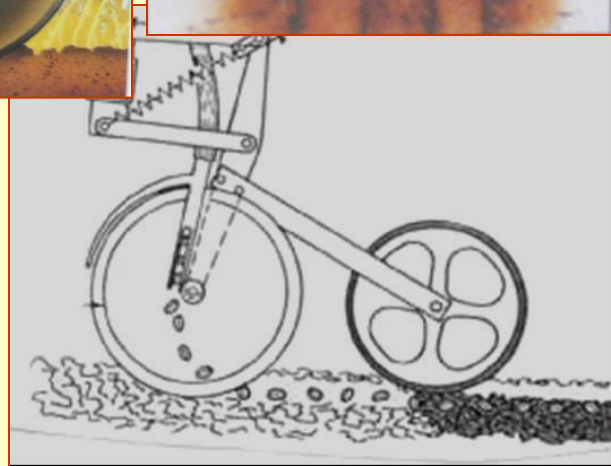
Create soil condition helping seeds or propagating materials germinate and emerge quickly and improve the impact of chemicals and starter fertilisers.

A good seedbed:
- ❑ crumbled (non-dusty),
- ❑ settled, no over-compacted,
- ❑ moist and free from weeds,
- ❑ conserving surface





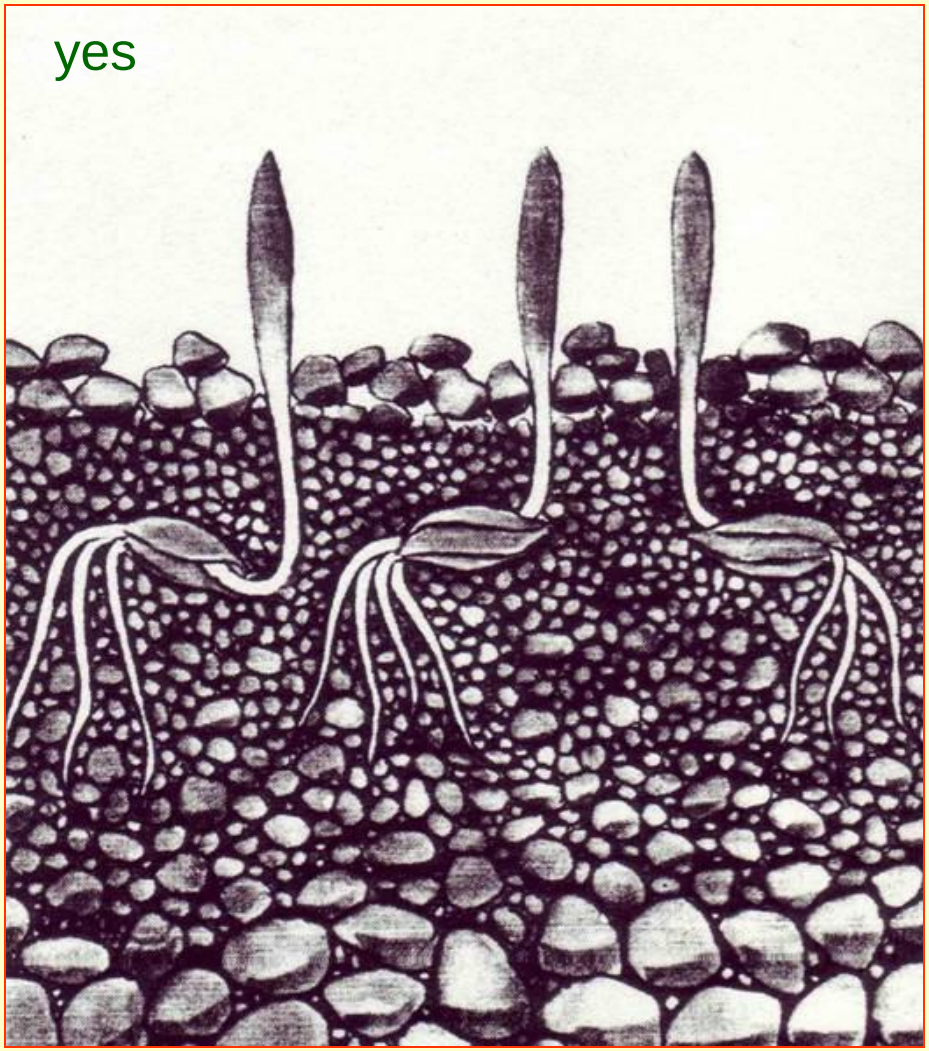
SOWING



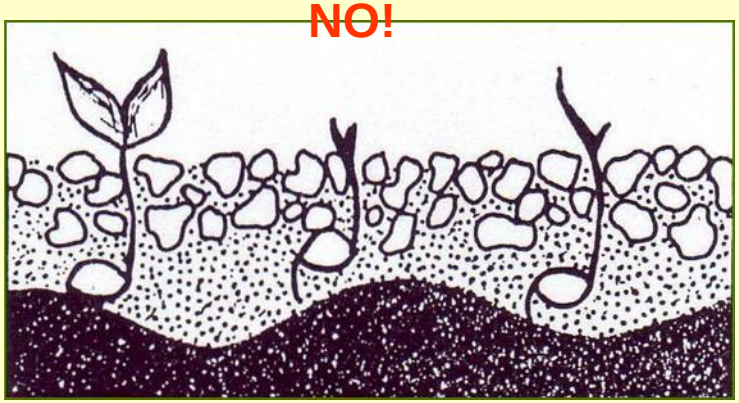
- ❑ + seedbed preparation (there are machines)
- ❑ Creating seed furrow
- ❑ Put seeds into soil (above seedbed base)
- ❑ Press the soil to seeds
- ❑ Create soil conserving surface

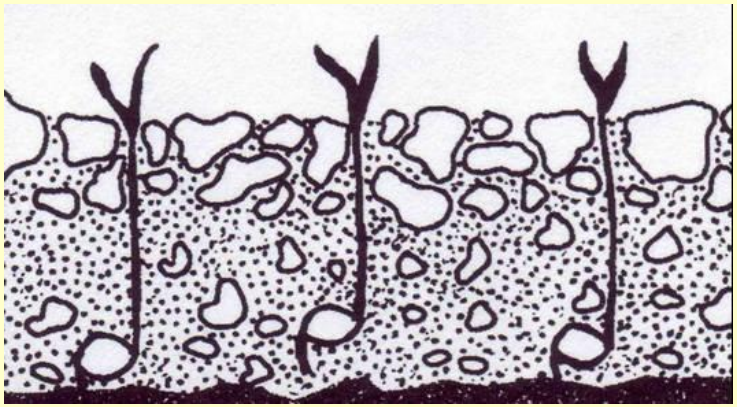
Seedbed requirements

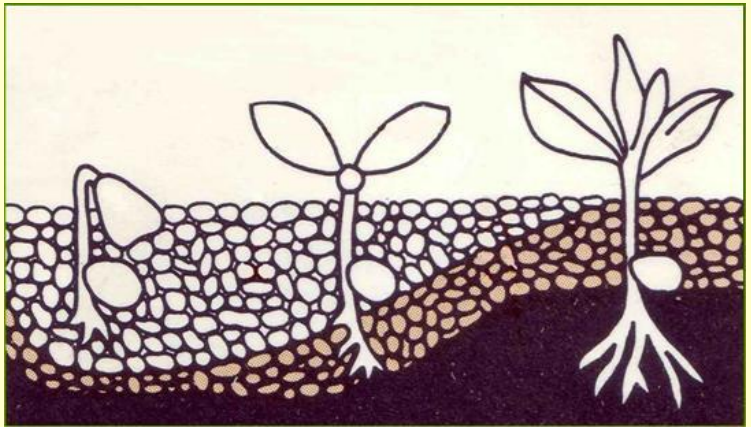
yes



NO!







Conventional sowing (following seedbed preparation)

Wheat sowing – good soil state (brown forest)

Sowing maize

Ridge tillage system