TECHNISCHE UNIVERSITÄT DRESDEN

int Institute of Natural Materials Technology

Faculty of Mechanical Science and Engineering - Chair of Agricultural Systems Technology

DEVELOPMENT OF A TILLAGE MACHINE FOR SEEDBED CULTIVATION OF HEAVY SOILS

Matthias Marsel, Th. Herlitzius, T. Bögel, Technische Universität Dresden
A. Roth, B. Neunkirchen, Antriebstechnik-Roth GmbH
H. Eidam, T. Sander, Eidam Landtechnik GmbH
75. Internationale Tagung LAND.TECHNIK – AgEng
Hannover

11.10.2017

Content

Tillage of heavy soils

Project objective and system requirements

Machine concept and working tools

Functional prototype machine and fieldtest results

Conclusion and outlook

Heavy Soils

general facts

- soils with high propotion of clay or loam (> 50%)
- high soil fertility (“Bodenpunkte” > 50 up to 100)
- ca. 850.000 ha of heavy soils in Germany (≈ 7% of arable area)

advantages

good nutrient supply and water holding capacity

increased crop yields

Source: ble

disadvantages

“minute soils”, tillage is very wheater-dependend

tillage is energy intensive need of heavy machines

tillage and seedbed-cultivation

- high area output needed by short tillage time
- basic tillage with plough or cultivators
- acceptable seedbed-quality usually with multiple transitions

common implements for seedbed cultivation

source: Väderstad

source: Amazone

source: die-landmaschine.at

Tillage Prototype of TU Dresden from 1988

characteristics

- specialized for ploughed heavy soils
- traction and steering by the implements
- only mechanical variable drives

Development of an active powered implement for seedbed cultivation of heavy soils with low draft force requirements and an acceptable seedbed quality within one transition.

Roth SYSTEMTECHNIK ANTRIEBSTECHNIK

EIDAM LANDTECHNIK

innovativ von der Idee zum Produkt

AMAZONE

BBG

TECHNISCHE UNIVERSITÄT DRESDEN

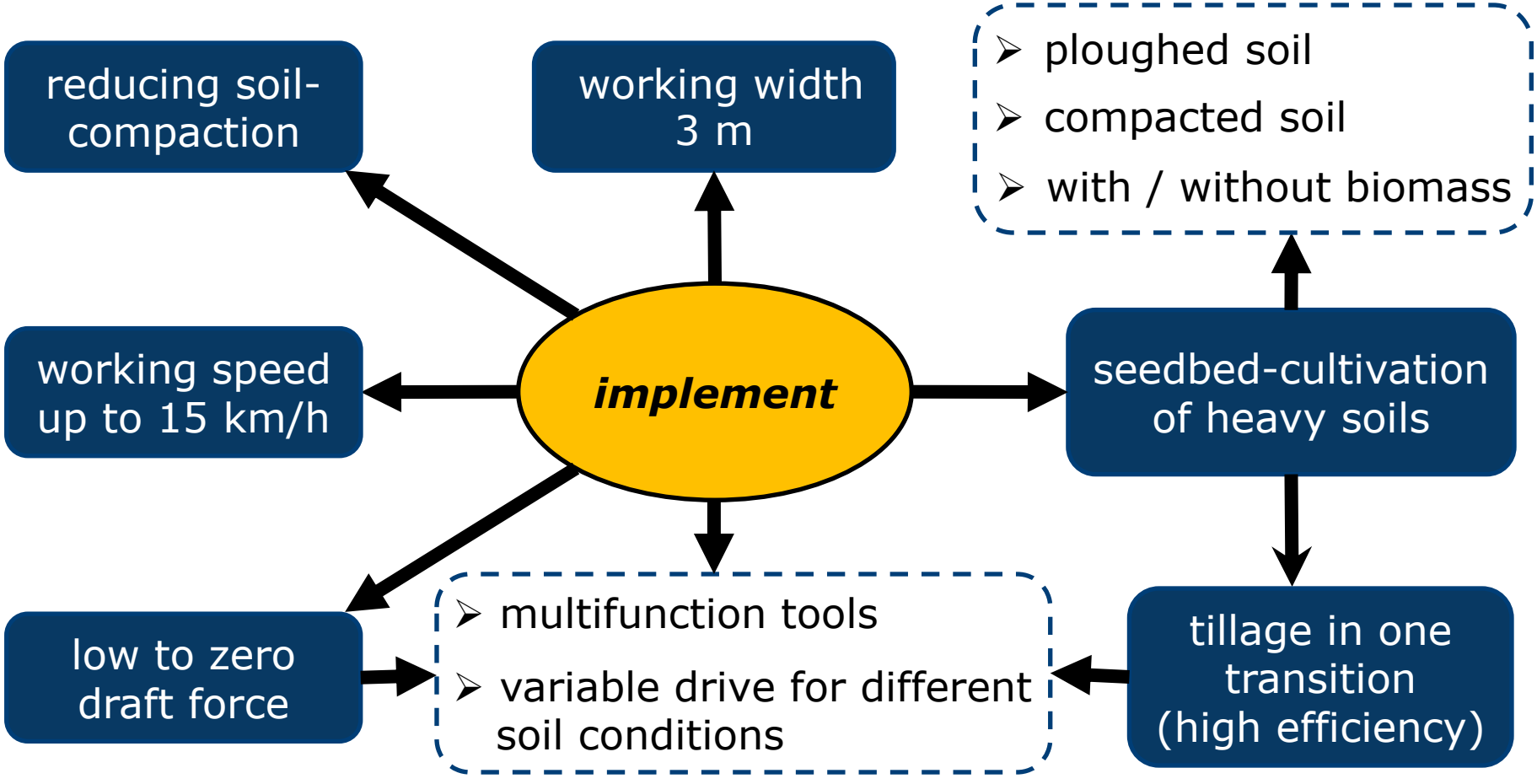
ast

Europäische Union

Europa fördert Sachsen.

EFRE

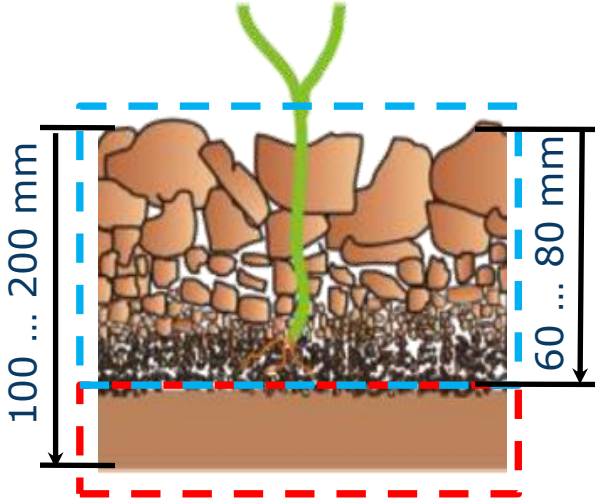
Europäischer Fonds für regionale Entwicklung


reducing soil-compaction
working width 3 m
ploughed soil
compacted soil
with / without biomass
working speed up to 15 km/h
implement
seedbed-cultivation of heavy soils
low to zero draft force
multifunction tools
variable drive for different soil conditions
tillage in one transition (high efficiency)

seedbed-cultivation

step 1:

- subsoiling
- pre crushing
- deep compacting



step 2:

- fine crushing
- rear compacting
- leveling

additional:

- generate propulsion
- support machine

tools for tillage step 1

star packer

thooth packer flat

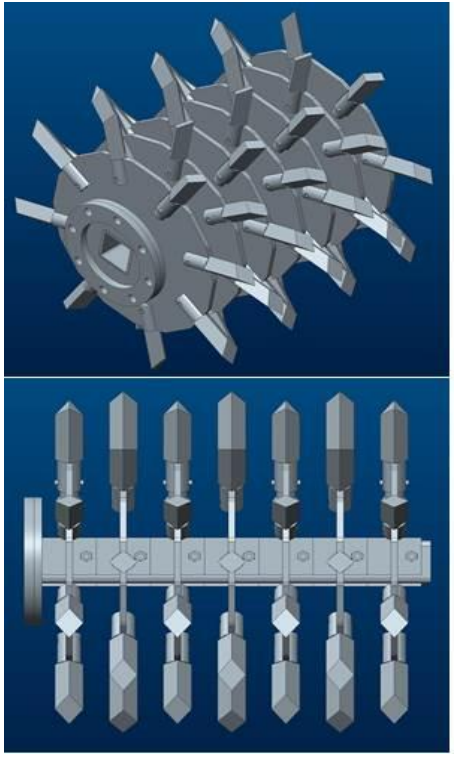
thooth packer tilt

advanced tool

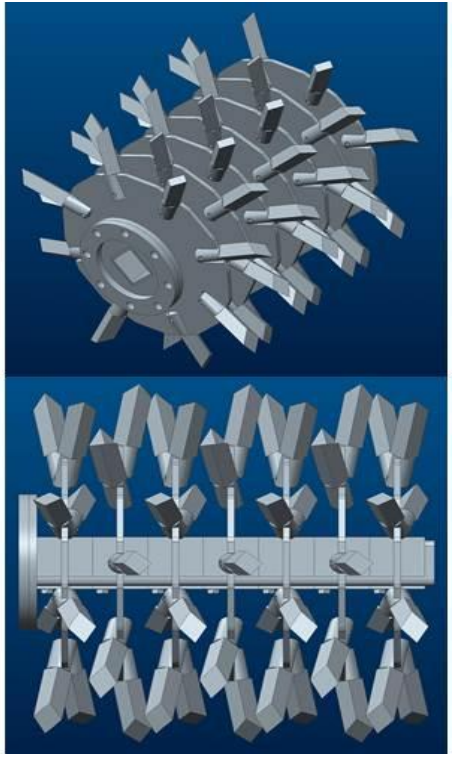
Characteristics for generating propulsion:

- outer diameter
- number of working elements
- slip

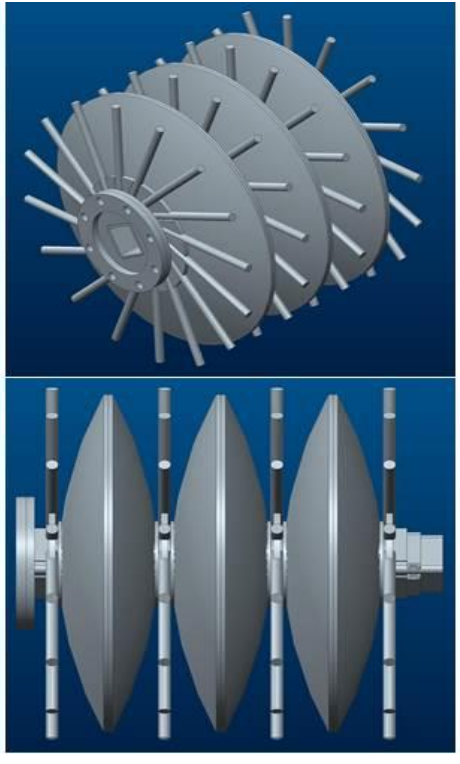
tools for tillage step 2



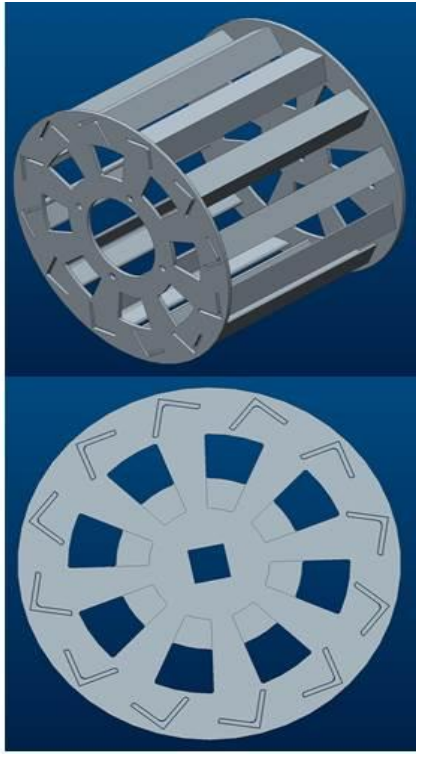
standard tine rotor



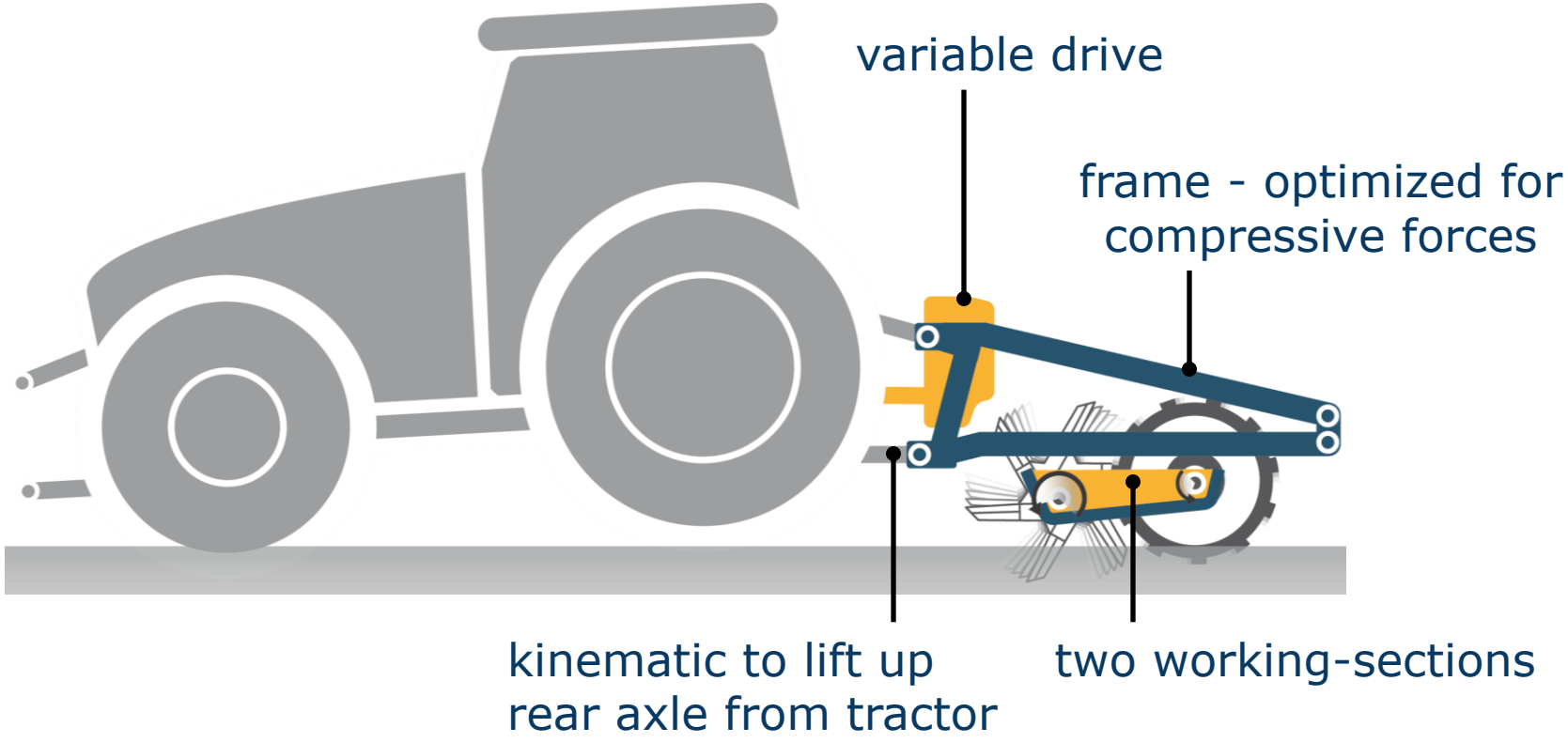
tilt tine rotor



passive-active-tool



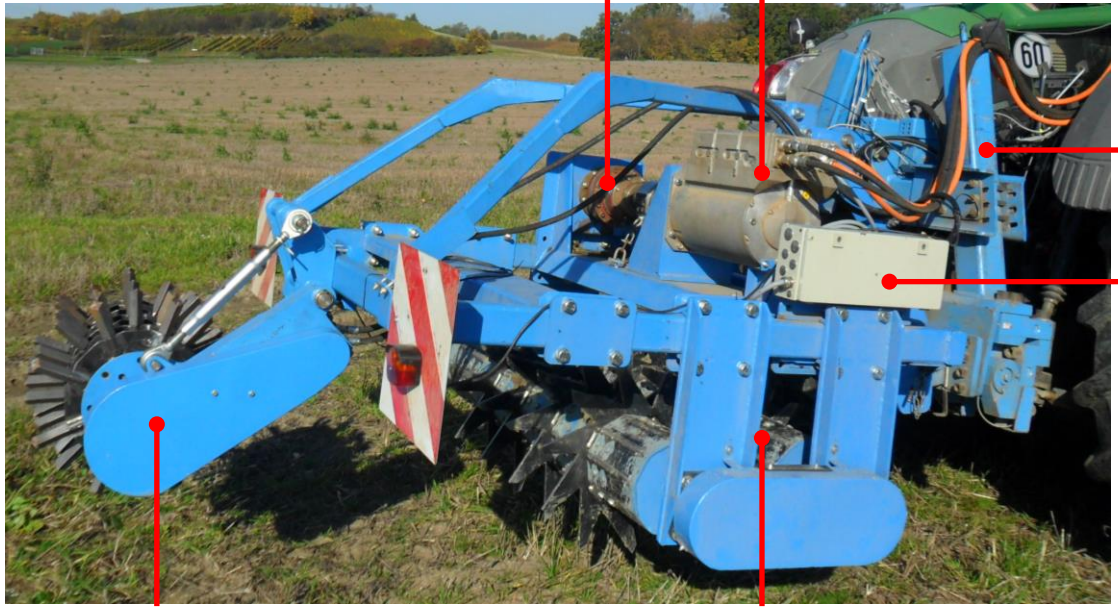
angle iron crumble roller


variable drive
frame - optimized for compressive forces
kinematic to lift up rear axle from tractor
two working-sections

Functional Prototype Machine

planetary gear & chain drive

electric drive (140 kW PMSM) with integrated inverter



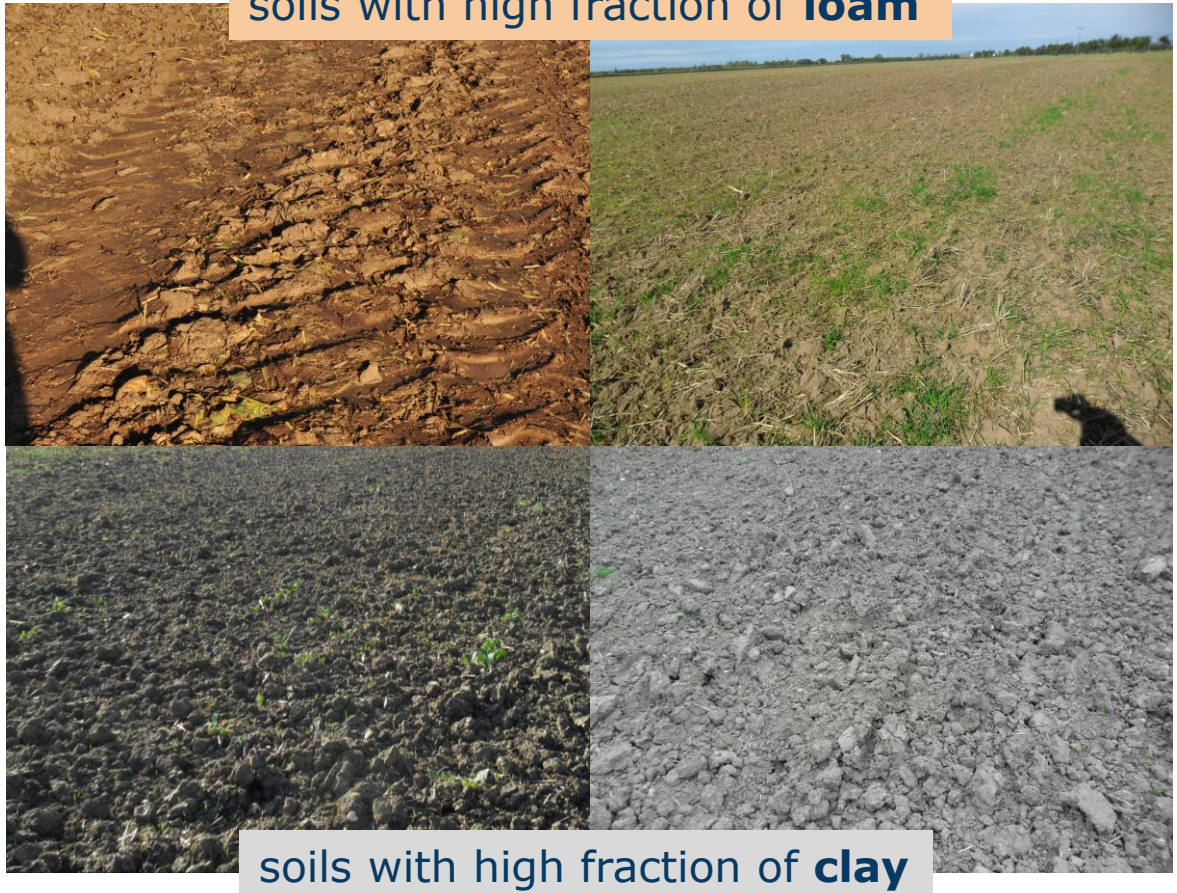
force measurement adapter with 6 DOF

ECU for motor control and ISOBUS

working-section 2 (0,5 m working width)

working-section 1 with double rotor (1 m working width)

soils with high fraction of **loam**

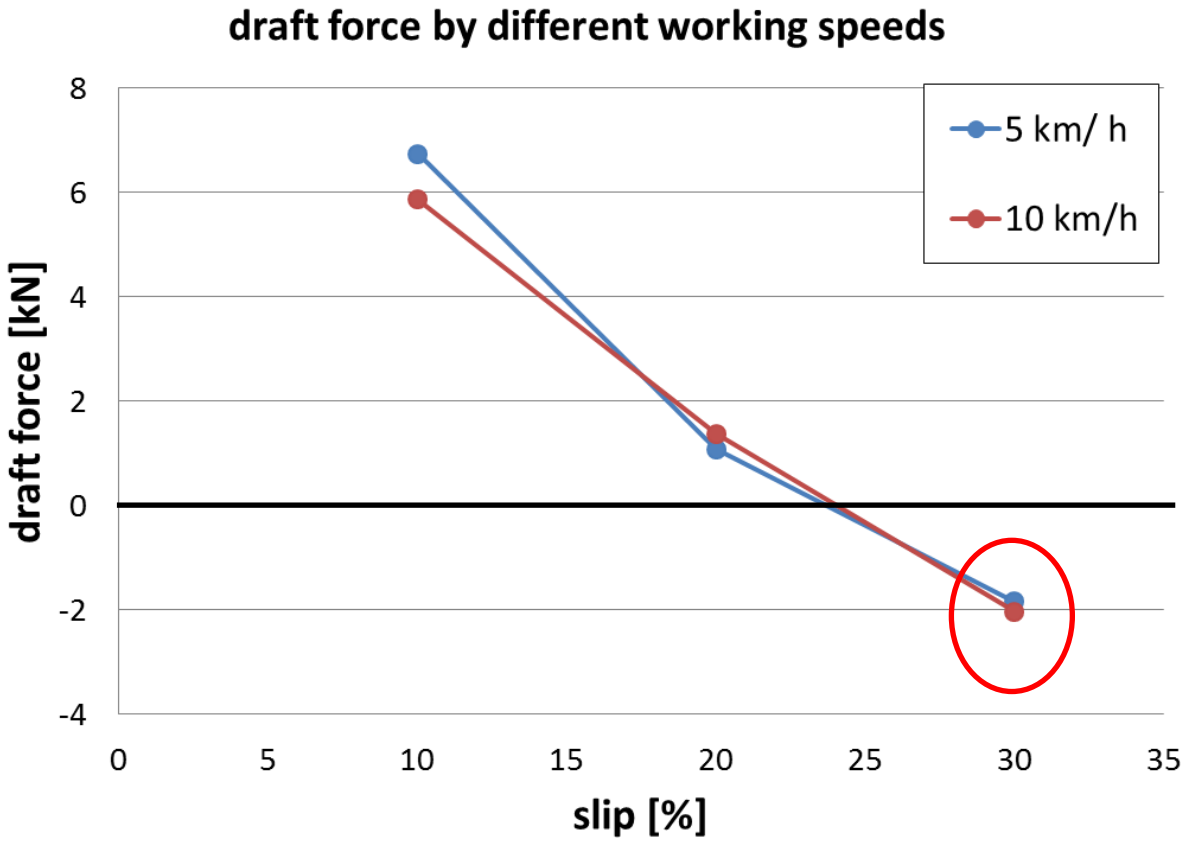


soils with high fraction of **clay**

test conditions:

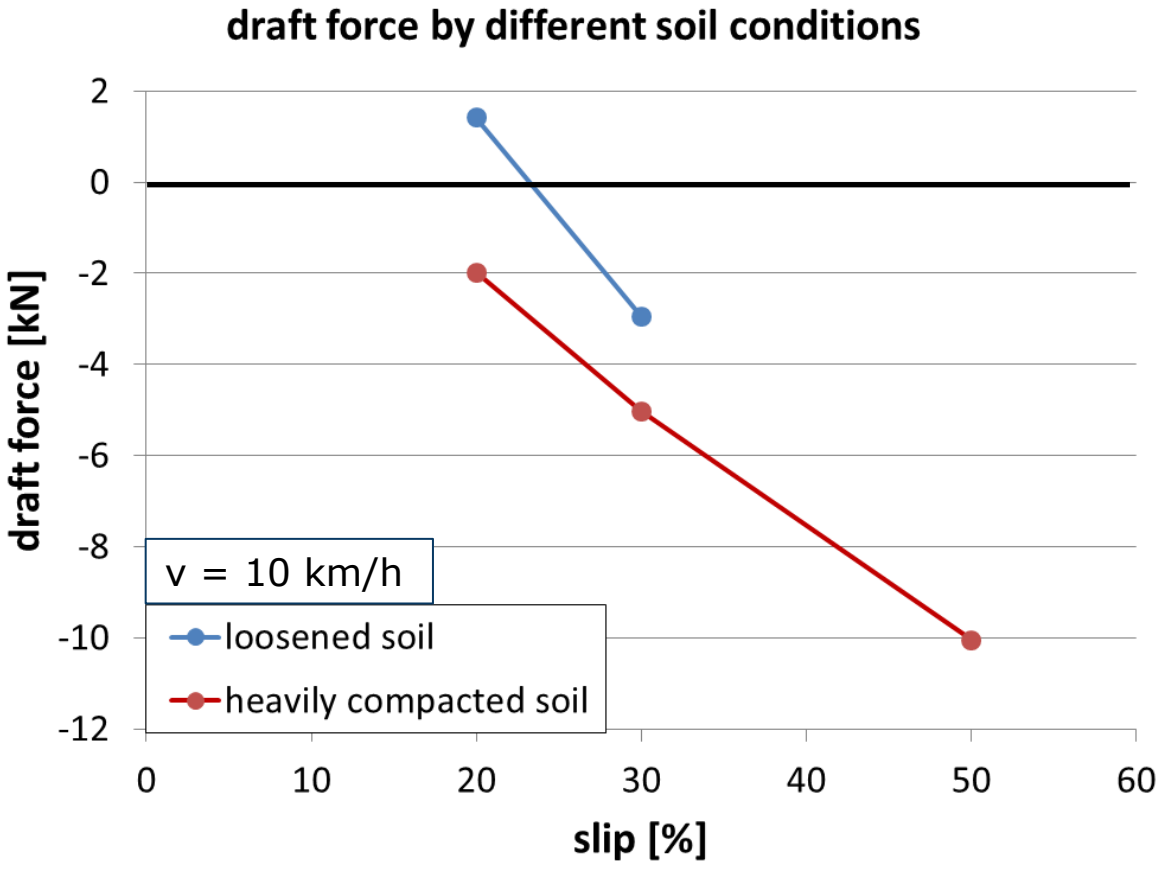
- very dry … wet
- loosened … compacted
- soils with previous tillage

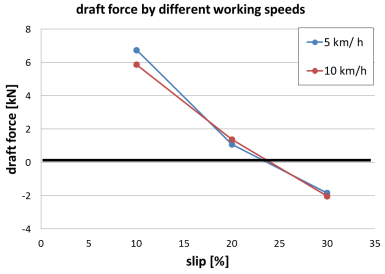
Field Tests Results

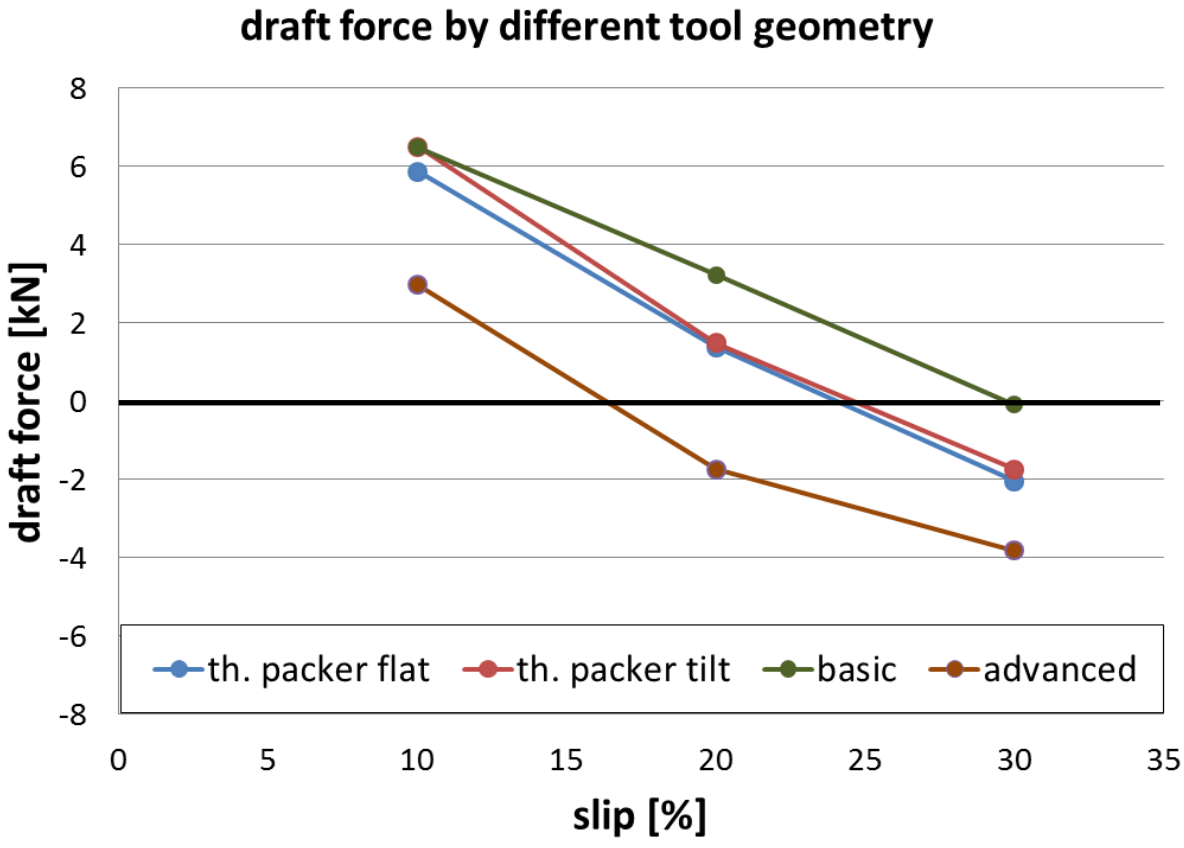


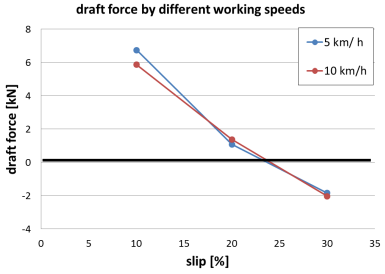
generation of
propelling force
(negative draft force)

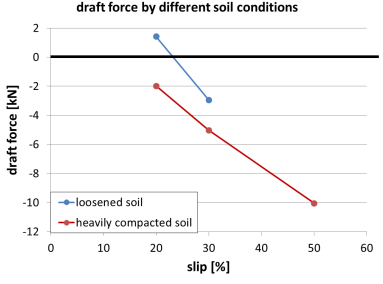
Field Tests Results

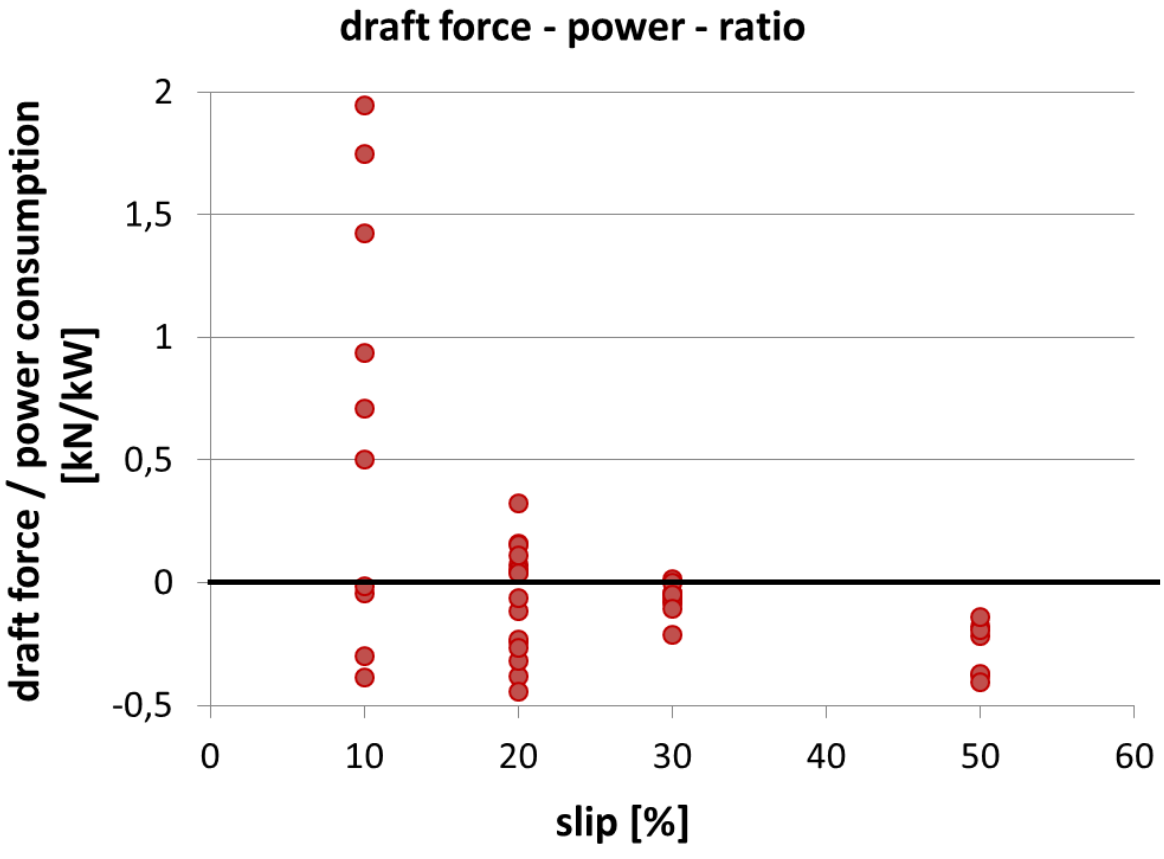


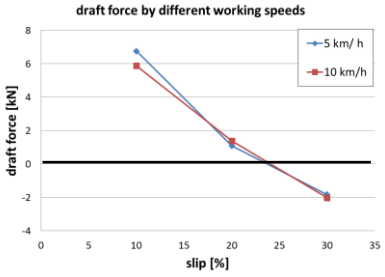


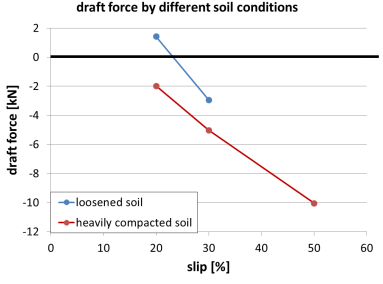

draft force by different tool geometry
draft force [kN]
8
6
4
2
0
-2
-4
-6
-8
0
5
10
15
20
25
30
35
slip [%]
th. packer flat
th. packer tilt
basic
advanced

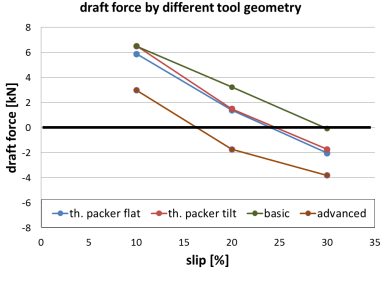

draft force by different working speeds
draft force [kN]
slip [%]
5 km/ h
10 km/h


draft force by different soil conditions
draft force [kN]
slip [%]
loosened soil
heavily compacted soil


draft force - power - ratio
draft force / power consumption [kN/kW]
2
1,5
1
0,5
0
-0,5
0
10
20
30
40
50
60
slip [%]


draft force by different working speeds
draft force [kN]
5 km/ h
10 km/h
slip [%]


draft force by different soil conditions
draft force [kN]
loosened soil
heavily compacted soil
slip [%]


draft force by different tool geometry
draft force [kN]
th. packer flat
th. packer tilt
basic
advanced
slip [%]

Field Tests Results

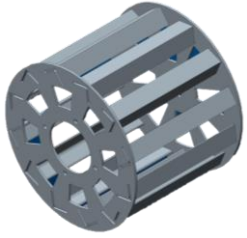
work result: −

work result: −

work result: O

work result: +

Field Tests Results



work result: O

work result: O

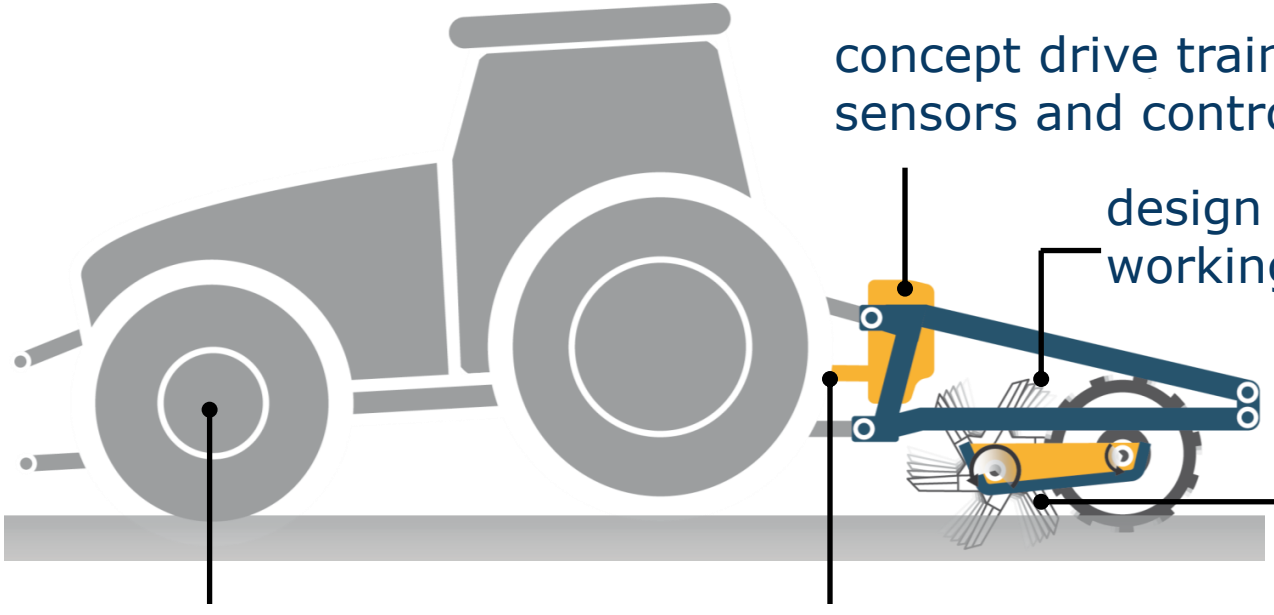
work result: +

work result: −

Conclusion

- heavy soils offer a good fertility, but tillage is “energy intensive”
- functional prototype machine at TU Dresden with working width of 1 m
- machine concept, tools and generation of propulsion verified
- propelling force depends on slip, soil condition and tool geometry
- higher slip ratios reduces draft force or even generate propelling forces

Next Steps



concept drive train, process sensors and control structures

design implement with working width 3 m

optimize working tools for compacted soils

develop steering concepts

design a construction for lift up rear axle tractor

Thank you for your Attention !