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Work productivity review of mechanical tree planting

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Introduction

- **Reforestation methods**: Natural regeneration or Artificial regenerations
- **Artificial regeneration**: Manual planting, Mechanical planting and aerial/or ground seeding
- **Mechanical planting** can be 10 times more productive than manual and higher survival rates up to 13%
- **Maximum slope:** 20%
- Rocks, rough surface, uncleared terrains, very wet/dry= Lower productivity

https://marketplace.carbonmarketinstitute.org/

https://www.fs.fed.us

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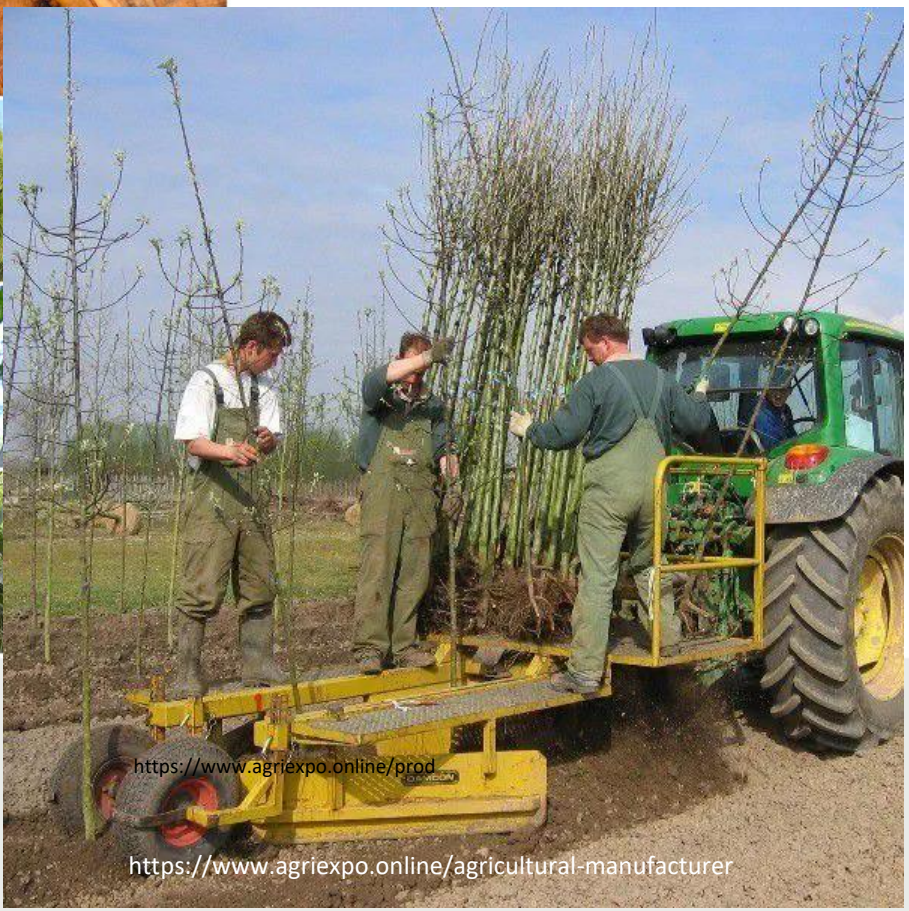
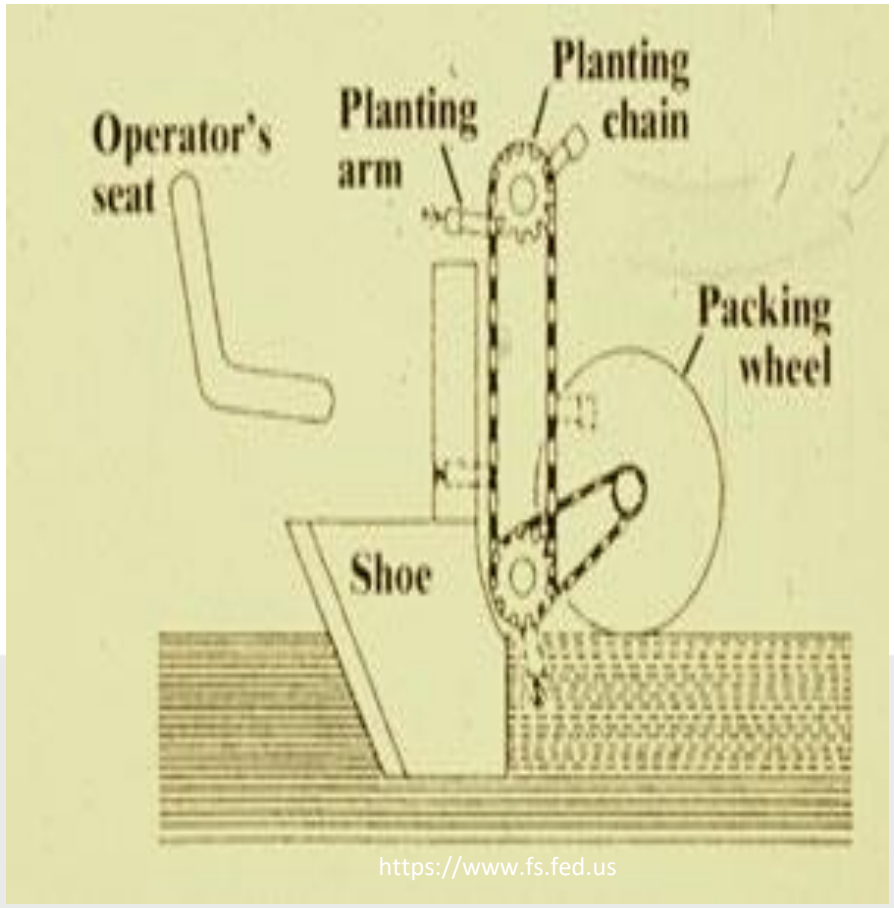
Types of planting machines

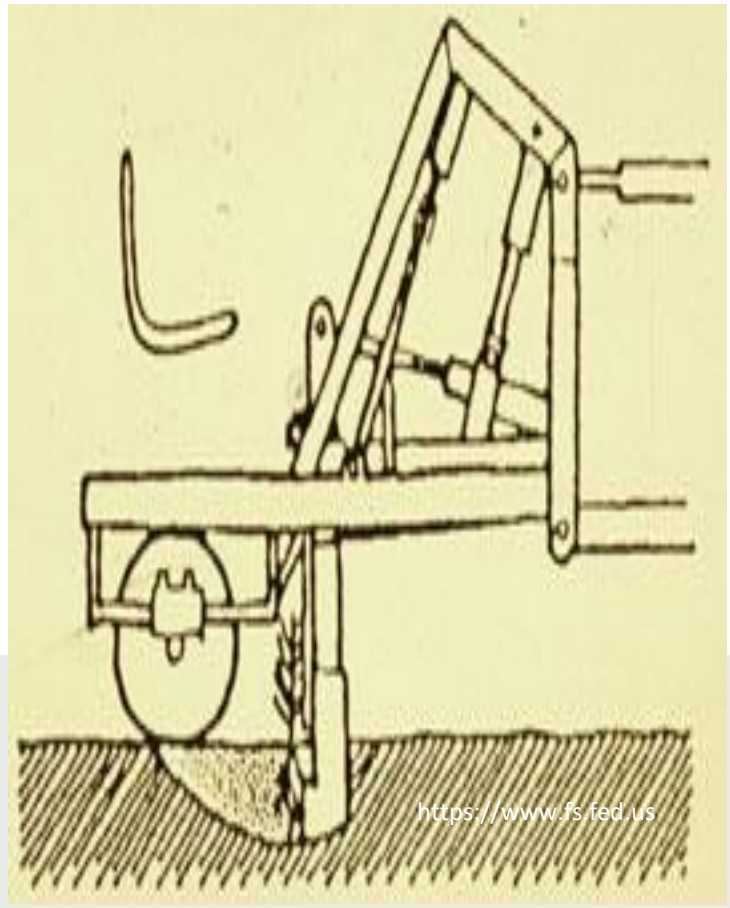
Bareroot planters



Continuous furrow planters



Intermittent planters



Work productivity

- **Productivity**: A ratio of some measure of output to some measure of input uses (Griliches, 1998)
- **Benefits of work study**: increasing work design, performance and continual work productivity improvement (Heinimann, 2021)
- **Need**: Utilising the mechanised planting more widely in order to reduce the costs and increase the productivity (Nilsson et al. 2010)

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M-planter in Finland

- **Seedlings**: Norway spruce
- **Variables**: stoniness, stumps, surface obstacles and humus layer

Higher number of stones and stumps and thicker humus layer ⟹ *Decreased productivity*

Rantala and Laine (2010)

Productivity (Seedlings/PMH_0): 143-169

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M-planter in Finland

- **Seedlings**: Norway spruce
- **Variables:** slash, slope, number of surface obstacles and stumps, stoniness and thickness of humus layer
- **Six operators** with four machines (no impact as all operators were experienced)
- **Quality**: acceptable
- **Planting density**: 1800 seedlings per ha

Laine and Rantala (2013)

Photo by Mikko Syri.

Productivity (Seedlings/PMH$_0$): 279-387

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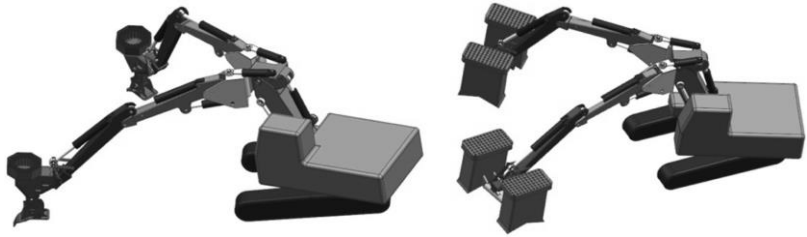
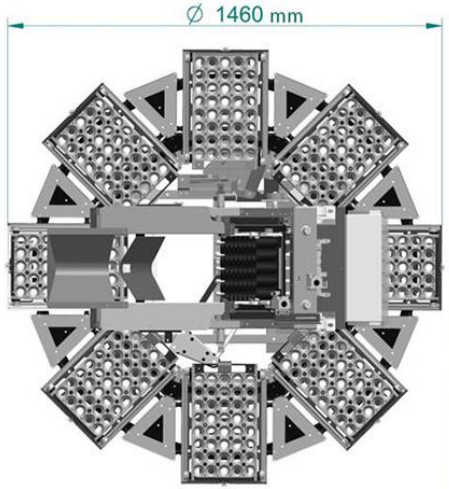
M-planter or Bracke in Sweden

- **Semi-automation technology:** provides better control and higher productivity.
- **Two-arms machines** more productive than single arm.
- Two-arms and four headed machines did NOT yield higher productivity.
- **Tray-wise seedling loading:** 9% higher productivity than piece-wise loading.

Productivity (Seedlings/PMH$_0$): 200-475



Errson et al. 2013



Errson et al. (2014)

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Bracke P11.a planter (and MTM1000) in Brazil

Guerro et al. 2019

- **Seedling**: Eucalypt (*E. grandis* × *E. urophylla*)
- **Variable**: Planting space

https://www.brackeforest.com/products

3m× 1m *Productivity (Seedlings/PMH$_0$): 355*
3m× 1.5m *Productivity (Seedlings/PMH$_0$): 324*

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Risutec tested in NSW/Australia

- **Seedlings**: Pine
- **Quickly replanting burnt forests**
- **Spot cultivation:** no need for site preparation.
- **Multiple tasks in one pass:** cultivation, planting and potential application of water and fertiliser.
- **Productivity**: N/A

https://www.farmweekly.com.au

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Conclusions

- Skilled operators and suitable work sites are key (Laine, 2017).
- Recovering the slash and stump can help increasing planting productivity (Laine and Rantala, 2013).
- Nurseries to provide quality seedling (suitable age and size) to ensure planting success (Laine and Rantala, 2013).
- Mechanized planting is widely used in clear-cuts. But it can also be more cost effective for selective cutting and retention forestry regime using watering and fertilizing capacities (Errson, 2014).

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Conclusions

- Higher carbon emissions and soil compaction by mechanized planting compared with manual (Ramantswana et al. 2020).
- Develop 3-headed planting device for rough terrain and various silvicultural regimes (Errson, 2014).
- Mental and physical strains of the operators (Laine, 2017).
- Integrating and optimising whole planting chain from nursery to planting (Laine, 2017).

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Thank you!

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