Mechanization of harvesting processes in Eucalyptus stands

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Forest situation in China

source: wikimedia, 2011; Turnbull, 200

Standing volume Ø 71,0 m³/ ha

- Northeast: Ø 84,4 m³/ ha
- Southwest: Ø 171,1 m³/ ha
- South: Ø 42,0 m³/ ha

Annual harvest (2005)

- 63,9 Mio m³

Esp. southern situation

- young forest stands
- low standing volume per ha
- strong board and pulp industry

Eucalyptus plantations in China

- Intensive establishment of *Eucalyptus* plantations in southern China since 1980th
- Today, plantations cover an area of 1.5 Mio. ha, equates in 13 % of world *Eucalyptus* plantations
- Strong variation between annual increment of the plantations: Ø 10 – 15 m³/ ha/ a
- In 2002 the harvested volume of Eucalyptus wood was 5,0 Mio m³ in 2002
  - equates 11,3 % of the annual cutting
  - compared to 7 % of the forest area
- Main product is round wood for pulp & paper industry

source: Bull, 1998; Qi, 2003; Turnbull, 2007; Xu et al., 2000; FAO, 2010

Framework of plantation forestry

Plantation forestry

- Is a basis for the national **pulp industry** and in future for **bioenergy** in China
- Must be internationally competitive regarding the
  - Biomass production
    (growth, genetic improvement, silviculture)
  - Productivity and cost of wood supply

- Harvesting operations are the most important cost element in plantation management (48 – 61 % of working time)
- **Benchmark: Brazil**
  - Biomass production: 30 m³/ ha/ a
  - Productivity of harvesting: 20 m³/ h

Actual situation of Eucalyptus harvesting in China

Felling

De-branching

Measuring logs

Cross cutting

Actual situation of Eucalyptus harvesting in China

Hauling

Hauling

Analysis of the actual harvesting process as a basis for improvements

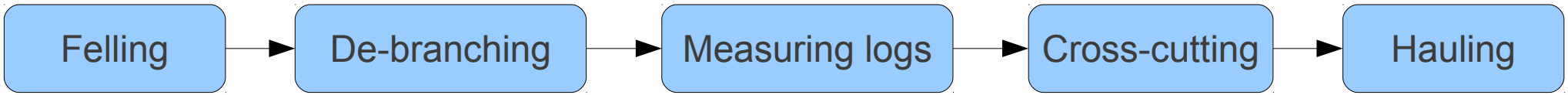
- Case study approach
- Experimental design
  - Plots of 40 x 10 m
  - 5 *Eucalyptus* stands, 18 plots
  - 3 *Mytilaria* stands, 8 plots

Analysis of the actual harvesting process as a basis for improvements

- Case study approach
- Experimental design
- Stand selection
  - Guangxi province, Pingxiang
  - Sub-/ tropical climate
  - Mean annual temperature 21,7 °C
  - Annual perception 1.385 mm
  - Red Soils, esp. Red – and Yellow Earth
  - Steep terrain; slope > 35 %

Analysis of the actual harvesting process as a basis for improvements

- Case study approach
- Experimental design
- Stand selection
- Systematic process description



Analysis of the actual harvesting process as a basis for improvements

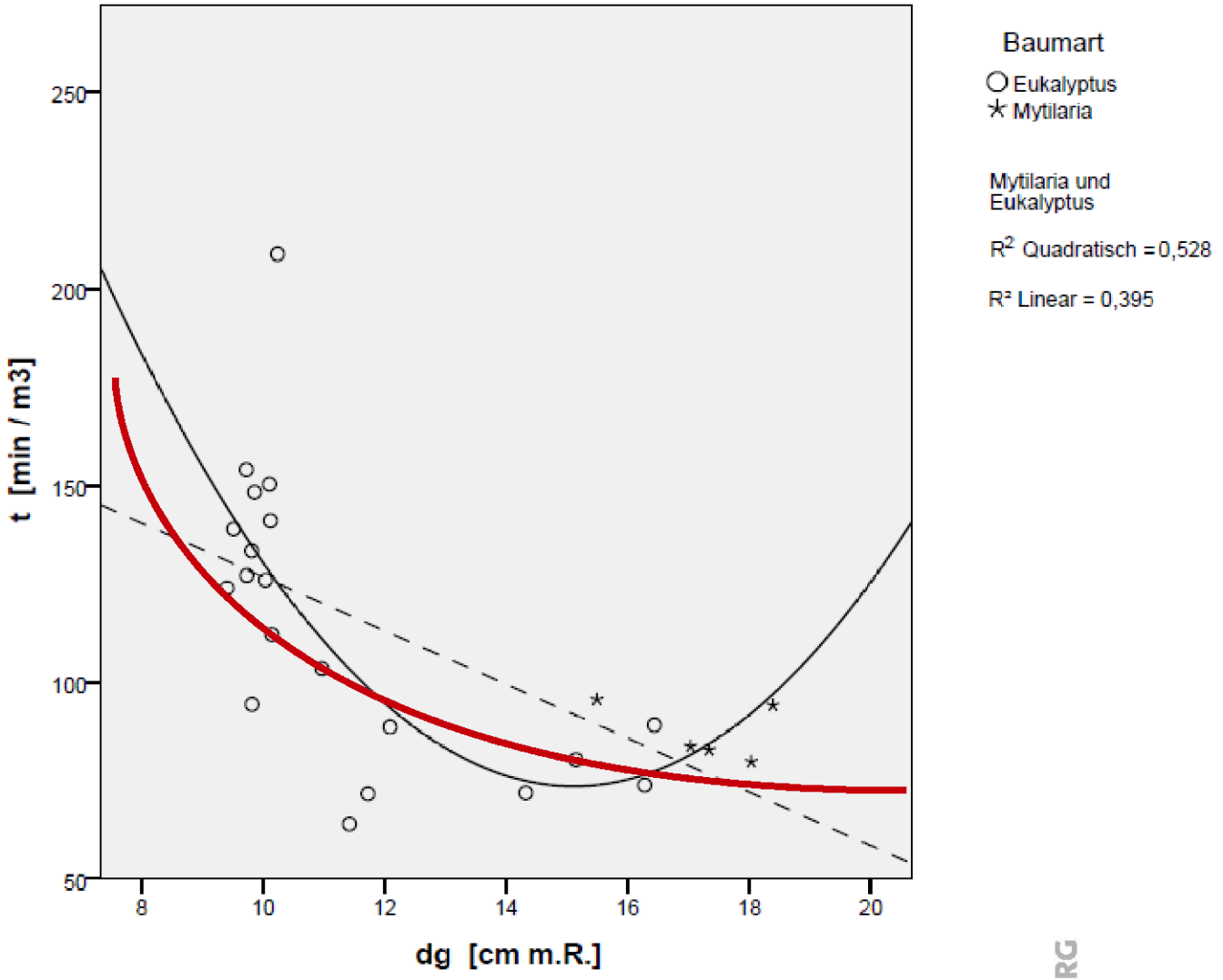
- Case study approach
- Experimental design
- Stand selection
- Systematic process description
- Observing time study
  - Using stop watch
  - 237,8 h of measurement

Analysis of the actual harvesting process as a basis for improvements

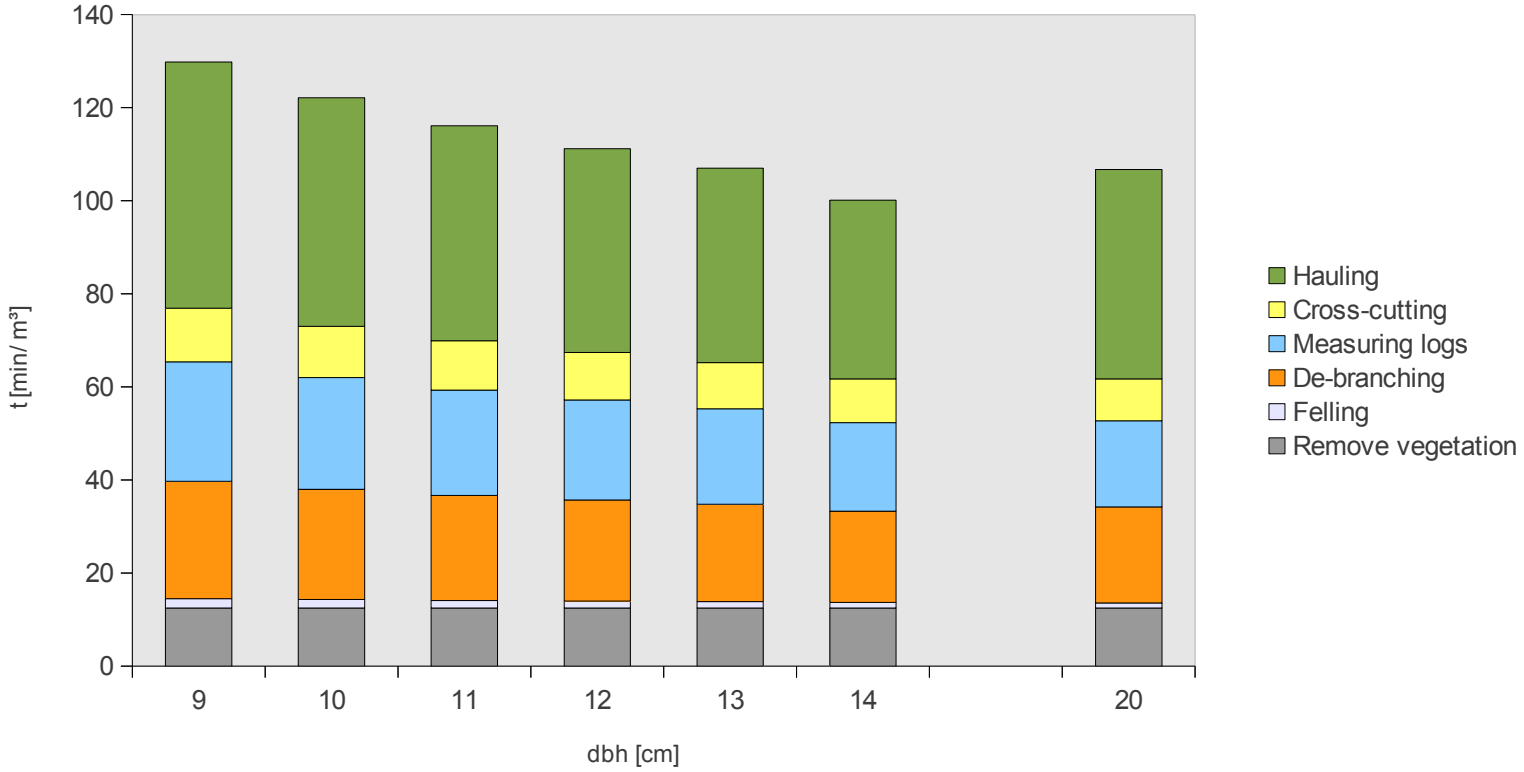
- Case study approach
- Experimental design
- Stand selection
- Systematic process description
- Observing time study
- Identification and measurement of influencing factors (independent variables)
- Productivity functions

Results: Time consumption per harvested m3, related to tree dimension

- Expected decrease in time consumption with increasing dbh/ tree volume (red line)
- Measured time consumption proposed this for small dbh's (black line)
- Time consumption is increasing again for big dbh's (black line)



Results: Working steps for harvesting



- Time consumption for hauling is increasing again, for big tree diameter (based on calculations)
- All other working steps remain the same or slightly decrease, with increasing tree diameter (dbh)

Conclusions

- Motor-manual harvesting is highly time demanding
- Harvesting productivity is low (about 0.4 m^3/ h)
- Possible improvements of productivity and cost could result from
  - Denied harvesting in stands with very small tree dimensions (< 10 cm)
    - ➔ Aim to grow bigger trees
      - Planting less tress per hectare (or early thinning) and/ or longer rotations
      - Genetic improvement
    - ➔ Mechanization of harvesting
      - priority in stands with bigger tree dimensions (> 16 cm)

Mechanization in forest plantations

Advantages and challenges of mechanized harvesting systems

+ Low safety risk
+ Mental instead of physical strain
+ High productivity
+ (Less) weather dependent
+ No limitations in tree size

- Very steep terrain/ soft soils difficult
- High investment and machine cost of operation
- Ecological “footprint”
- Less job opportunities (but qualified)
- Organizational requirements

Social effects of mechanized harvesting

- Manual harvesting provides much more labor work to local people, but in most cases unskilled labor, low salary and only on a seasonal basis
- Manual harvesting could be a 'second job'
- Manual harvesting is a 'community' work
- Mechanized harvesting systems offer few, but permanent jobs, with high qualification and payment of machine operator

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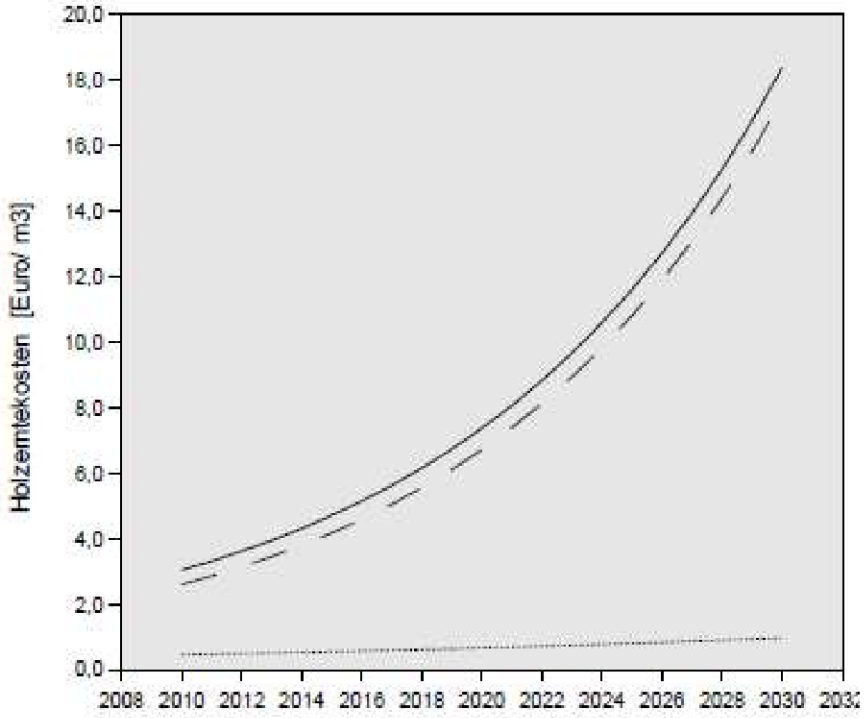
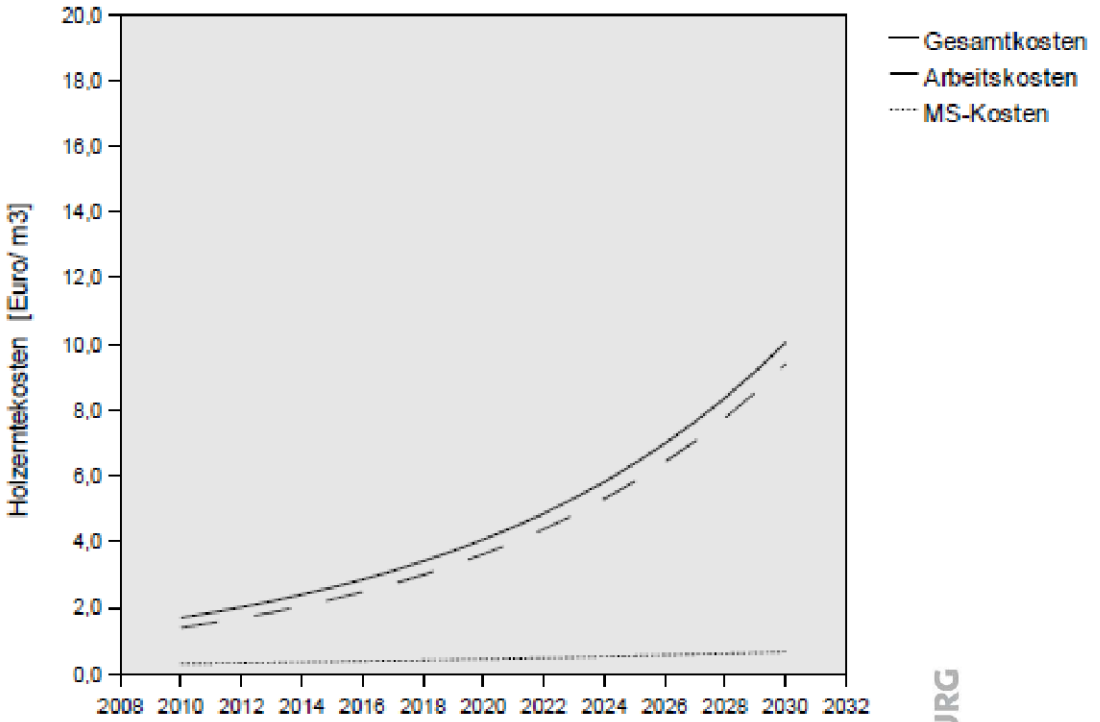
Perspectives for mechanized harvesting

- With increasing wage levels and a lack of people who are willing to work in the forest, the cost manual labor may increase drastically in the future
- To remain competitive, forest enterprises could implement higher mechanized operations on a broad scale

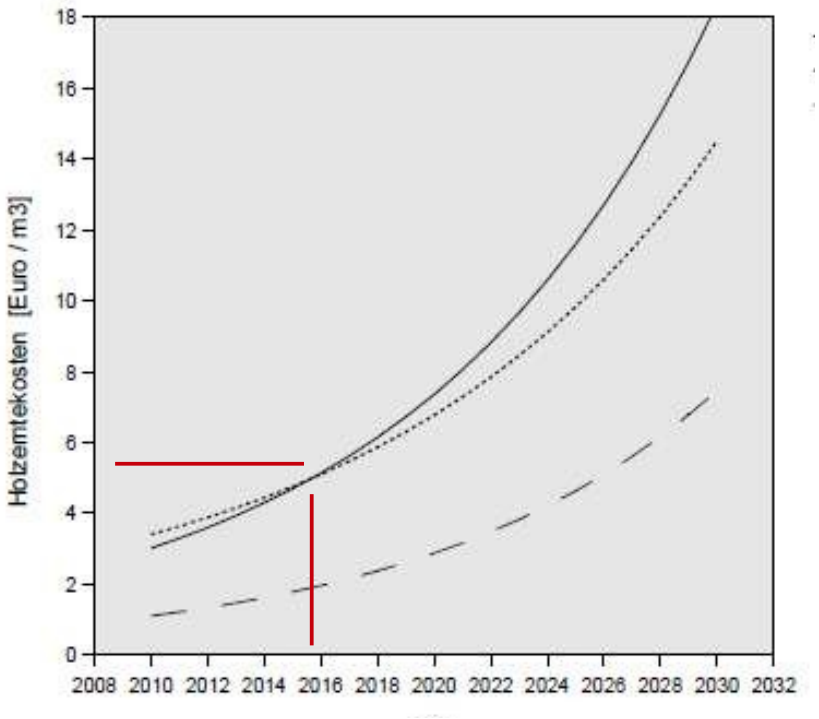


dbh = 9 cm

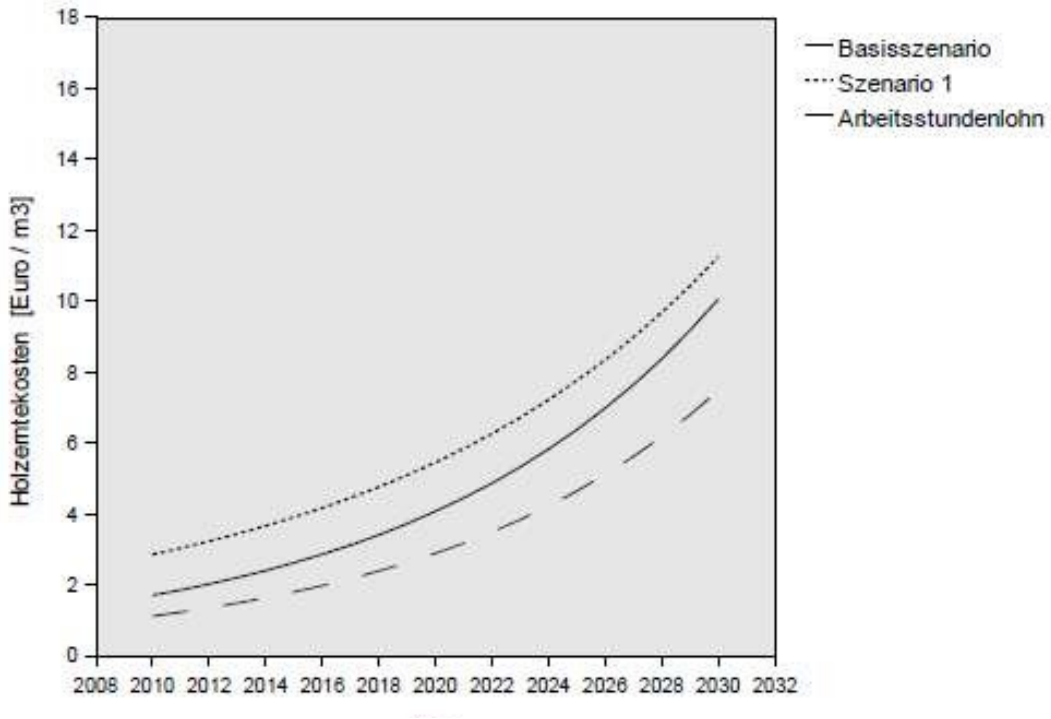


dbh = 16 cm

Perspectives for mechanized harvesting



dbh = 9 cm



dbh = 16 cm

- Mechanization of 'hauling' for small tree diameter (9 cm) is already today economically attractive
- For bigger tree diameter (16 cm), manual hauling is cheaper within the next years

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