

WORK ECONOMICAL ANALYSIS OF THE HARVEST OF MISCANTHUS

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XXXIV CIOSTA CIGR V Conference 2011
Efficient and safe production processes in sustainable agriculture and forestry
June 30th, 2011, Vienna - Austria

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Overview

- **Introduction**
- **Material and Methods**
- **Results of time studies**
- **Results of model calculations**
- **Conclusions**

Introduction - Miscanthus

- **Perennial crop growing up to 20 years.**
- **Harvested annually starting up from the second growing season**
- **Harvest end of March or in April (dry matter content higher than 85%)**
- **Used for fuel, horse bedding**

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Materials and methods

- Analysed procedures
  - Procedure 1: Harvesting as bulk chopped material

Materials and methods

- Analysed procedures
  - Procedure 2: Two-phase harvest with forage harvester and square baler

Materials and methods

- Analysed operations
  - Harvesting (chopping by the forage harvester, baling of the chopped material)
  - Transport including loading and unloading (transport of the chopped material respectively of the square bales)
  - Storage
- Time studies
  - All operations were divided into parts of an operation
  - Time measurement: Ortim a3
  - Influence factors for parts of an operation were evaluated (e. g. distance, masses, yield, water content, bulk density, grit size, loading space, speed)

- Statistical evaluation of time studies: ORTIMzeit Professional and SPSS 17.0.
- Model calculations were done based on determined times

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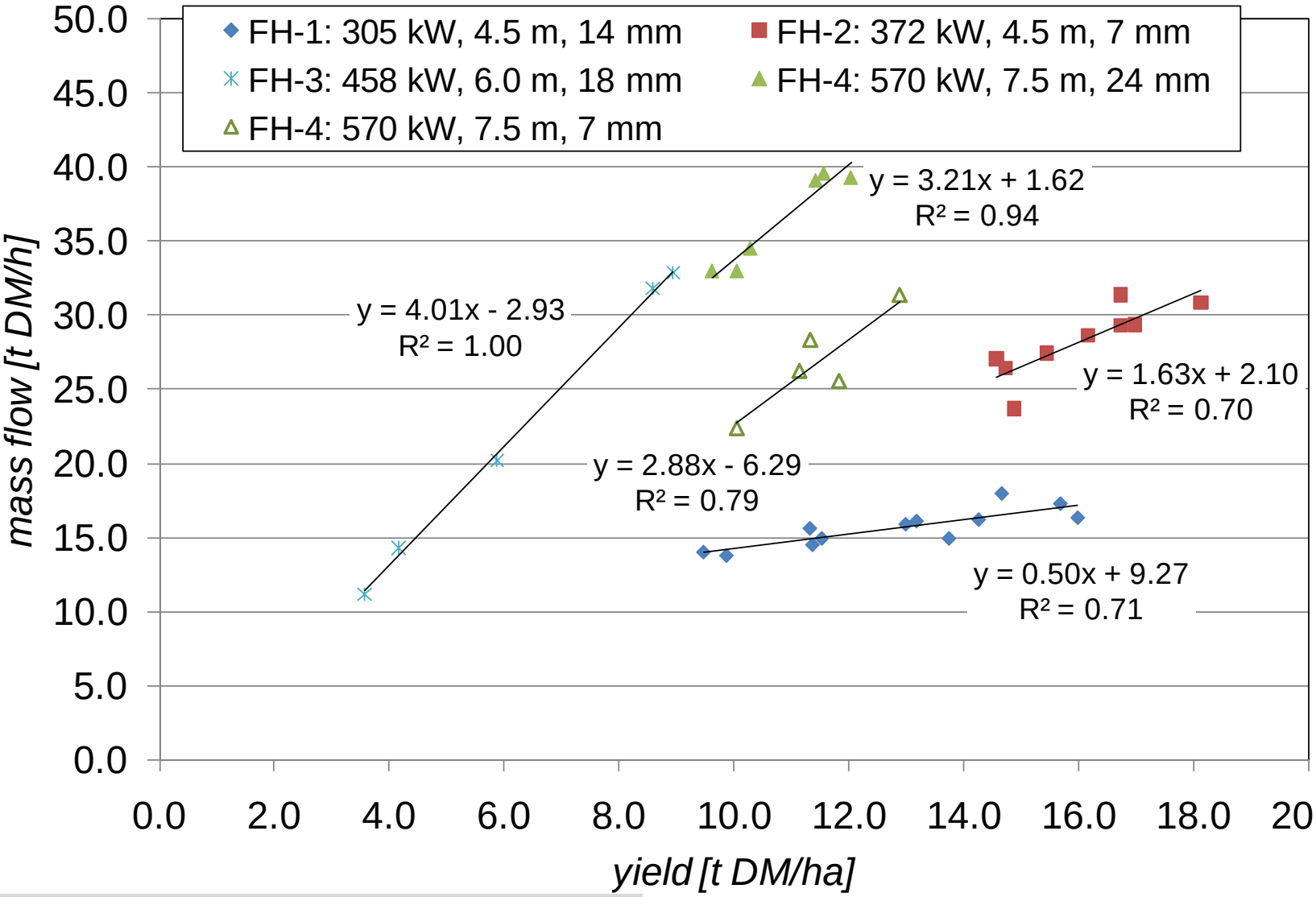
Procedure 1: Harvesting as bulk chopped material

- Parts of the operation of the forage harvester
  - Chopping
  - Turning on the headland
  - Changing the transport vehicles
  - Set-up and shut-down operations when arriving and leaving the field
  - Malfunction periods

Procedure 1: Harvesting as bulk chopped material



Mass flow related to effective chopping time

Laid miscanthus

- Caused by high nitrogen supply or snow
- Laid miscanthus causes obstruction at the header
- Effect on working time
  - Average time for removing an obstruction 0.48 min
  - For 90 % of the cases the value lies within 0.11 and 1.18 min
  - For strongly laid miscanthus after a chopping distance of every 70 m obstructions occurred on average.
  - Generally the driver of the forage harvester was not forced to leave the cab for removing the obstruction.
  - Usually obstructions are removed by driving shortly backwards and starting again.

Dust formation

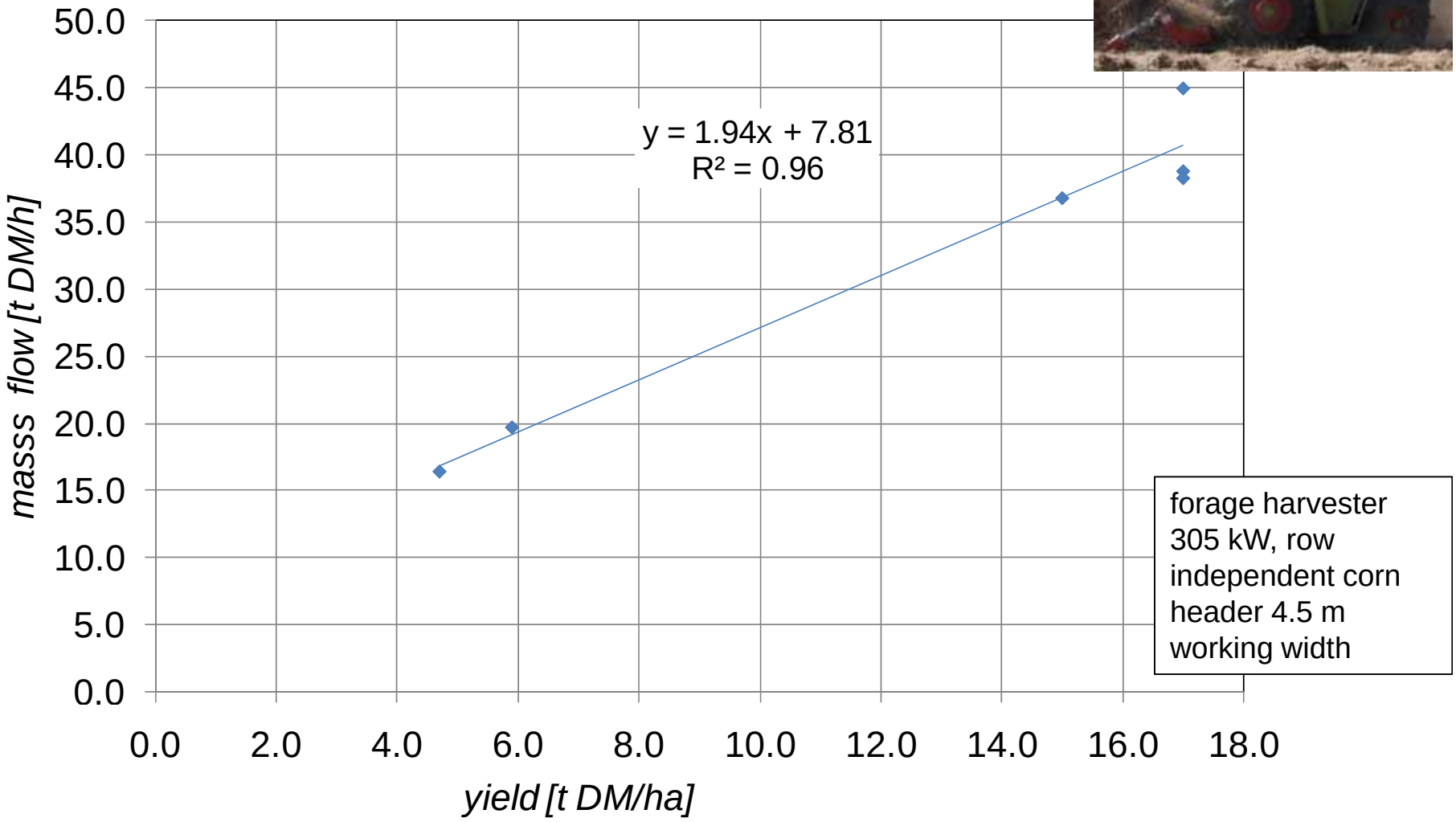
- Dust caused by the dry crop
- Additional time for maintenance occurs
- The cooler of the forage harvester had to be cleaned every 0.48 ha on average
- Average time requirement 2.06 min
- In 90% of the cases the value ranged between 1.06 and 3.65 min.

Procedure 2: : Two-phase harvest

Forage harvester and square baler

- Parts of the operation of the forage harvester
  - Chopping
  - Turning on the headland
  - Set-up and shut-down operations when arriving and leaving the field
  - Malfunction periods

Procedure 2: Chopping with open drum bottom



forage harvester 305 kW, row independent corn header 4.5 m working width

Mass flow related to effective chopping time

Procedure 2: : Two-phase harvest

Forage harvester and square baler

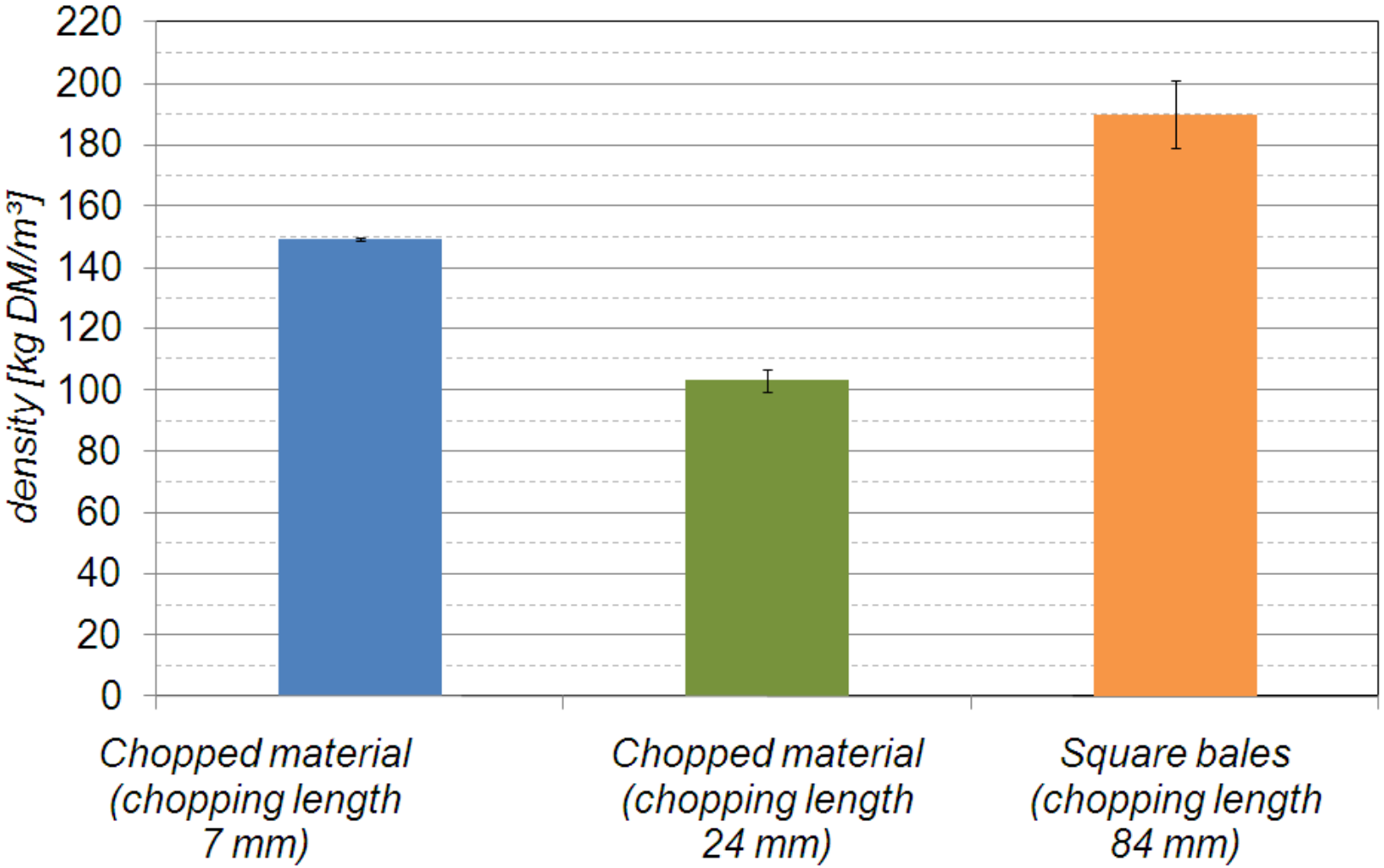
- Parts of the operation of the square baler
  - Baling
  - Turning on the headland
  - Set-up and shut-down operations when arriving and leaving the field
  - Malfunction periods

Procedure 2: Baling of chopped miscanthus

tractor 190 kW, bale width 120 cm, bale height 90 cm, bale length 220 cm

Mass flow related to effective baling time

Density of chopped material and bales



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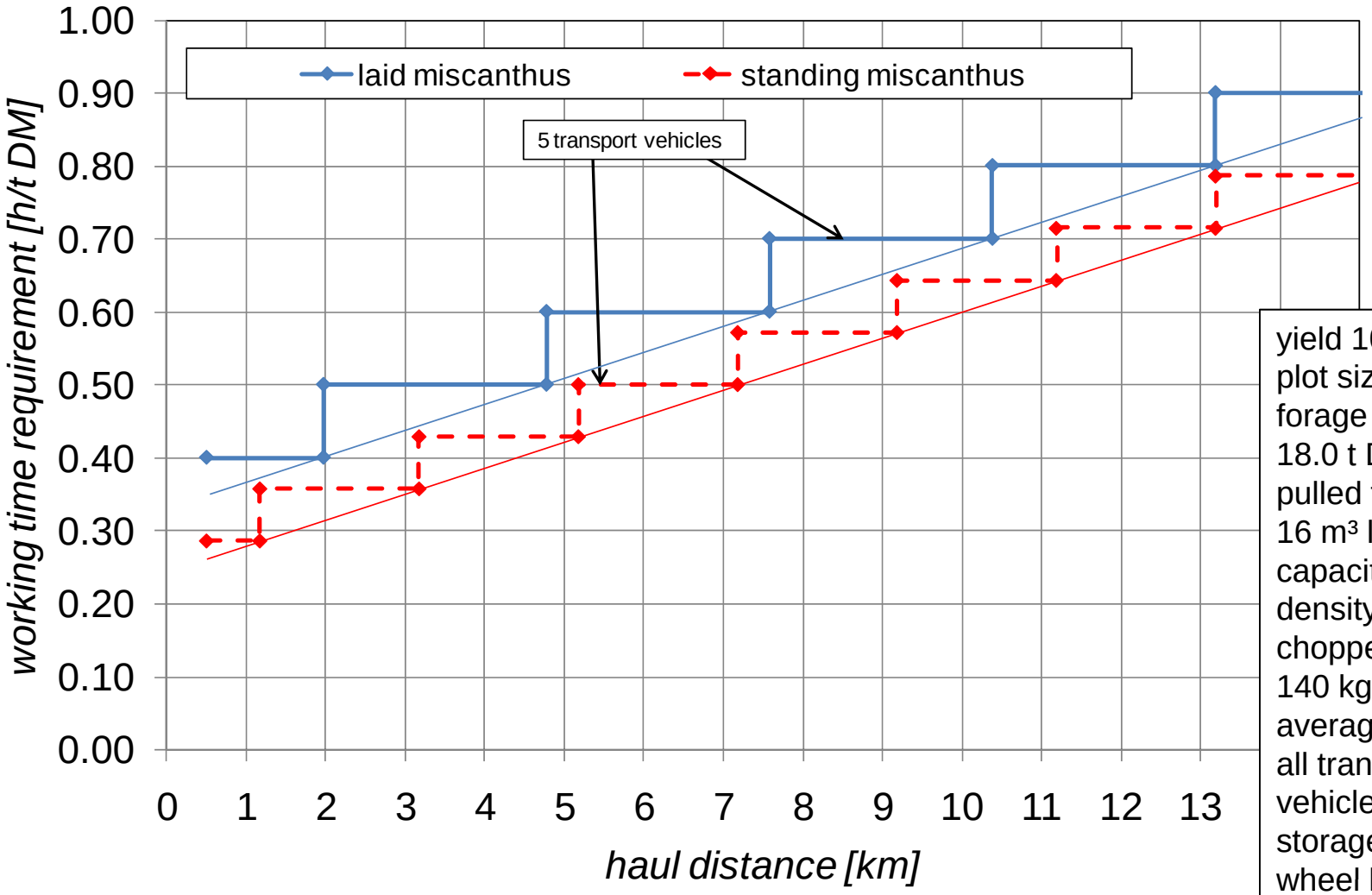
Model calculations

- The following model calculations includes the working time requirement of the
  - forage harvester
  - square baler (procedure 2)
  - transport vehicles
  - loader

Working time for harvesting as bulk chopped material

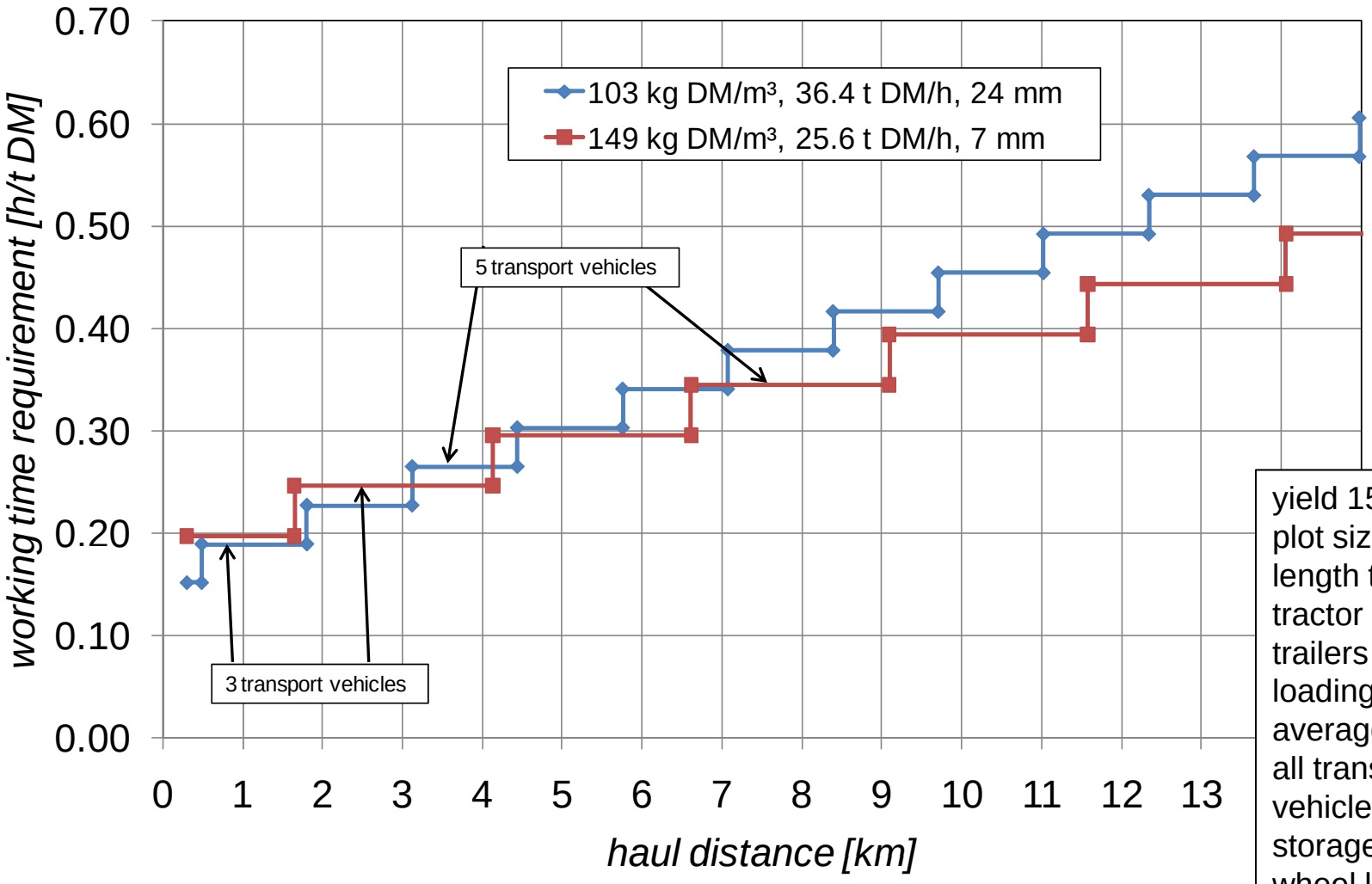
Procedure 1



yield 10 t DM/ha, plot size 3 ha, forage harvester 18.0 t DM/h, tractor pulled trailers with 16 m³ loading capacity, bulk density of the chopped material 140 kg DM/m³, average speed of all transport vehicles 25 km/h; storage with a wheel loader

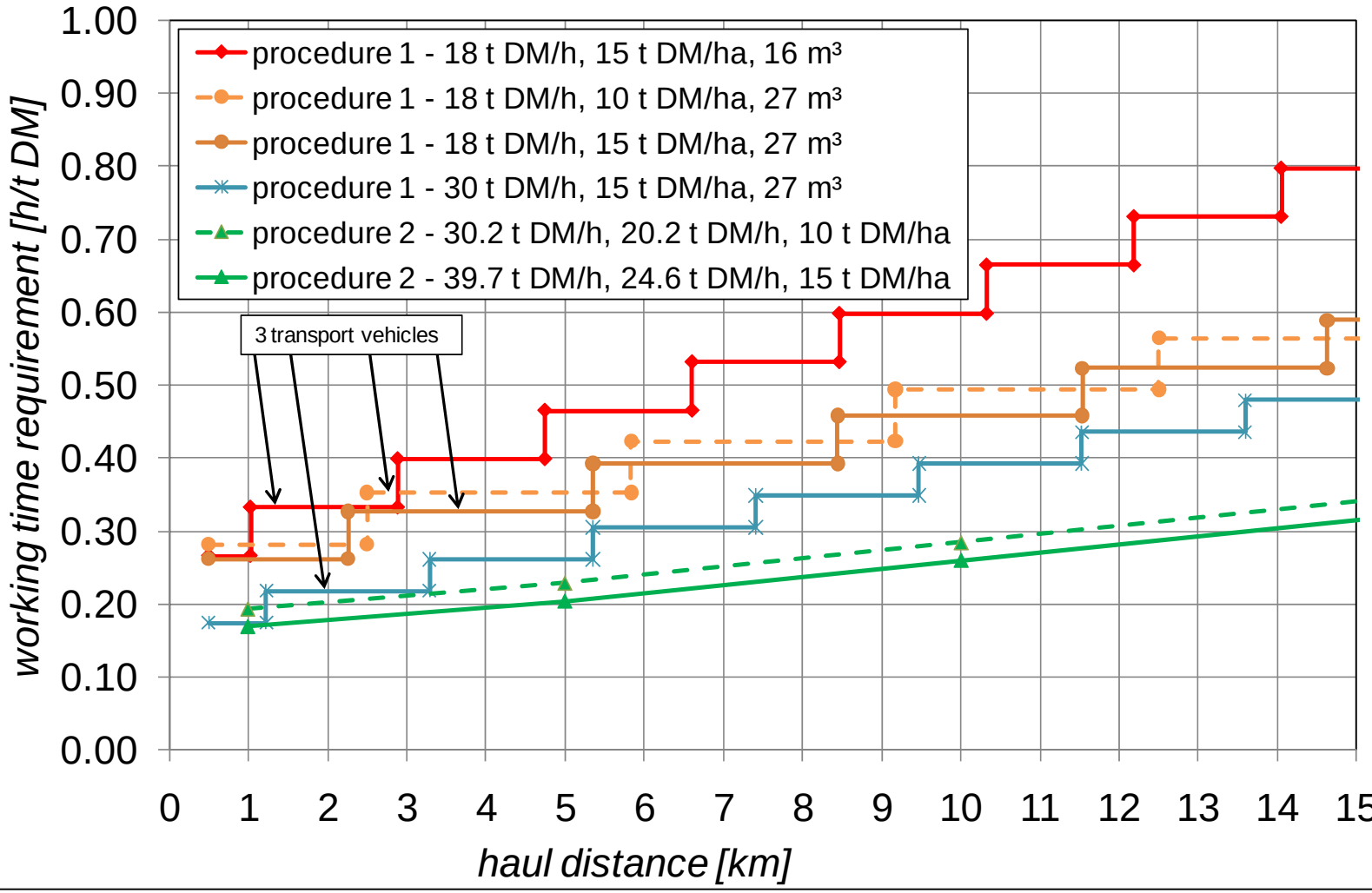
Working time for harvesting as bulk chopped material

Procedure 1



yield 15 t DM/ha; plot size 3 ha, ratio length to width: 3:1, tractor pulled trailers with 27 m³ loading capacity, average speed of all transport vehicles 25 km/h; storage with a wheel loader

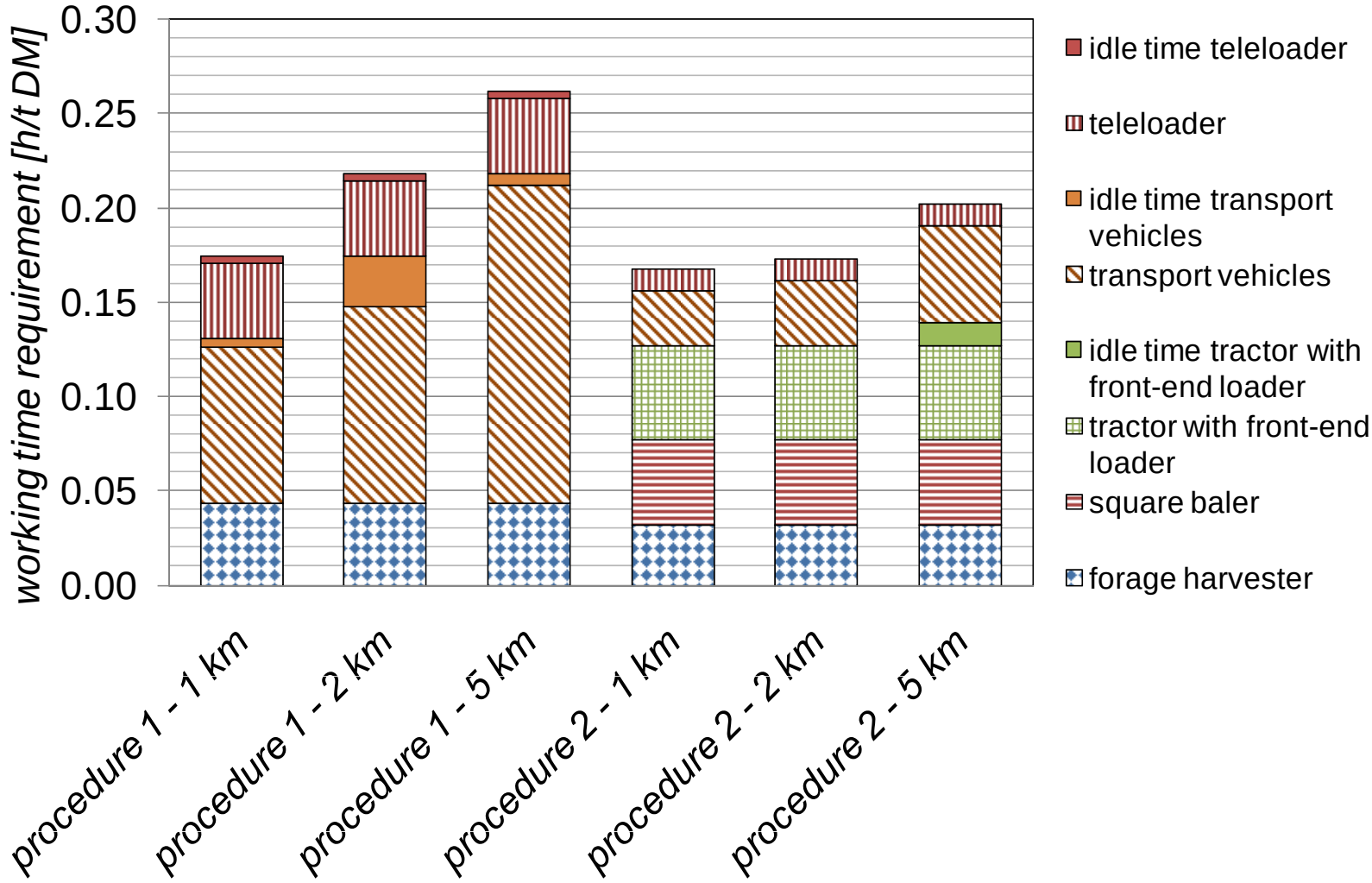
Working time for harvesting



plot size 3 ha, ratio length to width: 3:1, average speed of all transport vehicles 25 km/h; procedure 1: bulk density of the chopped material 140 kg DM/m³, storage with a teleloader; procedure 2: bale density 230 kg DM/m³, bale width 120 cm, bale height 90 cm, bale length 240 cm, 24 bales per trailer, loading the bales with a tractor mounted front-end loader, unloading and storage with a teleloader

Working time for harvesting

procedure 1 - 30 t DM/h, 15 t DM/ha, 27 m³
procedure 2 - 39.7 t DM/h, 24.6 t DM/h, 15 t DM/ha



Conclusions

- Chopping length significantly influences the mass flow through the forage harvester and the bulk density of the chopped material
- Increasing the driving speed when the yield is decreasing is mostly not possible due to problems arising with the crop flow at the row-independent corn header ➔ Yield influences the mass flow through the forage harvester
- The opened drum bottom and the higher theoretical chopping length in the second procedure allow a significant higher mean mass flow through the forage harvester (up to 45.0 t DM/h)
- The mass flow through the square baler depends on the mass of the swath. At a swath mass of the chopped material of 5.9 kg DM/m, the mean mass flow amounts 24.0 t DM/h

Conclusions

- Depending on the adjustment of the square baler and at a theoretical chopping length of 84 mm, the density of the square bales ranges from 165 kg DM/m³ to 233 kg DM/m³.
- According to model calculations harvesting miscanthus as bulk chopped material causes the lowest working time requirement (h/t DM) for chopping, transport and put into storage at haul distances up to 1.2 km, when using trailers with a loading capacity of 27 m³.
- For larger haul distances the procedure 2 is more effective.

Are there any questions?