

# Physical work load during driving agricultural vehicles

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# Introduction

- More and more agricultural work is done by driving meanwhile various types of vehicles have become common on farms.
  - Increasing number of working hours by using vehicles, unvaried work load and vibrations
  - Being exposed to whole body vibration while sitting in a twisted posture increases the risk of back injury; the risk will be increased when a person is exposed to these two factors at the same time.
- Two thirds of farmers have had back disorders during previous 12 months
  - In tractor driving the rotation of the back commonly exceeds the normal area of operation
  - Whole body vibration is strongly associated with back disorders - the typical range of vibration values for common farm tractors on the EU market commonly exceed a daily exposure action value and occasionally a daily exposure limit value, too



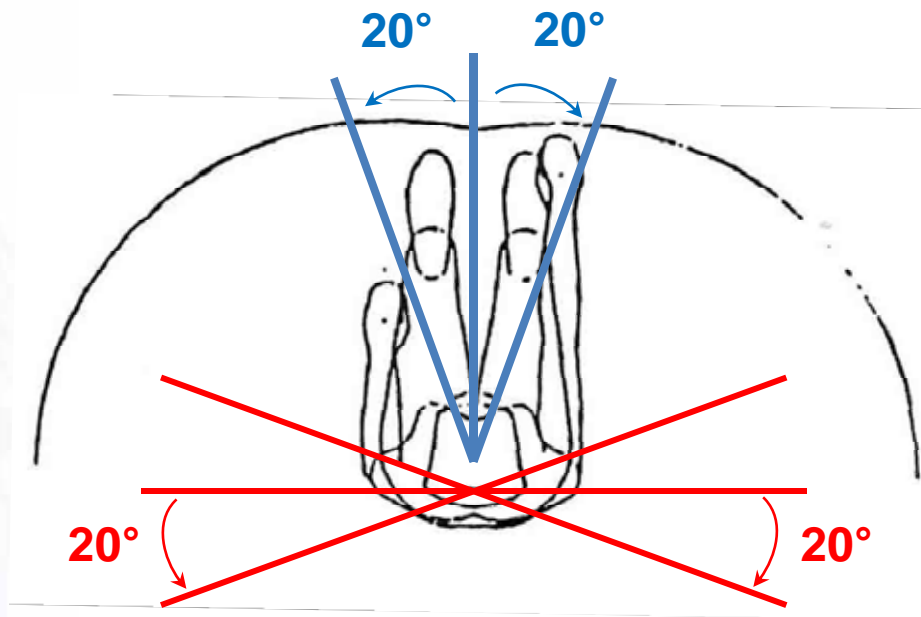
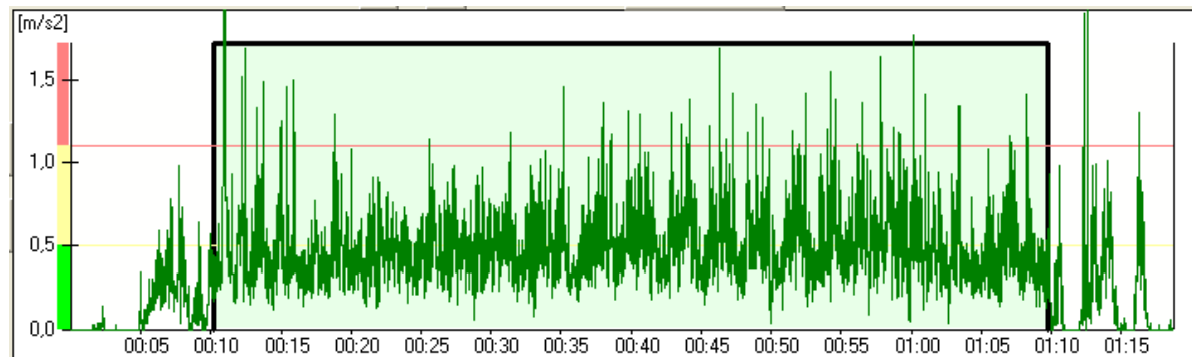


Photo: Mela



- Daily exposure action value of  $0.5 \text{ m/s}^2$
- Daily exposure limit value of  $1.15 \text{ m/s}^2$



# Aims of the study

- To find out physical work load caused by working postures and whole body vibration during driving various types of agricultural vehicles in different kind of tasks.
- To determine the numbers of working hours with various vehicles on farms.
- To gather technical solutions and advisable driving techniques to decrease the physical work load for choosing and using farm vehicles.

In this paper the focus is on working postures and whole body vibration during field operations – silage and crop harvesting – carried out by farm tractors and combine harvesters.



# Material and Methods

- Measurements on six middle-size or large farms with versatile machinery: three cattle farms and three crop farms.
  - Working postures and whole body vibration are determined during the most essential tasks on each farm:
    - Feeding, manure removing, silage harvesting
    - Harrowing, spraying, crop harvesting
- The amount of machine work on each farm calculated by using TTS-Manager programme (Kaila and Tuure 2005) based on standard times in agriculture.
- Technical solutions and advisable driving techniques to decrease the physical work load for choosing and using farm vehicles gathered in literature analysis.





## Machinery in silage harvesting



# Machinery in crop harvesting





# Measurements

**Twisted and bent postures of back and head:** by applying OWAS method (*Ovako Working Posture Analysing System*)

- video recording / still camera (photo every fifth second during a recording period)

**Whole body vibration:** measured by the wireless HealthVib® WBV measurement system

⇒ vibration dose and the dominating direction of vibration by the measuring period

**Driving speed and distance:** small-sized GPS data logger (Ventus® G730)

⇒ driving speed during operations and moving

⇒ distance



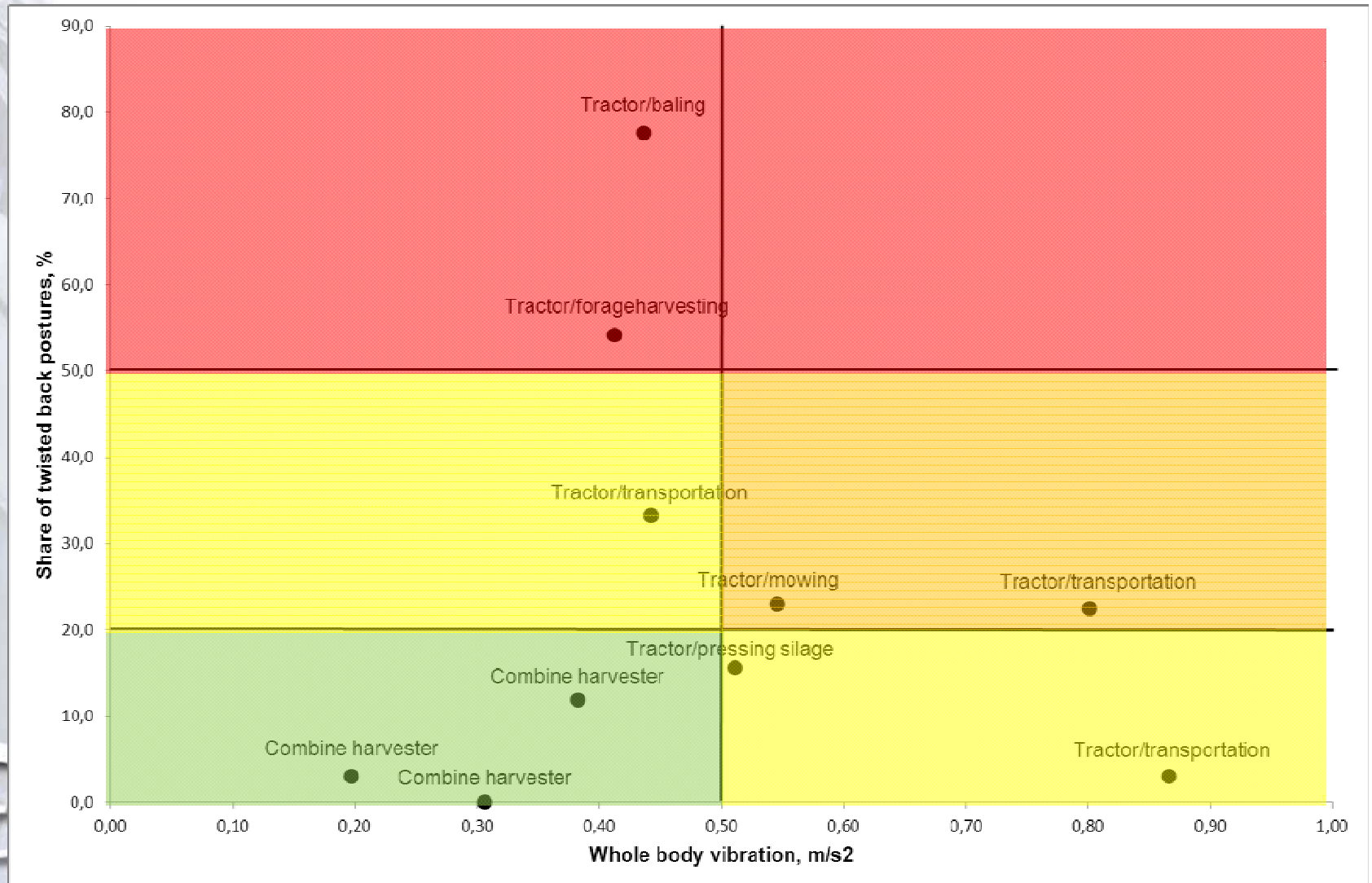


# Results

Work, vehicle, operation		Make, Type	Model	Mass kg	Speed km/h	Whole body vibration		Twisted (>20°) postures		
						m/s <sup>2</sup>	Dominant axis	Back, %	Head, %	
Silage harvesting	Tractor	Mowing	Valtra C150	2004-2006	5270	9,7	0,55	Y	23,0	18,0
		Forageharvesting	Valtra 6300	2001-2003	4170	4,3	0,41	Y	54,2	51,1
		Transportation - sand road	New Holland TS100	1997-2003	4470	9,0	0,80	X	22,5	4,6
		Pressing on the silo	Valtra C150	2004-2006	5270	2,3	0,51	X	15,6	32,4
Crop harvesting	Combine harvester	Harvesting	Sampo Rosenlew 2035	1997-2002	5700	4,6	0,31	Z	0,0	10,1
		Harvesting	New Holland TC54	2003	8700	3,1	0,20	Z	3,0	18,0
		Harvesting	Claas Lexion 480	1999	15800	5,8	0,38	Z	11,9	38,4
	Tractor	Transportation - sand road	Valtra 6850	2007	4700	17,7	0,87	X	3,0	18,8
		Transportation - field/field road	Valtra N141	2005-2007	4950	11,4	0,44	X	33,3	54,5
		Baling - round baler (straw)	Valtra T202	2009	6090	11,5	0,44	Y	77,6	53,2



# WBV & twisted back postures





# The amount of machine work

An example: a dairy farm

Milking cows                      55 cows  
 Arable land                         164,9 ha

Annual working hours	TOTAL		Driving work			
	h/year	%	Silage harvesting h/year	Cleaning & littering h/year	Feeding h/year	%
Plant production	1011	18,7	255			25,2
Animal production	3227	59,8		308	84	12,1
Planning & Management	1158	21,5				
Sum	5395	100,0				12,0

Total annual machine work hours:

- Tractor                              683 h
- Combine harvester              59 h



# Discussion 1

- *Combinations of the whole body vibration and poor back postures were the most harmful during baling, forageharvesting, mowing and transportation by a tractor.*
- Working postures were poorest during harvesting with a forageharvester and during baling with a round baler.
- Improving working postures
  - *Ergonomics of the cabin: design & layout*
  - *Adjustable seat & controls AND using these possibilities*
    - *Various sizes of drivers*
    - *Various machine operations*
    - *Proper working posture*
  - *Front linkage & implements in front of the tractor*
  - *Reverse drive controls (driving backwards)*
  - *Joystick controls*
  - *Mirrors & cameras + monitors*



# Discussion 2

- During most field operations with a tractor the dominant axis in WBV was the crosswise one (Y). During transportation and during silage pressing, however, the longitudinal axis (X) was dominant. The dominant vibration axis during crop harvesting with a combine harvester was the vertical axis (Z).
  - Emphasis should not only go to vertical vibration damping of the chair and the cab.
- Decreasing whole body vibration
  - Choice of machine: suspension of axles, the cabin & the seat
  - Adjusting the seat suspension according to the driver and work
  - Twin mounted wheels, broad tyre profile
  - Decreasing tyre pressure
  - Setting down the speed especially on poor shape surfaces
  - Proactive driving
  - Maintenance of roads, machines and implements



# Discussion 3

- Other ways to decrease work load
  - Efficient machinery
  - Decreasing the number of driving operations
  - Job rotation
  - Unoccupied machines



Photo: Aalto University



Photo: Mika Peltonen







Photo: Markku Lähti



Photo: Markku Lähti

Thank you!

