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Department of Sustainable
Agricultural Systems

Fuel consumption, CO₂ emissions and energy efficiency of soil tillage systems in Austria

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Overview

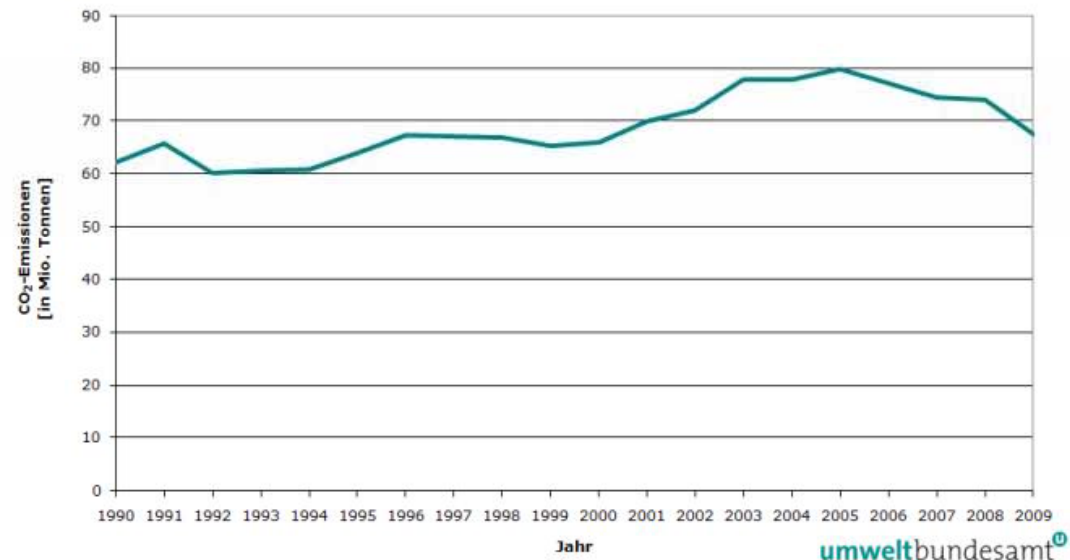
- Introduction
- Material & methods
- Results & discussion
- Conclusions



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1. Introduction

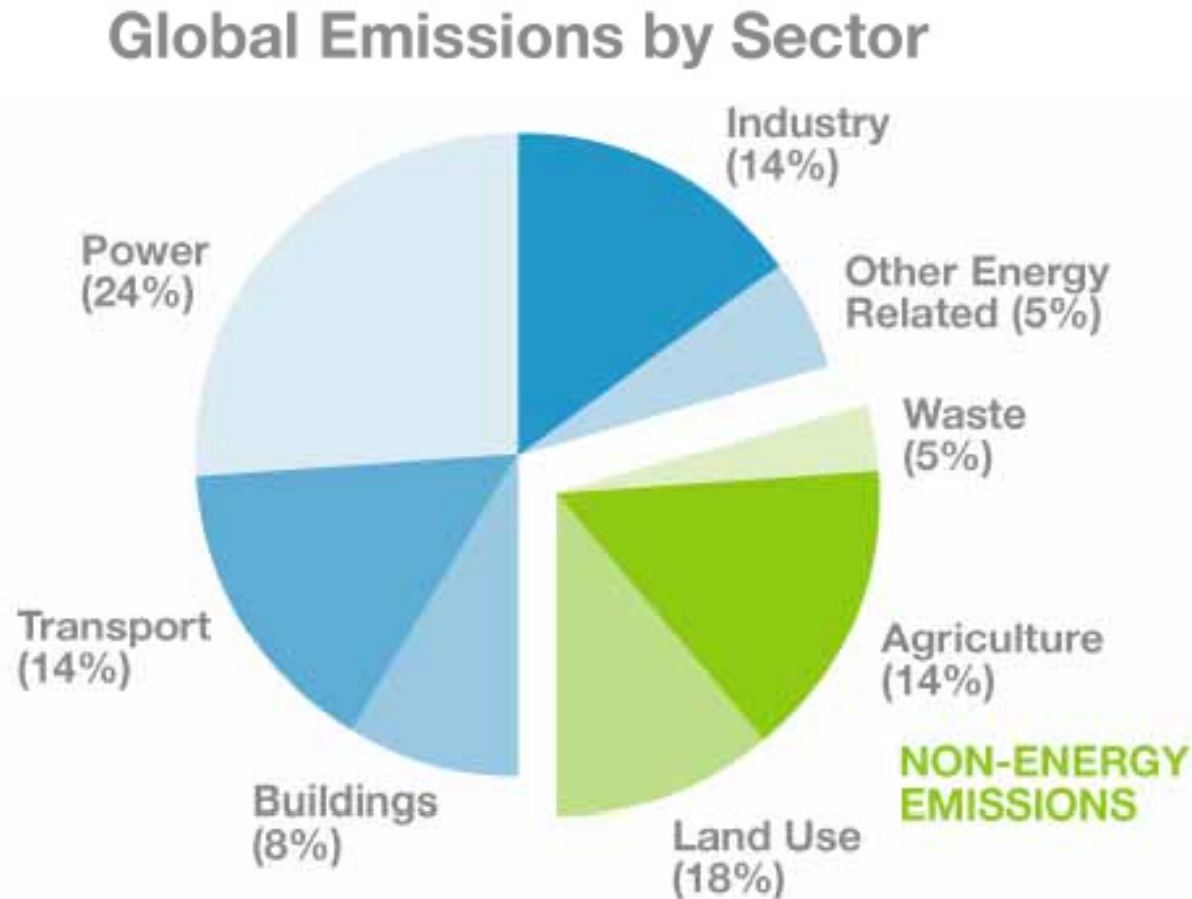
- Japan 1997 : Kyoto protocol
- Greenhouse gas reduction by 13% (base: emissions 1990)
- 2008: 86.6 Mio t CO₂
- 2009: 67.6 Mio t CO₂
- Emissions increased by 8.5 % compared to 1990
- World 2007:
28 962 Mio t CO₂



1. Introduction



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Total emissions in 2000: 42 GtCO₂e

2. Material & methods

- 3 soil tillage practices:
 - conventional tillage (ct):
 - Disc harrow or heavy cultivator
 - Moldboard plough
 - Combined power harrow and seeding machine
 - reduced tillage (rt):
 - Disc harrow or heavy cultivator
 - Combined power harrow and seeding machine
 - no tillage (nt):
 - Seeding machine for no tillage



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2. Material & methods

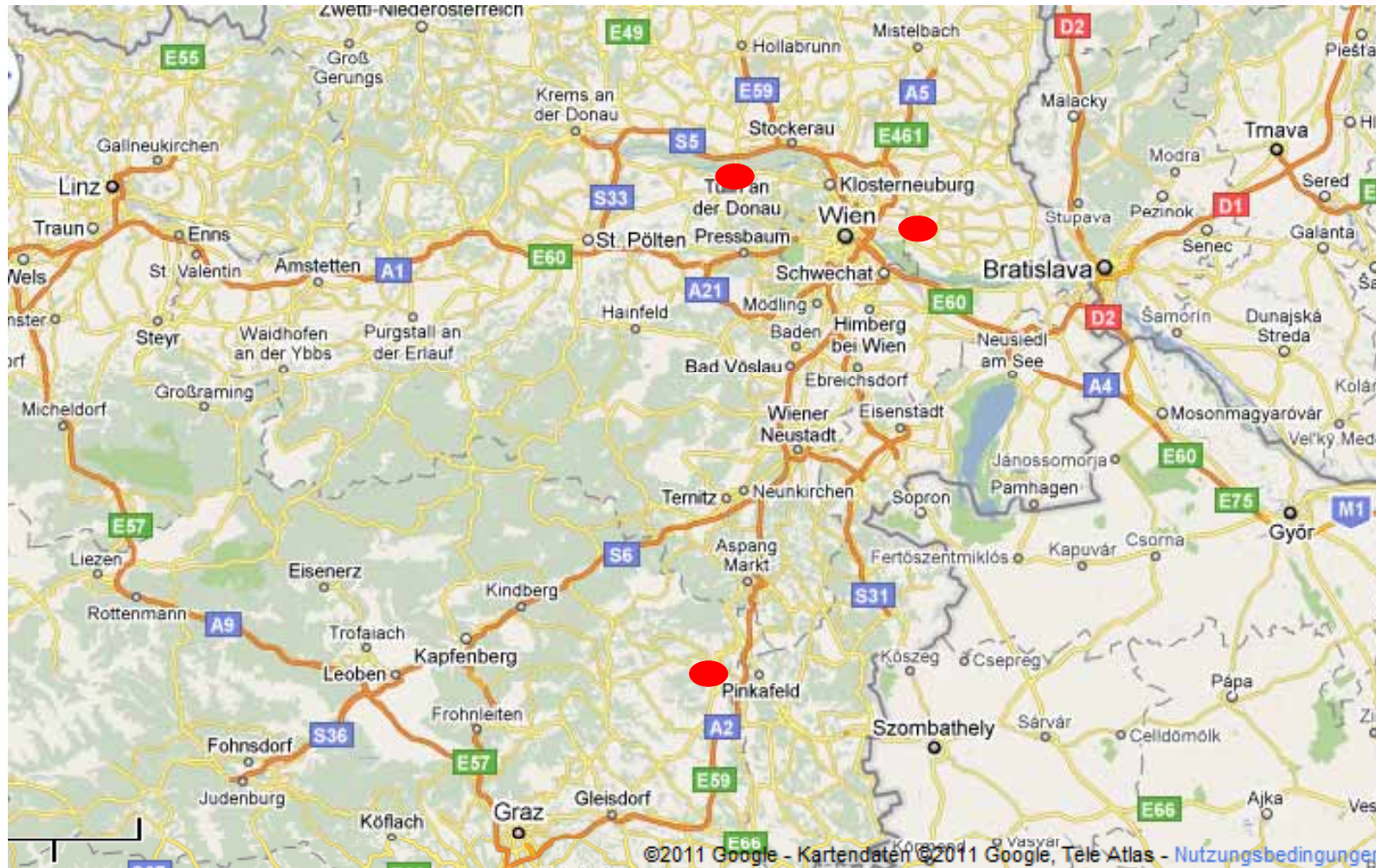


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- Description of the 3 locations in Austria:

	<i>Tulln</i>	<i>Gross Enzersdorf</i>	<i>Kirchberg am Walde</i>
Average temperature	9.4 °C	9.8 °C	9,1 °C
Average rainfall/year	685 mm	546 mm	730 mm
Soil texture	loamy clay	silty loam	loamy sand
Type of soil	Gleyc Chernozem	Chernozem	Brown earth

2. Material & methods



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2. Material & methods

2 methodes to measure fuel consumption (soil tillage and seeding)

- Gross Enzersdorf: high-performance flow-meter (PLU 116H)
- Tulln & Kirchberg am Walde: volumetric measurement of fuel through filling in the fuel tank
- 1 repetition =
(2 field lengths + 1 turning process)

fuel consumption for soil care and
harvest estimated by KTBL

- Fuel: 1 l= 2.65 kg CO₂



2. Material & methods

- CO₂-emission for agricultural inputs according to literature factors



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Input	kg CO ₂ /kg Substance	Literature
Diesel fuel	3.15	KTBL (2008)
Herbicide	8.33	KTBL (2008)
Fungicide	5.54	KTBL (2009)
Insecticide	23.7	KTBL (2010)
Calcium Ammonium Nitrate (CAN)	6.81	Kongshaug (1998)
Diammonium phosphate	0.46	Kongshaug (1998)
Urea (46 % N)	1.33	Kongshaug (1998)
NPK (15:15:15)	1.12	Davis and Hagland (1999)
Seed	0,21	

2. Material & methods

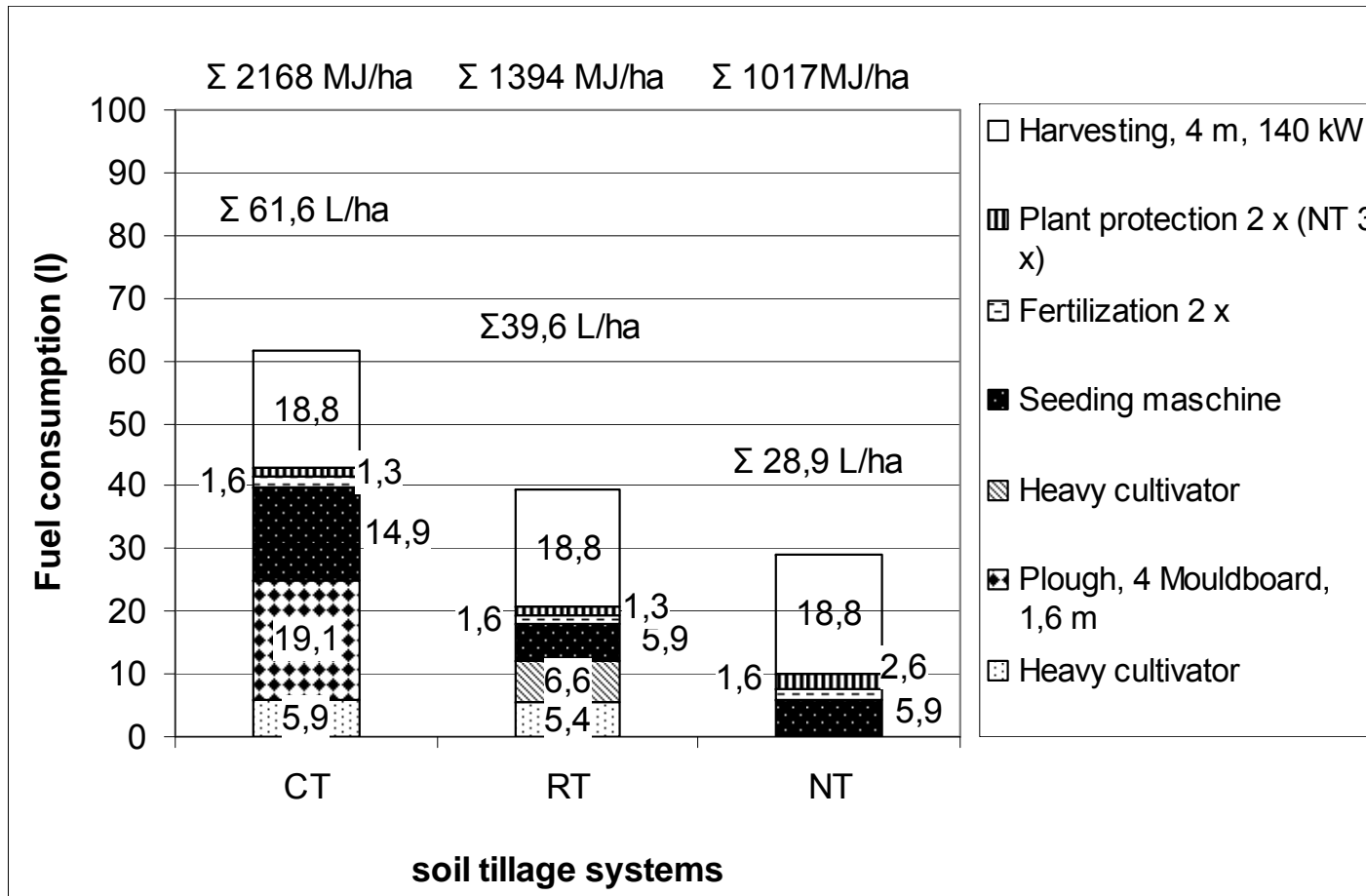


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3. Results & discussion

Fuel consumption of different tillage systems in Gross Enzersdorf (LA)

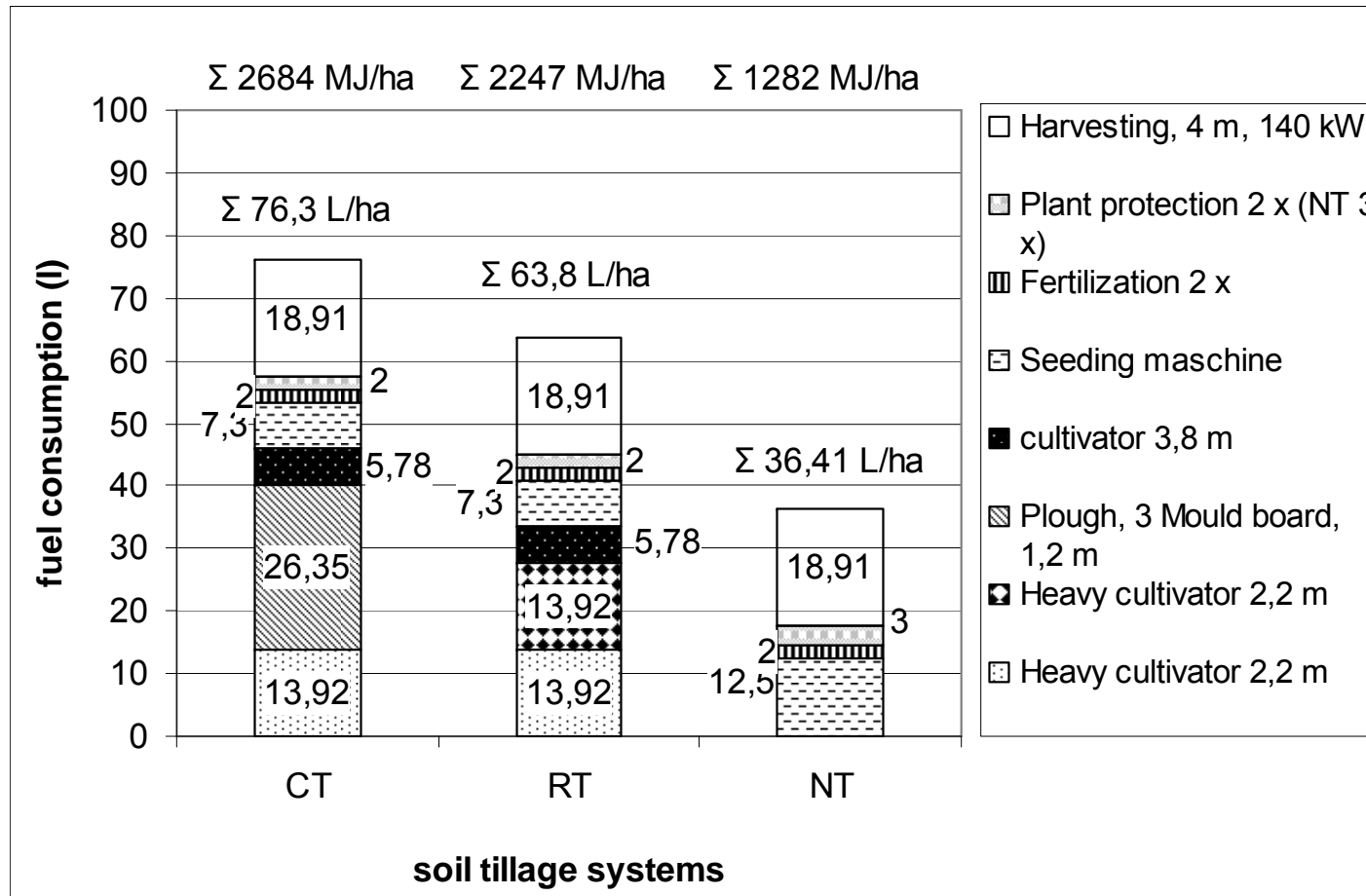


3. Results & discussion

Fuel consumption of different tillage systems in Kirchberg (ST)



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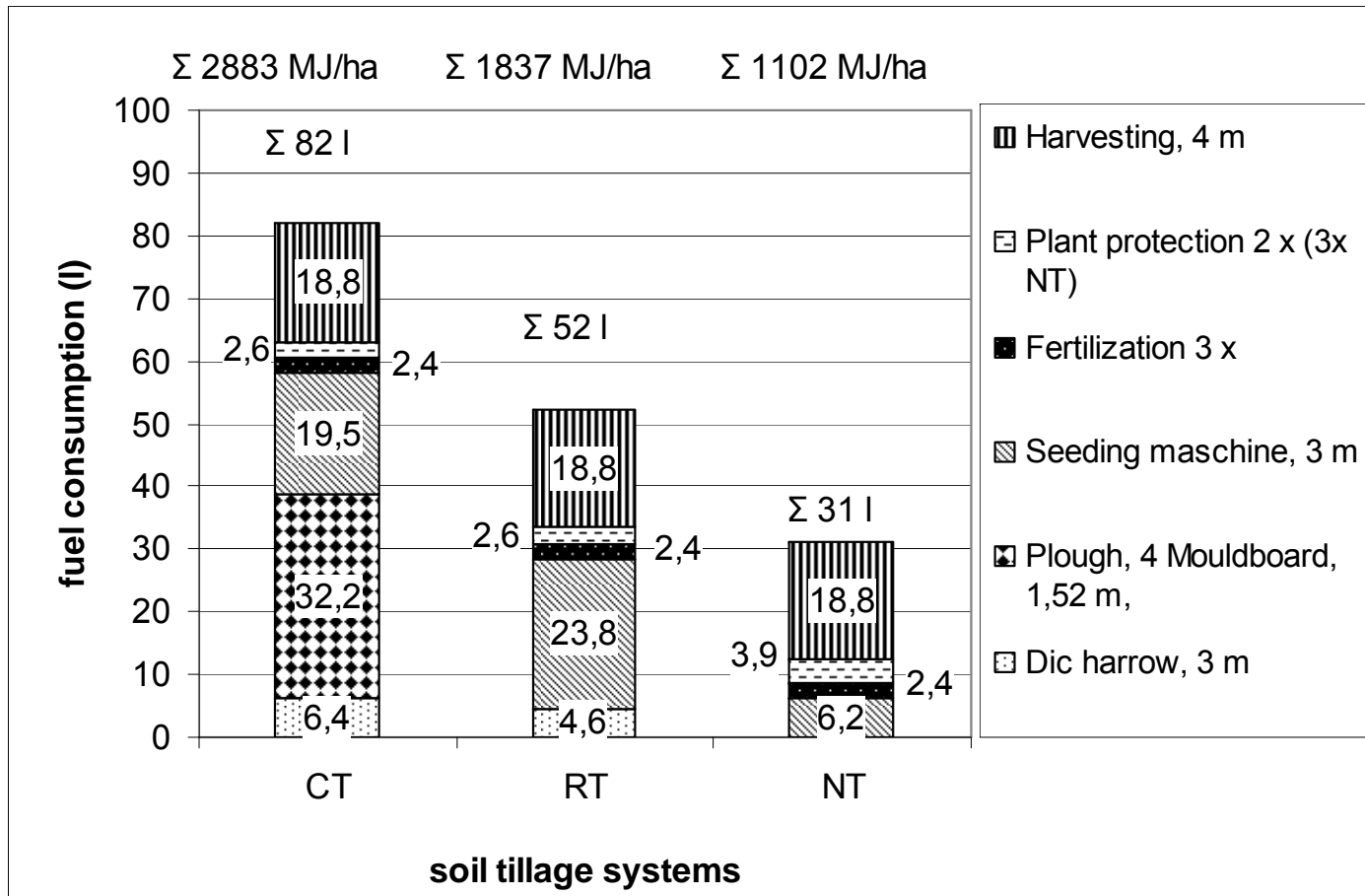


3. Results & discussion

Fuel consumption of different tillage systems in Tulln (LA)



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3. Results & discussion



CO₂- emission



CO₂ emissions for wheat production in different soil tillage systems at Gross Enzersdorf	CT	RT	NT
Direct CO ₂ emission (kg CO ₂ /ha)	163	105	79
Fuel for soil tillage (kg CO ₂ /ha)	106	47	17,7
Fuel for fertilizer application* (kg CO ₂ /ha) 12 m; 60 kW; 0.8 l•ha ⁻¹ ; 2-times	4,2	4,2	4,2
Fuel for pesticide application* (kg CO ₂ /ha) 12 m; 60 kW; 1.3 l•ha ⁻¹ ; +1 <i>glyphosate</i> application in no tillage	3,5	3,5	6,91
Fuel for harvest (combine)* (kg CO ₂ /ha) 4 m, 140 kW, 18.8 l•ha ⁻¹	49,8	49,8	49,8
Indirect CO ₂ emission (kg CO ₂ /ha)	2623	2623	2640
Fertilizers (kg CO ₂ /ha) 380 kg NAC (27:0:0) (kg CO ₂ /ha)	2586,3	2586,3	2586,3
Seeds (165 kg/ha) (kg CO ₂ /ha)	35	35	35
Herbicides (775 g/ha)			
+ 1 Round-up in no tillage (kg CO ₂ /ha)	1,7	1,7	18,4
Total CO₂ emission (kg CO₂/ha)	2.786	2.728	2.718
CO₂ intensity (kg CO₂/kg Ertrag)	0,586	0,509	0,525

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<i>CO₂ emissions for wheat production in different soil tillage systems at Kirchberg</i>	CT	RT	NT
Direct CO ₂ emission (kg CO ₂ /ha)	203	169	97
Indirect CO ₂ emission (kg CO ₂ /ha)	2212	2212	2324
Total CO ₂ emission (kg CO ₂ /ha)	2415	2381	2324
CO ₂ intensity (kg CO ₂ /kg Ertrag)	0,326	0,307	0,307

3. Results & discussion



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<i>CO2 emissions for wheat production in different soil tillage systems at Tulln</i>	CT	RT	NT
Direct CO2 emission (kg CO2/ha)	217	138	83
Indirect CO2 emission (kg CO2/ha)	2.212	2.212	2.227
Total CO2 emission (kg CO2/ha)	2429	2350	2310
CO2 intensity (kg CO2/kg Ertrag)	0,394	0,382	0,364

4. Conclusions



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- Fuel consumption reduced about 50 %, change from CT to NT
- Direct/indirect emissions & field yield: conclusive for evaluation of tillage system
- location (type of spoil) influences the fuel consumption
- 90 % of CO₂ emission due to fertilizer
- CO₂ intensity important information



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