Technologie- und Förderzentrum
im Kompetenzzentrum
für Nachwachsende Rohstoffe

Resilient food production with green tractors – The ResiTrac project

22nd International Conference on Renewable Mobility January 21st, 2025 in Berlin

K. Obermaier; A. Schröder (John Deere); P. Emberger

P25KEm001

Co-funded by the European Union

Outline

1. Introduction

2. Material and method

3. Field test

4. Test stand measurements

5. Summary and Outlook

Resiliant food production with green Tractors

Increase resiliance of food production by

- domestic production of plant oil
- independence from fossil fuels in agricultural machines
- supply of domestic protein feed
- regional value creation potential for rural areas
- usage of existing infrastructure

Partners:

JOHN DEERE

Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

Versuchszentrum
Centro di Sperimentazione
Research Centre
LAIMBURG

TFZ

Funding:

eit Food

Co-funded by the European Union

Target of the project

Development, test and introduction of tractors that can be

- operated with **100 % pure plant** oil with
- **equal power** performance and
- **equal maintenance** to serial diesel operation as well as
- **comfortable regeneration** of the exhaust gas aftertreatment system

Outline

1. Introduction

2. Material and method

3. Field test

4. Test stand measurements

5. Summary and Outlook

Fuel properties of rape seed oil DIN 51605

Parameter	Unit	Rapeseed oil		Diesel
Density (15 °C)	kg/m³	920	⟷	830
Calorific value	MJ/kg	37.1	⟷	42.5
Calorific value	MJ/l	34.1	⟷	35.3
Kin. viscosity (40 °C)	mm²/s	35.5	⟷	2...4
Carbon content	% by mass	77.5	⟷	86.5
Hydrogen content	% by mass	11.6	⟷	12.9
Oxygen content	% by mass	10.9	⟷	-

High energy density (comparable to diesel fuel)

Physical properties differ from diesel fuel

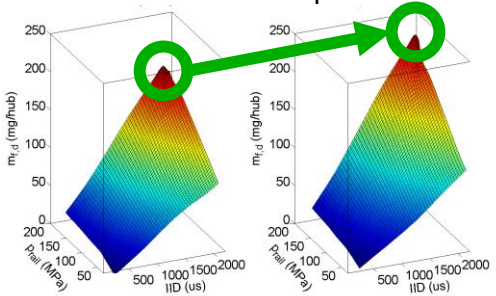
Approach

- Development of ECU software and fuel system adjustments
- Implementation of the adjustments on the test tractors
- Field test monitoring of the tractor concerning
  - operation behaviour
  - fuel and engine oil quality
  - real driving emissions
- Power and emission measurement on tractor test stand
- Derivation of optimization measures

Engine and tractor adaptation by John Deere

Adjustment of fuel injection map

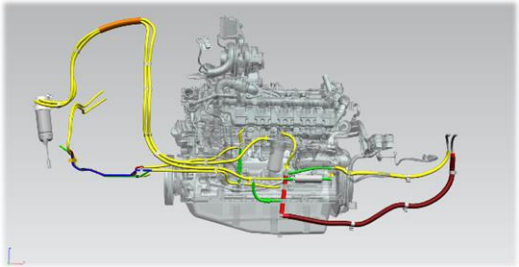
Diesel



Rape seed oil

Implementation

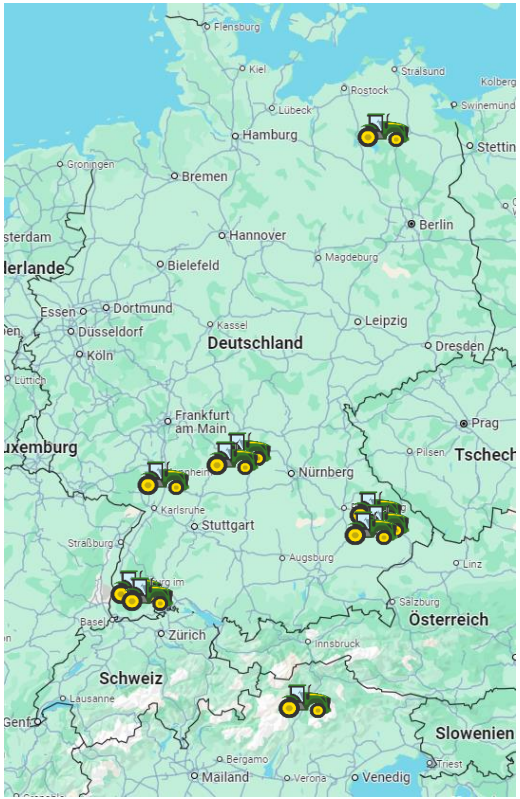
Hardware adjustment of fuel system



Graphics: A. Schröder (John Deere), Photo: Speiseder (TFZ)

Overview tractors

Type	Location	Engine power / # cyl.	Field test hours
6R 215	GER	158 kW, 6 cyl.	829
6R 215	GER	158 kW, 6 cyl.	1116
6R 195	CH/GER	143 kW, 6 cyl.	828
6R 185	GER	136 kW, 6 cyl.	540
6R 185	GER,	136 kW, 6 cyl.	854
6R 185	GER	136 kW, 6 cyl.	932
6R 150	GER	110 kW, 4 cyl.	833
6R 150	CH/GER	110 kW, 4 cyl.	768
5130 ML	GER	100 kW, 4 cyl.	test bench
5130 ML	IT	100 kW, 4 cyl.	test bench



All tractors: EU Stage V, exhaust aftertreatment (DPF, DOC, SCR)

Outline

1. Introduction

2. Material and method

3. Field test

4. Test stand measurements

5. Summary and Outlook

Photo: TFZ

Field test - monitored fuel quality at delivery or production

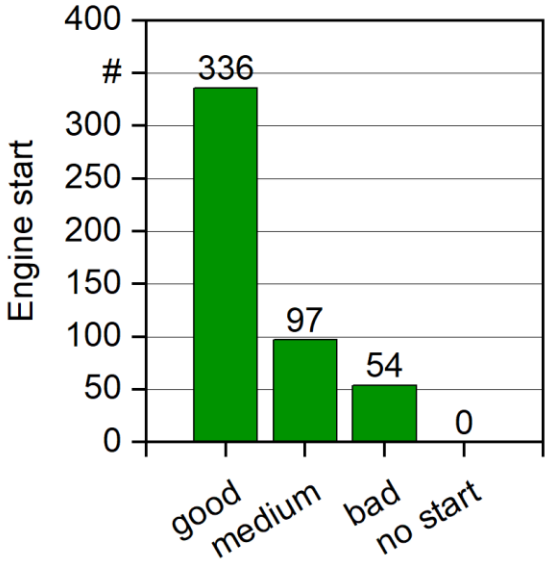
- Rapeseed oil fuel quality meets DIN 51605
- Self-produced rapeseed oil fuel at a site twice with little high water content

Parameter	Min	Max	Unit	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Phosphorous	-	3	mg/kg	0.5	0.4				<0.1		0.7		<0.1	<0.1	<0.1
Calcium	-	1	mg/kg	0.4	0.2	<0.1			<0.1	<0.1	0.8	0.11	0.7	0.1	0.5
Magnesium	-	1	mg/kg	<0.1	<0.1	0.4			<0.1	0.7	0.1	0.4	<0.1	<0.1	<0.1
Sulphur	-	10	mg/kg	<5	<5	<0.1			<1	0.2	1.2	<0.1	<1	<1	1.1
Oxidation stab.	6	-	h	7.95	6.74	8.27	6.45	6.64	9.40	8.59	8.31	8.89	7.10	7.87	7.27
Acid number	-	2.0	mg/g	0.721	1.746	0.443	0.660	0.640	0.063	-	1.422	0.376	0.89	0.652	0.676
Water content	-	750	mg/kg	452	247	516	562	479	35	404	766	533	648	543	756
Contamination	-	25	mg/kg	26	11	9	17	10	23	20	6	23	20	10	7

Field test - fuel quality in use

- Cleanliness of the refueling system sometimes not given
  → Contamination of the fuel and unnecessary fuel filter blockage
- Raising awareness of fuel hygiene necessary in parallel to tractor market launch

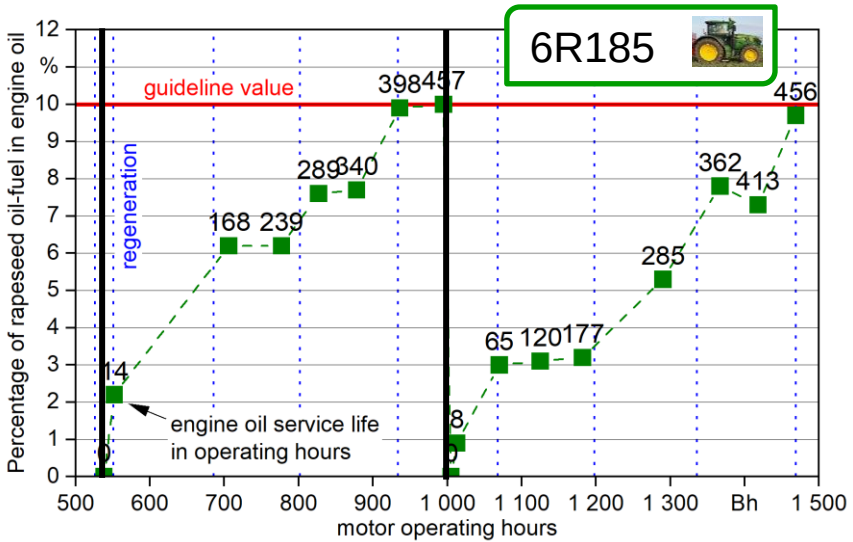
Engine cold start

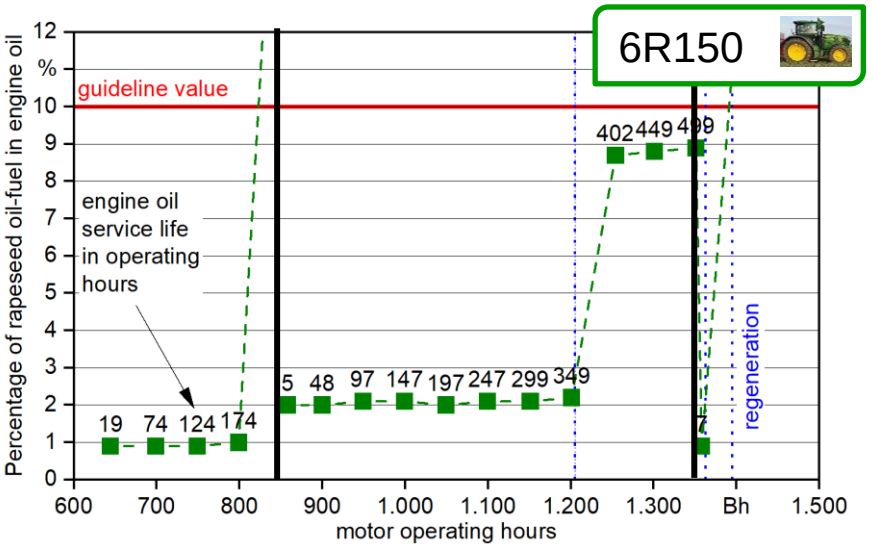


- Almost 70 % of engine cold starts are rated as good
- Always engine start possible

Photo: Röther (BaySG), Speiseder (TFZ)

Field test – engine oil quality





- Fuel intake during normal operation very low, during EAT regeneration high
  → further optimisation necessary in ongoing project
- Other engine oil parameters OK

Outline

1. Introduction

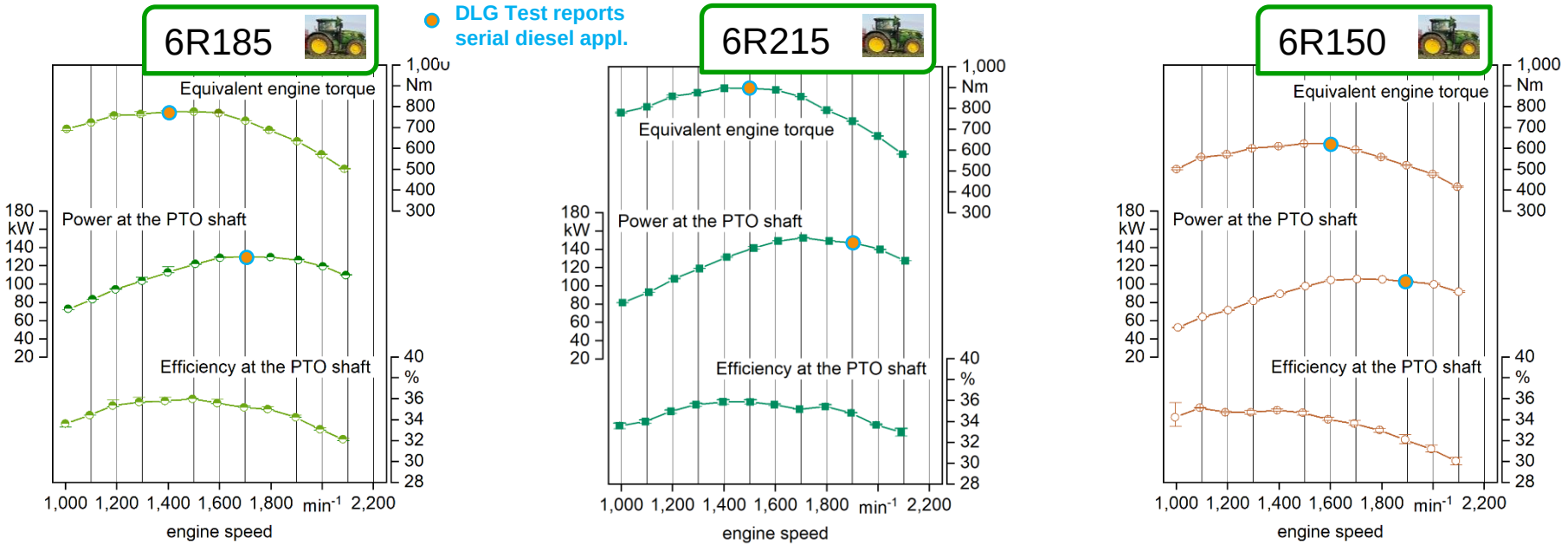
2. Material and method

3. Field test

4. Test stand measurements

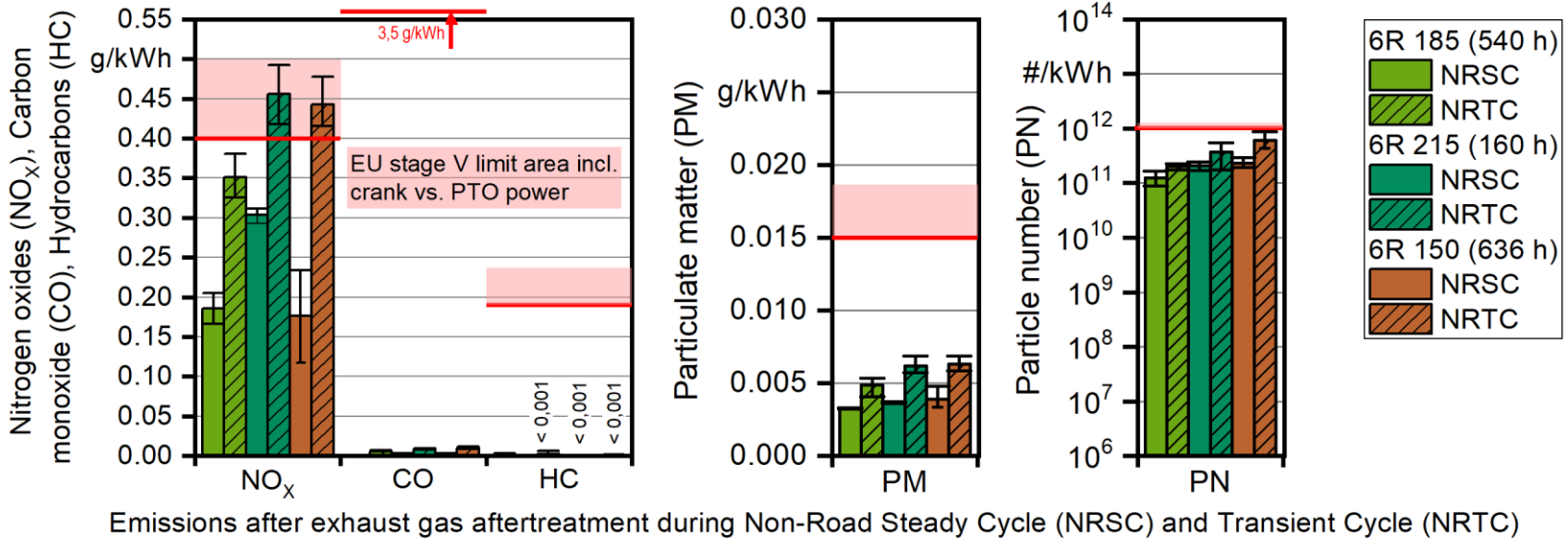
5. Summary and Outlook

Power, torque, efficiency



- Power and torque equal to serial diesel application

Emission behaviour



Emissions after exhaust gas aftertreatment during Non-Road Steady Cycle (NRSC) and Transient Cycle (NRTC)

- NO_X emissions of 2 tractors in the limit range for NRTC
- All other parameters well below the limits

Outline

1. Introduction

2. Material and method

3. Field test

4. Test stand measurements

5. Summary and Outlook

Summary

- Delivered and self-produced rape seed oil fuel quality is good
- Raising awareness of the farmers for fuel hygiene necessary
- EAT regeneration: high intake of rapeseed oil into engine oil
- Power, torque and efficiency equal to serial diesel tractors
- Emission behavior mostly within the requirements of stage V

Outlook

- Ongoing data collection in the last field test year
- Optimization of EAT regeneration; real driving emissions measurement

Key message

- Agricultural, domestic plant oil fuel supply with high quality demonstrated
- Technical solutions to use plant oil fuel in tractors are well advanced

Resilient food production with plant oil operated tractors possible

Sufficient economic and political framework conditions are lacking

Technologie- und Förderzentrum
im Kompetenzzentrum
für Nachwachsende Rohstoffe

Thank you for your attention!

Photo: TFZ

Partners:

Funding:

Co-funded by the European Union