

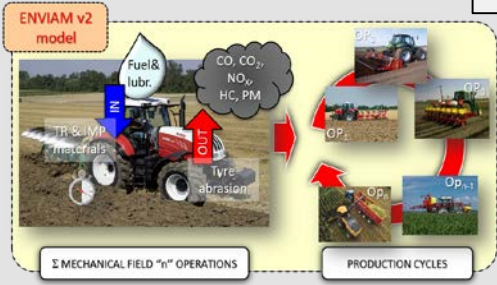
INTRODUCTION

- Agricultural operations are strongly influenced by site-specific pedological and climatic working conditions. The use of the same machine in different site-specific conditions, as well as the performance of the same operation in equal site-specific conditions (but with different machines), strongly influence the environmental costs of the operation itself;
- Methodologies to quantify the environmental impacts of mechanical field operations are widely applied, but, usually, system inputs and outputs come from international databases or literature and rarely represent the studied situation.

GENERAL OBJECTIVES

- To quantify site-specific secondary data related to mechanical field operations in EU cereal cropping, from primary soil tillage to grain and straw transportation, paying particular attention to barley;
- To use this environmental inventory to perform the LCA analysis related to barley cultivation in EU.

MATERIALS and METHODS



BarNow scenarios (2019)

S1NOW S2NOW S3NOW

BarPlus scenarios (2030)

S1PLUS S2PLUS S3PLUS

	u.o.m.	S1	S2	S3
Agricultural Area Used	ha	50	100	200
Barley area (60% AAUs)	ha	30	60	120
Other Crops (35% AAUs)	ha	17.5	35	70
Green crops (5% AAUs)	ha	2.5	5	10
Soil texture	-	-	medium	-
Cropping area	-	-	flat	-
Barley field distance	km	-	2.0	-
Barley field shape	-	-	rectangular	-
Barley field length	m	-	800	-
Cropping sequence	-	(1) NPK fertilization, (2) ploughing, (3) harrowing, (4) sowing, (5) weed control, (6) N fertilization, (7) grain harvesting and (8) transport, (9) straw collection and (10) transport		
Cropping inputs	kg·ha ⁻¹	Organic fertilizer: 0; Seed rate: 190; Herbicide: 1.45; Irrigation: 0		

Type of Material	BarNow (year 2019)		BarPlus (year 2030)	
	DM (%)	Yield (t·ha ⁻¹)	DM (%)	Yield (t·ha ⁻¹)
Grain	81.5%	6.5 (5.3)	88.0%	7.5 (6.6)
Straw	84.5%	6.5 (5.5)	86.3%	7.3 (6.3)

Agronomic aspects	u.o.m.	BarNow (year 2019)	BarPlus (year 2030)
Crop nutrients requirements	kg·ha ⁻¹	N = 100; K ₂ O = 20; P ₂ O ₅ = 40	N = 120; K ₂ O = 20; P ₂ O ₅ = 40
1 st mineral fertilization	kg·ha ⁻¹	150 (NPK 20-20-20)	150 (NPK 20-20-20)
2 nd mineral fertilization	kg·ha ⁻¹	220 Urea (46%)	265 Urea (46%)

Technical improvements	u.o.m.	BarNow	BarPlus
Diesel engines emission stage	-	TIER 3B	TIER 5
Diesel engines equipment	-	None	(SCR) and AdBlue® (5% of diesel consumption)
Diesel engines specific fuel consumption	g·kWh ⁻¹	depending on the tractor (approx. range: 200-250)	Acmsm = -10%

Mechanical improvements	u.o.m.	BarNow	BarPlus
Mineral fertilizer - Seeder (row) - Sprayer - Combine Harvester - Balers (round)	ha·h ⁻¹	-	ΔEFC = +15%
Plough (shovels) - Harrow (rotary) - Dumper (for grain) - Trailer (for straw)	ha·h ⁻¹	-	ΔEFC = +10%

RESULTS and DISCUSSION

- Fuel consumptions – and the corresponding emissions into the atmosphere – strongly depend on both tractor's engine loads and duration of each working time: the assumption of a constant engine load (maximum value) for each working time – and thus a constant specific fuel consumption – leads to wrong evaluations in terms of fuel consumptions and emissions;
- BarNow inputs amounted to: fuel FC = 67-74 kg·ha⁻¹, lubricants LC = 0.56-0.73 kg·ha⁻¹ and mass MC = 7.9-8.8 kg·ha⁻¹. Emissions of CO₂ amounted to EM_{CO2} = 211-233 kg·ha⁻¹. BarPlus inputs amounted to: FC = 55-60 kg·ha⁻¹, LC = 0.54-0.69 kg·ha⁻¹, MC = 7.2-8.0 kg·ha⁻¹ and AdB = 2.8-3.0 kg·ha⁻¹. EM_{CO2} = 173-189 kg·ha⁻¹. The highest fuel (and consequently CO₂ emissions) and mass consumptions are, in any scenario, related to tillage operation.