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## Life Cycle Assessment of wheat production: Influence of nutriment intake

S. Gerbinet, Sylvie Groslambert and A. Léonard

<sup>1</sup>University of Liège, Chemical Engineering – PEPs, Belgium, www.chemeng.uliege.be – <u>saicha.gerbinet@ulg.ac.be</u>



**Introduction:** What is the impact of fertilizers? Which is the best strategy? The aim of this study is NOT to compare organic vs conventional agriculture but to compare the manure based vs the mineral based fertilizers: therefore the amount of phytosanitary product is the same in all the scenarios.

- An important cereal with a lot of applications in the feed and food industries (e.g. starch production) Wheat: •
  - Growing context of biobased products, a better understanding of the impact of its production is needed, using Life Cycle Assessment (LCA)
  - Primary data are taken from Agrybalise [1], backround data from Ecoinvent using Simapro (excluding infrastructure and long term emissions).
  - Impact assessment method: *ReCiPe 2016 Midpoint (H)* [2]

## **Several scenarios** Functional unit = 1 kg of wheat produce in France

## **Amount of fertilizers:**

Calculate to be equivalent to the

Scenario 1: "Conventional": mix between livestock manure and mineral fertilizers – based on Agribalyse data [1]

Scenario 2a: Maximal use of organic fertilizers based on the European nitrate directive (i.e. : 170 kg of N from organic fertilizers) Scenario 2b: Maximal use of organic fertilizers based on the European nitrate directive exception for region with high livestock

(i.e.: 250 kg of N from organic fertilizers)

Scenario 3: 100% mineral fertilizers

Scenario 4: Intermediate scenario: All the P provided by organic fertilizer – excess of K – N needs completed by minerals fertilizers Scenario 5: 100% mineral fertilizers with measure to improve the NUE (nitrogen use efficiency): use of inhibitor and precision

farming technologies: Reduction of N<sub>2</sub>O emissions (-38 %), NH<sub>3</sub> emissions (-70%) and NO<sub>3</sub> emissions (-50%)

- conventional case (using mineral fertilizers equivalent (MFE) for the organic fertilizers)
- N equivalent always equal, in some  $\bullet$ case excess of P and K.

Same yields

Theses scenarios are extreme scenarios, not representative of agricultural practices (except the conventional) but have been selected to allow a good understanding of the impact of fertilizers. Several discussions with agronomist experts have been conducted to validate the hypothesis.

Some sensitivity analysis have been conducted on the conventional case. Example: distance transport for organic fertilizers (base case: 10 km – alternative case: 400 km)

	Convetionnal	Manure (170 kg N/ha/yr)	Manure (250 kg N/ha/yr)	Mineral	Inter- mediate	Mineral - improved NUE	Unit	100%													
Yields (t/ha)			7100			7266	kg/yr														
Straw			4297			4398	kd DM	80%													
% Of straw remove			52				%	0070													
N-fertilizer. as N	163	117	93	167	150	152	kg/ha														
P-fertilizer. as P <sub>2</sub> O <sub>5</sub>	25	0	0	33	0	33	kg/ha	60% —												┢──₿┦	
K-fertilizer. as K <sub>2</sub> O	42	0	0	64	0	64	kg/ha														
Applied organic	1.90	22.95	33.75		7.92		ton/ha														
N in organic (total)	11.12	170.00	250.00		58.66		kg/ha	40% —													
P <sub>2</sub> O <sub>5</sub> in organic (total)	6.78	95.63	140.64		33.00		kg/ha														<b>400</b> km
K <sub>2</sub> O in organic (total)	11.88	260.15	382.57	0	89.77	0	kg/ha	20% —													10 km
N in organic (mineral equivalent)	4.14	50.03	73.58		17.27		kg/ha	2070													
P <sub>2</sub> O <sub>5</sub> in organic (mineral equivalent)	7.92	95.63	140.64		33.00		kg/ha														
K <sub>2</sub> O in organic (mineral equivalent)	21.54	260.15	382.57		89.77		kg/ha	0%													
Herbicide application			0.46				kg/ha	nine	ation	dion	ation	NON	id his	in the second	incited	icited	ister	10/10H	Citty	ation	
Pesticide application			0.90				kg/ha	1 wall	ornio di	inco opi	ico opiic	° coto	coto	رم،	OT NC	OT	×0 <sup>T</sup> .6		e	SUMP	
Fungicide application			0.65				kg/ha	Globie astrer	, ial 30	Lentro	eeutre	stiale	Nater	atimee	inoser	inoser	resource	esour	, et d	21	
Total N mineral equivalent. as N	167	167	167	167	167	>167	kg/ha	Nate N.	errest wi	Mate. No	ine rer	er cles	12 4	No.	atc	arcin	ztalle c	ossilli	2/32		
Total P mineral equivalent. as P <sub>2</sub> O <sub>5</sub>	33	96	141	33	33	33	kg/ha	articul	4rest.					HIMSI	an nor	Lin	· ×				
Total K mineral equivalent. as K <sub>2</sub> O	64	260	383	64	90	64	kg/ha	11e2						*	HUMUL						
NUE	77	68	65	78	74	87	%														



Results	100%					Т			Т	.																																
Climate change :									L		ıl										ı			I							L						II				•	Fields emissions (others)
Nitrogen fertilizers	80%		.							Ш	Ш											_		Ш															11			Fields emissions
<ul> <li>Production: non</li> </ul>	00,0		Ш			Ш		1		П	П	П		П									. I	П								Н						117	Ш	۲.		(organic)
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<ul> <li>Use: N<sub>2</sub>O emissions: large</li> </ul>	60%	Ш	ш			Ш				Ш	Ш					Ш	Н	ı.					Ц	Ц			Ш	Ц		4		Ц							Ц	Ш	ŀ	Mechanization
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nutriments.		Ш				н		Ш	L	П	П	П		П	П	Ш	Ш	Ш	Н					П	Н		H	н				Ш	Ш				Ш		Ш	н		
Scenario with mostly organic		н	H			н			L	П	П	П		П	П	Ш	Ш	Ш	Н					П	Н		Н	н				Ш	Ш				Ш		Ш	н	•	P2O
fertilizers perform worst	20%	#	111			Н				Н	Н	Н	Н		Н	Н	Н	Н					Н	Н	Н	H	H	H			L	Н	н			$\square$	₽		₽	₽		Ν
• Measures to improve NUE:		н	Ш			н								П	П	Ш	Ш	Ш	Н								Н	Ш		П		Ш	Ш				Ш		Ш	н		
impact reduction		Ш				11	11			П	П	н		Ш	П	Ш	Ш	Ш					н	П	Ш		Н	Ш		П		Ш	Ш				Ш		Ш	н	l .	Seeds
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fertilize uncerta categor	ers). But differences < ainties on these ries	Global warming	Fine particulate Terrest matter formation acidifica	ial Freshwater ion eutrophication	Marine eutrophication	Wineral with ecotoxicity	Freshwater ecotoxicity	arine ecotoxicity Human c	E E E E E E E E E E E E E E E E E E E	Mineral resource Kiperal with Scarcity	Fossil resource V scarcity	Wineral With Water consumption	
<ul> <li>The aim of this study is to compare several strategies for nutriments intake by wheat in France context. France have the particularity to have a conventior agriculture with large yield and efficient use of fertilizers.</li> <li>Except in mineral resources scarcity, the mineral based fertilizers case always preforms better or the differences are too small to be significant. The techniq to reduced the NUE allows a reduction of the impact</li> </ul>													
sions •	These scenarios have by things are not characted quality, the influence of Nevertheless, this study	peen defined v erized by this s f a crop rotation y is a first step	with great care study, such as t on, the possible to a better und	but some as he contribut environmen erstanding o	sumptions a ion of the n tal impact o f the influen	are heav on-mine of organic ce of diff	y such as k ral part of fertilizers ferent fertil	keeping the the organic production lizers strateg	yield constant c fertilizers, th (considered gies.	nt in the fir ne impact o as a waste	st scenario of organic from livest	os. More, a fertilizers o ock produc	lot of on soil ction).
[1] ADEME,	"L'outil Agribalyse," 2014. [Online]. A	vailable: http://www.	.ademe.fr/expertises/p	oduire-autrement,	/production-agrico	ole/passer-a-	laction/loutil-ag	gribalyse.					

[2] M. Goedkoop, R. Heijungs, M. Huijbegts, A. De Schryver, J. Struijs, and R. van Zelm. 2009. ReCiPe 2008 : A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Ruimte en Milei. 132 p.

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