GREENHOUSE GAS ASSESSMENT OF WINE PRODUCED IN PORTUGAL

Filipa Figueiredo[1], Érica Castanheira[1], António D. Ferreira[2], Henrique Trindade[3] and Fausto Freire[1]

[1] ADAI-LAETA, Dept of Mech. Engineering, University of Coimbra, Coimbra, Portugal

[2]Centro de Estudos dos Recursos Naturais, Ambiente e Sociedade, Departament of Pure and Environmental Sciences, ESAC, Coimbra, Portugal

[3] Centre for the Research and Technology of Agro-Environment and Biological Sciences (CITAB), University of Trás-os-Montes e Alto Douro (UTAD), Portugal

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Outline

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    - Main goal
2. Life-cycle model and inventory
    - Life-cycle model
    - Inventory
3. Results and discussion
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Background and Motivation

Wine is one of the most important agro-industrial sectors in Europe and in Portugal

Portugal produced 624 million litters of wine and exported 227 million litters in 2013

Environmental life-cycle impacts of wine production have been explored in previous studies however, in Portugal just for the wine region of “Vinho Verde”

Main Goal

To present a life-cycle (LC) greenhouse gas (GHG) assessment of wine produced in five wine regions of Portugal

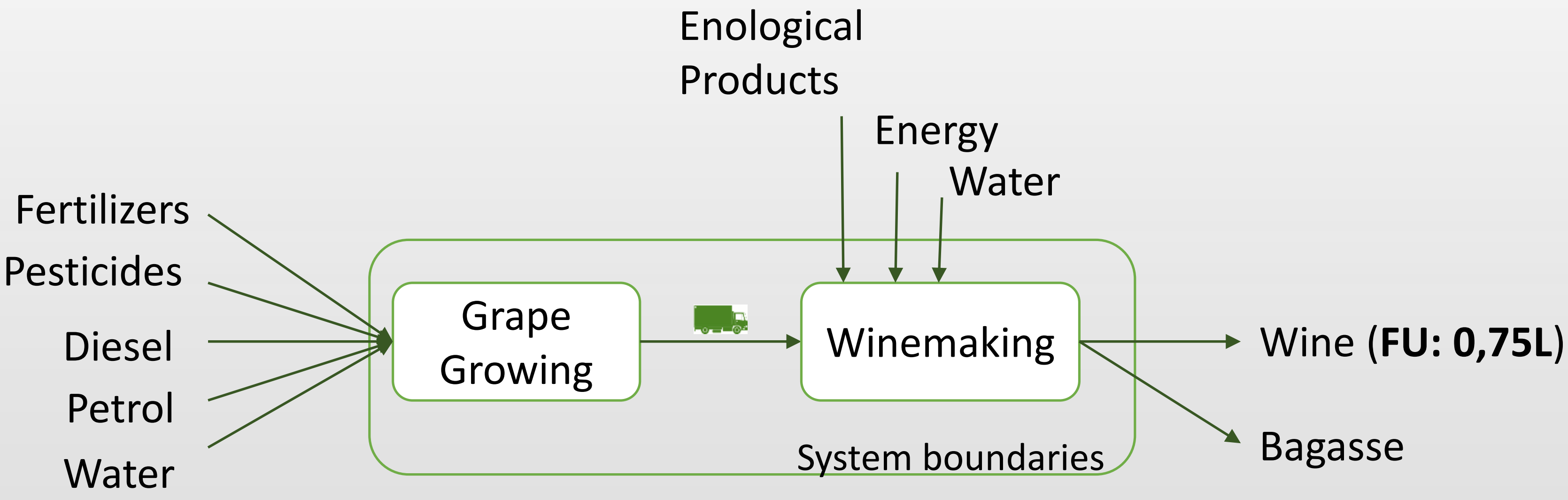
- Make a comparative inventory analysis for the different producers
- Identify the LC phase of wine production with higher environmental performance
- Identify the processes with more contributors to the GHG emissions

Life-cycle model

- ❖ Eleven different LC inventories for grape growing from 5 different regions was analyzed
- ❖ Three wine producers from three different regions was considered

Four different types of wine Red, White, Rose and Sparkling

Life-cycle model



- A cradle-to-gate approach was considered
- LC model included grape growing (viticulture), grape transportation and wine production, but did not include packaging and distribution;
- Bagasse was sold, but it represents a very low cash flow (↓1%) and no allocation of GHG emissions was performed

Inventory (1)

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	Region	B				D		C	
	Producer / Area	BA 17ha	BB 3ha	BC 6ha	BD 6ha	DA 2.5ha	DB 6ha	CA 14ha	CB 7ha
	Year	2011 and 2012	2012	2012	2012	2012	2012	2012	2011
Chemical Fertilizers	N (kg)	17.5	72	-	18	-	-	13	46
	P (kg)	35	48	-	16	-	-	26	83
	K (kg)	35	48	-	20	-	-	27	83
	Calcium Nitrate (kg)	6.8	-	-	-	-	-	-	-
	$CaCO_3$ (kg)	280	-	-	-	-	144	-	140
	Boron (g)	-	100	-	40	400	300	200	220
	Magnesium (kg)		-	-	-	6	-	-	-
	Magnesium oxide (kg)	-	-	-	-	-	12.6	-	-
Organic Fertilizers	N (kg)	-	-	-	4.3	-	-	-	-
	Poultry manure (kg)	-	-	-	-	400	9418	-	-
Pesticides (a.i.)	Azoxystrobin (kg)	9	-	0.2	-	-	0.13	1.5	-
	Glyphosate (kg)	1.44	-	2.34	1.2	-	1.35	-	-
	Folpet (kg)	0.95	2.23	1.5	1.24	0.6	-	-	1
	Metalaxyl-M (g)	50	100	50	-	170	-	-	-
	Mandipropamid (g)	60	-	60	-	-	-	-	-
	Copper oxide (g)	440	-	480	-	-	-	-	-
	Mancozeb (kg)	-	-	-	0.22	0.6	2.7	0.98	-
	Fosetyl-Al (kg)	-	1.5	-	0.53	0.45	-	0.98	2.1
	Sulfur (kg)	-	-	-	-	2.5	13.6	78	-
	Trifloxystrobin (g)	-	80	-	-	-	-	-	-
	Tebuconazole (g)	-	8	-	40	-	-	-	-
	Cymoxanil (g)	-	100	-	200	-	290	-	-
	Copper (kg)	-	1.9	-	1.5	-	-	-	0.74
	Fungicide unspecified (kg)	-	1	-	-	-	-	-	-
	Pesticide unspecified (g)	-	-		-	-	450	-	-
	Penconazole (g)	-	-	40	30	30	-	-	-
	Glufosinate (g)	-	-	-	430	-	-	-	-
	Chlorpyrifos (g)	-	-	-	240	-	-	-	-
	Spiroxamin (g)	-	-	-	170	-	-	-	-
	Metiram (kg)	-	-	-	1.56	-	-	-	-
	Fenhexamid (g)	-	-	-	410	-	-	-	-
	Methoxyfenozide (g)	-	-	-	80	-	-	-	-
	Copper oxychloride (g)	-	-	-	-	400	570	-	-
	Tetraconazol (kg)	-	-	-	-	-	-	-	1.26
Diesel (L)		176 [a]	475	580	333 [a]	194	270	200 [a]	139 [a]
Grape transportation (km)		6	10	6	50	1	12	1	12
Productivity (t)		5.85 6.50	6.00	8.30	4.12	3.20	6.83	6.79	6.94

	Region	E						F	
	Producer	EA			EB			FA	
	Area	87ha			168ha	193ha		65ha	
	Year	2010	2011	2012	2010	2011	2012	2010	2011
Chemical Fertilizers	N (kg)	0.15	0.06	0.03	-	-	-	2.5	-
	P (kg)	61.9	22.4	13.4	0.27	0.24	-	20	18
	K (kg)	63.6	21.5		0.54	1.25	0.78	10.3	12.9
	Fito algae (kg)	-	-	-	-	1.81	1.81	-	-
	CaCO3 (kg)	28.9	160.9	-	-	-	-	44.1	-
	$CaMg(CO_3)_2$ (kg)	305.7	225.3	679.9	-	-	-	-	-
	Boron (g)	-	-	-	45	39	-	-	-
	Magnesium oxide (g)	-	-	-	-	194	194	-	-
Organic Fertilizers	N (kg)	15.6	-	8.8	-	-	-	18.6	25.8
	P (kg)	6.4	-	4.4	-	-	-	8.3	12.9
	K (kg)	6.4	-	4.4	-	-	-	-	-
Pesticides (a.i.)	Oxiflurone (g)	-	-	-	743	373	249	-	-
	Glyphosate (kg)	1.57	1.07	1.16	1.07	1.84	1.83	-	-
	Flazasulfuron (g)	-	-	-	2.97	15.5	7.77	-	-
	Kresoxim-Methyl (g)	-	2.29	34.5	42.8	72.5	15.5	-	-
	Copper hydroxide (g)	-	-	-	833	635	544	-	-
	Cyazofamid (g)	-	-	-	77.4	-	13	-	-
	Fluopicolide	-	-	-	91.7	20.5	34.2	-	-
	Fosetyl-Al (g)	-	69	-	1388	311	-	2262	-
	Spiroxamine (g)	-	-	-	232	453	259	-	-
	Proquinazida (g)	-	-	-	31	-	-	-	-
	Tebuconazole (g)	121	86.2	-	77.4	-	-	145	85.1
	Sulfur (kg)	2.76	5.06	6.21	22.6	24.6	12.3	9.85	19.7
	Flufenoxuron (kg)	-	-	-	11.3	-	-	-	-
	Quizalope-P-ethyl (g)	-	0.58	-	-	9.1	11.7	-	-
	Diflufenican (g)	-		-	-	16.6	15.5	-	-
	Folpet (kg)	1.17	1.48	1.06	-	1.43	-	0.09	2.71
	Metalaxyl-M (g)	293	172	264	-	77.8	64.8	400	400
	Cimoxanyl (g)	27.6	46	22.1	-	49.7	60.1	125	111
	Copper oxychloride (kg)	-	-	-	-	1.27	1.17	0.86	-
	Metiram (g)	-	-	-	-	185	171	-	-
	Pyraclostrobin (g)	-	-	-	-	16.8	15.5	-	-
	Iprovalicarb (g)	-	114	-	-	88.6	88.6	-	-
	Chlorantraniliprole (g)	-	-	-	-	6.2	12.4	-	-
	Metoxifenocida (g)	-	-	-	-	14.9	14.9	-	-
	Trifloxystrobin (g)	-	-	-	-	-	-	154	-
	Mancozeb (kg)	0.321	0.534	0.257	-	-	-	2.26	-
	Amonium glufosinate (g)	379	371	344	-	-	-	185	92.3
	Terbuthylazine (g)	919	-	-	-	-	-	-	-
	Myclobutanil (g)	17.1	-	-	-	-	-	-	0,3
	Quinoxyfen (g)	17.1	25.9	230	-	-	-	-	-
	Meptyldinocap (g)	-	129	133	-	-	-	-	-
	Boscalid (g)	-	4.60	69.0	-	-	-	-	-
	Dimethomorph (g)	-	8.31	-	-	-	-	-	-
	Chlorantraniliprole (g)	-	4.60	-	-	-	-	-	-
	Cyprodinil (g)	-	-	51.7	-	-	-	-	-
	Fludioxonil (g)	-	-	17.2	-	-	-	-	-
	Metrafenone (g)	-	-	34.5	-	-	-	-	-
	Glufosinate (g)	-	59.7	-	-	-	-	-	-
	Thiophanate methyl (kg)	-	-	2,1	-	-	-	-	-
Water (L)		4138	4138	4713	-	-	-	-	-
Diesel (include diesel for grape transportation) (L)		75.6	124.7	132.2	88.9	96.2	92.5	184.6	215.4
Petrol (L)		-	-	-	-	-	-	1.54	1.54
Productivity (t)		2.89	3.51	2.55	4.35	3.50	4.35	5.38	5.77

Inventory (2)

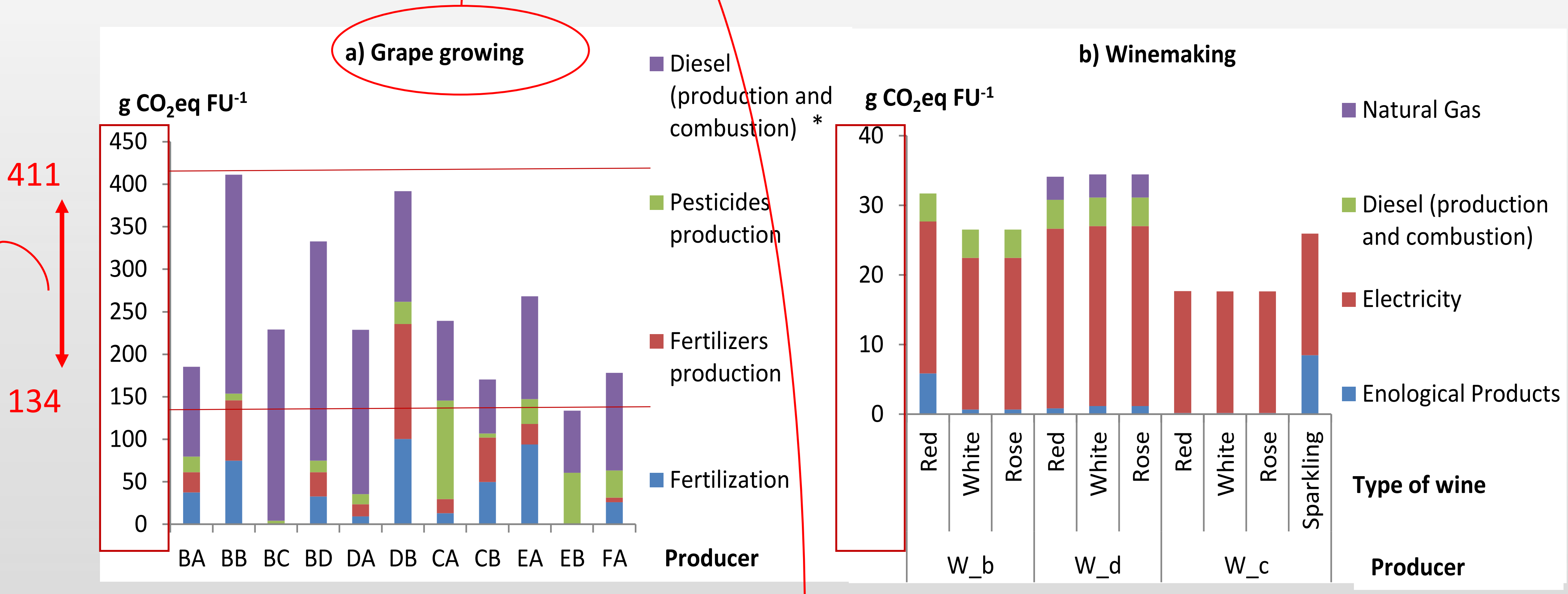
Inputs	Producer	W_b			W_d			W_c				Units
		Red	White	Rose	Red	White	Rose	Red	White	Rose	Sparkling	
Enological Products												
	Sulfur dioxide	67.5	67.5	67.5	97.8	97.8	97.8	56.3	56.3	56.3	56.3	mg
	Sugar	3	-	-	-	-	-	-	-	-	-	g
	Yeast	225	225	7.5	130	130	130	-	10	10	9000	mg
	Ascorbic acid[a]	37.5	45	45	-	50	49.8	-	-	-	-	mg
	Sorbate[a]	37.5	113	113	-	-	-	-	-	-	-	mg
	Filtrostabil (Arabic gum)[a]	0.75	-	-	-	-	-	-	-	-	-	mg
	Citric acid[a]	-	75	75	-	-	-	-	-	-	-	mg
	CMC [stabilizer]	-	1.5	1.5	-	-	-	-	-	-	-	mg
	Nutrients	-	-	-	326	326	326	-	-	-	-	mg
	Tannins[a]	-	-	-	52.2	52.2	52.2	-	-	-	-	mg
	Enzymes[a]	-	-	-	7.83	7.83	7.83	-	-	-	-	mg
	Gelatins[a]	-	-	-	-	750	750	-	75	75	75	mg
	Bentonite	-	-	-	-	-	-	188	169	169	169	mg
	Albumin[a]	-	-	-	-	-	-	93.8	-	-	-	mg
	Metatartaric acid[a]	97.9	-	-	-	-	-	-	-	-	-	g
	Tartaric acid[a]	-	-	-	163	163	163	-	-	-	-	mg
Energy												
	Electricity	47	47	47	56	56	56	38	38	38	38	Wh
	Diesel	1.3	1.3	1.3	1.3	1.3	1.3	-	-	-	-	mL
	Natural Gas	-	-	-	49	49	49	-	-	-	-	J
Water		1.75	1.75	1.75	0.98	0.98	0.98	0.08	0.08	0.08	0.08	L
Grapes		1	1	1	1	1	1	1	1	1	1	kg
	Outputs											
Wine		0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	L
Stalk		26	26	26	26	26	26	26	26	26	26	g
Bagasse		0.11	0.11	0.11	0.11	0.11	0.11	0.23	0.23	0.23	0.23	kg

- Type and quantities of enological products are different to the different considered regions;
- When we compare the same region, the Enological products applied are the same for wine and rose wine;
- To each producer, energy and water inputs presented the same quantities per 0,75L of wine, because the production occurs simultaneously

mass allocation was considered to distribute this inputs ;

Results

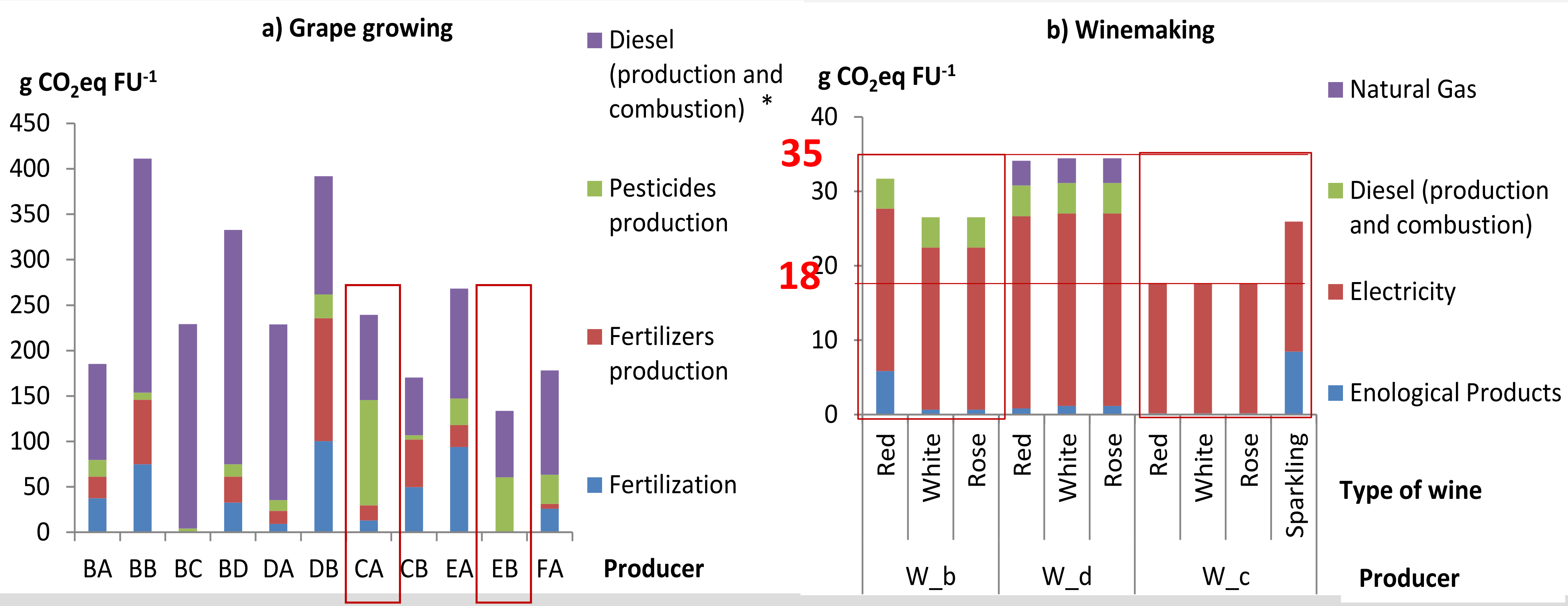
82% - 99%



151 – 446 g CO_2 per 0.75 L wine

Lower energy and fertilizer use by *EB* compared to *BB*

Results



- Main contributors to the GHG emissions were diesel and pesticides
- For the remaining producers fertilizers and diesel were the main contributors to GHG emissions
- W_b ↑ GHG emissions to red wine due to sugar use
- W_c ↑ GHG emissions to sparkling wine due to yeast use

Conclusions

- There is a significant variation of the GHG intensity of the wine for the various producers, but not for the different types of wine;
- The total wine GHG intensity varies between 151 g CO_2eq and 446 g CO_2eq per 0.75 L of wine;
- Grape growing is the LC phase with the highest GHG emissions (88% to 92%);
- Efforts to reduce GHG emissions should be focus on the cultivation

Adoption of best agricultural management practices

soil analysis

land morphology

weather conditions

Conclusions

- **Future work**

  - ❖ Considered more impact categories (e.g. acidification, marine and freshwater eutrophication) and other impact assessment methods (e.g. Usetox, due to the higher application of pesticides);

  - ❖ In addition, due to the high variation on the results, an uncertainty analysis should be included;

  - ❖ Different packages must be analyzed;

  - ❖ Different export scenarios should be considered.

Thank You!
Questions and Comments

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Emails: filipa.figueiredo@dem.uc.pt, erica@dem.uc.pt, aferreira@esac.pt, htrindad@utad.pt, fausto.freire@dem.uc.pt

http://www2.dem.uc.pt/CenterIndustrialEcology/

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