REPORT

On NUTS 3 classified areas in Romania (i.e. counties) where the typical greenhouse gas emissions from cultivation of agricultural raw materials can be expected to be lower than or equal to the emissions reported under the heading 'Disaggregated default values for cultivation' in part D of Annex V to Directive 2009/28/EC

On the basis of Contract No 24 of 12 July 2010 concluded between the Ministry of Agriculture and Rural Development and the National Institute of Research and Development in Soil Science, Agrochemistry and the Environment - ICPA Bucharest, the 'Computer system to determine the impact of indirect change in the use of agricultural land in order to obtain biofuels and bioliquids in Romania' was put into place.

This was used to draw up the report on NUTS 3 classified areas in Romania (i.e. counties) where the typical greenhouse gas emissions from cultivation of agricultural raw materials are lower than or equal to the emissions reported under the heading 'Disaggregated default values for cultivation', in accordance with the requirements laid down in Article 19(2) and Annex V to Directive 2009/28/EC.

The greenhouse gas emissions resulting from cultivation of plants and energy consumption throughout the chain of production of biofuels and bioliquids were calculated using the methodology proposed by the Energy Institute of the Joint Research Centre – JRC ('Information on the calculating greenhouse gas emissions from cultivation of arable crops: non-soil emissions' – 07.04.2010 [*sic*]). As the methodology was developed by the European Commission's Joint Research Centre, it may be considered as a point of reference for the assessment of typical greenhouse gas emissions, which are to be compared with the emissions reported under the heading 'Disaggregated default values for cultivation' in part D of Annex V to Directive 2009/28/EC.

The calculations did not take into account the direct effect of modifying land use, on the grounds that there would not be a significant change to crop structure and that land with other uses (pasture, meadows, orchards, vineyards) would not be transformed into arable land. Therefore, all the figures produced by this report refer to arable land.

The specific parameters for farms and crops were introduced according to the specific soil, climate and technological conditions in Romania.

Values for N_2O emissions from the soil were determined using data associated with the report 'Global pattern of N_2O emissions from soils due to cultivation of potential biofuel crops', authored by Renate Koeble and Adrian Leip of the Joint Research Centre (Ispra) Institute for Environment and Sustainability (**http://afoludata.jrc.ec.europa.eu/index.php/dataset/files/221**).
The values generated by this report were averaged at county level and corrected using values considered in this study for nitrogen-based mineral fertilizers.

Specific inputs for farms and crops

The framework technologies for the crops used to produce biofuels and bioliquids (wheat, maize, sunflower, soya, oilseed rape, sugar beet) provided by the Ministry of Agriculture and Rural

Development were used to specify the input values for the consumption of diesel in agricultural works and the consumption of plant health substances.
The consumption of (nitrogen, phosphorus and potassium) fertilizers was calculated using the coefficients in the Code of Good Agricultural Practice, depending on the estimated crop production (kg of nitrogen, phosphorus, potassium per tonne of main product) – see table 1.

The programmes used to determine values for greenhouse gases were used for the following harvest levels:

- Ø the national multi-annual average for 1991-2008, provided by the National Institute of Statistics (see table 2);
- Ø the lower harvest threshold, defined by the difference between the multi-annual average (1991-2008) and the standard deviation for the production series;
- Ø the upper harvest threshold, defined by the sum of the multi-annual average (1991-2008) and the standard deviation for the production series;
- Ø production where the default values of the crop coefficients are equal to those provided by Annex V/part D - see table 3.

Table 1

Average consumption (exports) of soil nutrients in the generation of harvests (kg of nutrients/tonne of main harvest and the quantity corresponding to the secondary harvest)

Crops		Nutrients (conventional active substances)		
		N	P_2O_5	K_2O
Autumn wheat	grain: straw 1 : 1.3	26.5	13.7	16.4
Grain maize	grain: stalks 1 : 1.6	27.5	12.5	16.5
Silage maize	whole plants with cobs	6.5	3.0	5.5
Sugar beet	roots: leaves and necks 1 : 1	4.9	2.0	6.0
Sunflower	seeds: stalks 1 : 3	36.5	17.5	50.0
Oilseed rape	seeds: stalks 1 : 3	51.5	36.0	44.0
Soya	grain: stems 1 : 1.5	70.0*	22.5	34.0

*) mostly derived from symbiosis with nitrogen-fixing micro-organisms

Regression functions (power functions) between the greenhouse gas emissions (g $CO_{2\ ech}$ MJ-1) and the main crop production (t/ha) have been set up for each biofuel or bioliquid production chain. In this way it is possible to establish values for greenhouse gas emissions for any harvest level.

Table 2

Average national production values and the standard deviation for the period 1991-2008

Crop	Average production kg/ha	Standard deviation kg/ha
Wheat	2517	597
Grain maize	3073	800
Sugar beet	21951	5417
Sunflower	1210	228
Oilseed rape	1126	421
Soya	1525	499

Table 3

Production values needed to reach the typical values of the crop coefficient in Annex V/part D of Directive 2009/28/EC and the average production values in the EU-27 countries for the period 2000-2009, provided by Eurostat

Crop	Production level needed to reach the typical values in Annex V kg/ha	Average production values in EU27 countries 2000-2009 kg/ha
Wheat	6000	5500
Grain maize	4500	6600
Sugar beet	60000	55000
Sunflower	3600	1670
Oilseed rape	2400	3000
Soya	3200	2500

Spatial distribution and aggregation at administrative division level of crop coefficients

For the spatial analysis of the Annex V/part D crop coefficients, the methodology used was that proposed by the JRC, which uses the following production entry data:

1. multi-annual average values for harvests that can be obtained without irrigation, using optimum technology (compensating for fertilizer stress through the use of mineral fertilizers over the crop's entire period of plant development) assessed using the ROIMPEL agro-soil-climate simulation model together with the digital map of the soils of Romania (scale 1:200 000) and the climate data network database (10 x 10 km) for the period 1991-2008. Harvests were evaluated for each arable soil polygon (defined on the basis of the LCCS geo-referenced layer), based on satellite flights carried out in 2002);
2. minimum values for harvests that can be obtained without irrigation, using optimum technology, stated as the difference between the multi-annual average values and the standard deviation calculated using the ROIMPEL model (under the same conditions as in point 1);
3. maximum values for harvests that can be obtained without irrigation, using optimum technology, stated as the sum of the multi-annual average values and the standard deviation calculated using the ROIMPEL model (under the same conditions as in point 1);
4. multi-annual average values for harvests obtained without irrigation, using current technology.

The information on greenhouse gas emissions (g $CO_{2\ ech}$ MJ^{-1}) at county (NUTS 3) level was aggregated for the four levels of production as an average of the emissions from each arable soil-land unit.

The results of the calculations using the methodology proposed by the JRC are presented in Tables 4-8. Having analysed the data in these tables, typical greenhouse gas emissions from cultivation of agricultural raw materials calculated using this procedure can be expected to be lower than or equal to the emissions reported under the heading 'Disaggregated default values for cultivation' in part D of Annex V to Directive 2009/28/EC in the following NUTS 3 administrative divisions, as follows:

- Ø for wheat ethanol: all counties where potential production (average production and production in favourable years) is considered; no county in the case of average production recorded over the period 1991-2008 (table 4);

- Ø for maize ethanol: for average potential production, the typical emissions are equal to those in the Directive only in C•l•ra•i, Cara•-Severin, Dâmbovi•a, Ialomi•a, Ilfov, Maramure•, Satu Mare and Teleorman counties. For favourable years (approximately

one every three years), emissions are lower or equal in all the other counties, except for Alba and Harghita. In the case of average production recorded over the period 1991-2008 (table 5), no county has emissions lower than or equal to those in the Directive;

- Ø for oilseed rape biodiesel: all counties where potential production (average production and production in favourable and unfavourable years) is considered; in all counties where production recorded in the period 1991-2008 (table 6) is considered, except for Alba and Harghita;
- Ø in the case of sunflower biodiesel, emissions are lower than those in the Directive for average potential production in the following counties: C•l•ra•i, Cara•-Severin, Dâmbovi•a, Ialomi•a, Ilfov, Maramure•, Satu Mare and Vrancea. For Arad, Br•ila, Bra•ov, Giurgiu, Gorj, Teleorman and Timi•, the level is estimated to be equal to that in the Directive. In favourable years, the estimated emissions for potential production are lower than or equal to those in the Directive for all counties. In the case of average production recorded over the period 1991-2008, no county has emissions lower than or equal to those in the Directive (table 7);
- Ø for sugar beet bioethanol, emissions are estimated to be lower than or equal to those in the Directive for all the other counties except for Alba and Harghita. In Arad, Bihor, Bra•ov, C•l•ra•i, Cara•-Severin, Covasna, Dâmbovi•a, Giurgiu, Ialomi•a, Ilfov, Maramure•, Prahova, Timi• and Vrancea counties, the emissions are lower than or equal to those in the Directive, even in unfavourable years (potential production). In the case of average production recorded over the period 1991-2008, the following counties had emissions lower than or equal to those in the Directive: Arad, Bihor, Br•ila, Bra•ov, C•l•ra•i, Cara•-Severin, Covasna, Dâmbovi•a, Dolj, Gala•i, Giurgiu, Gorj, Hunedoara, Ialomi•a, Ilfov, Maramure•, Mehedin•i, Neam•, Prahova, Satu Mare, Teleorman, Timi• and Vrancea (Table 8).

Given the specific characteristics of Romanian agriculture, namely the coexistence of farms engaged in extensive and intensive agriculture, we believe that both typical emission values (columns 2 and 5 of tables 4-8) are relevant for biofuel producers. The figures in column 2 refer to farms engaged in intensive agriculture, with a surface area of over 50 hectares. The figures in column 5 refer to farms engaged in extensive agriculture, with a surface area of up to 50 hectares.
Therefore, columns 2 and 5 are the ones that are relevant to biofuel producers.
However, given the great climate variability in Romania, we have also included column 3 in tables 4-8 in order to show biofuel producers the range of typical emissions.
It is up to biofuel producers to choose whether to use column 2 or column 5.

Emissions from the extraction or cultivation of raw materials **Table 4**

Wheat ethanol

Typical emissions cf. Directive 2009/28/EC : 23 g CO2 ech / MJ

Average potential production ± standard deviation where no irrigation

Average production recorded

1991-2008

County	Potential production				Average production recordec	
	Production t/ha	ypical emissions $gCO2_{ech}$ MJ^{-1}			Production t/ha	ypical emission $gCO2_{ech}$ MJ^{-1}
	Average	Average	Range		Average 1991-2008	Average
	1	2	3		4	5
ALBA	5,62	20	17	26	2,53	26
ARAD	5,98	20	16	26	2,69	25
ARGES	4,89	20	17	25	2,20	26
BACAU	5,55	20	17	26	2,50	26
BIHOR	5,62	20	16	27	2,53	25
BISTRITA-NASAUD	6,13	21	17	26	2,76	25
BOTOSANI	6,37	20	16	27	2,87	25
BRAILA	5,47	21	16	28	2,46	26
BRASOV	7,05	21	17	26	3,17	25
BUZAU	5,69	21	16	28	2,56	26
CALARASI	5,48	21	16	30	2,47	26
CARAS-SEVERIN	5,91	20	17	24	2,66	25
CLUJ	6,65	20	17	26	2,99	25
CONSTANTA	6,16	20	16	28	2,77	25
COVASNA	7,50	21	17	25	3,37	24
DAMBOVITA	4,71	21	17	26	2,12	27
DOLJ	5,48	20	17	25	2,46	25
GALATI	5,93	20	16	27	2,67	25
GIURGIU	5,04	21	17	29	2,27	27
GORJ	5,58	20	17	26	2,51	26
HARGHITA	7,65	22	18	27	3,44	26
HUNEDOARA	6,46	20	17	25	2,91	25
IALOMITA	5,53	21	16	29	2,49	26
IASI	5,82	20	16	28	2,62	25
ILFOV	4,73	21	17	29	2,13	28
MARAMURES	5,33	21	17	26	2,40	26
MEHEDINTI	5,49	19	16	24	2,47	25
MUNICIPIUL BUCURESTI	3,81	22	17	29	1,71	29
MURES	6,18	20	17	26	2,78	25
NEAMT	5,82	20	17	26	2,62	25
OLT	5,26	20	17	26	2,37	26
PRAHOVA	5,47	21	17	28	2,46	26
SALAJ	5,25	20	17	26	2,36	26
SATU MARE	5,19	21	17	27	2,34	26
SIBIU	5,98	21	17	26	2,69	26
SUCEAVA	6,78	20	17	26	3,05	25
TELEORMAN	5,26	20	17	26	2,37	26
TIMIS	5,91	20	17	26	2,66	25
TULCEA	5,50	21	16	29	2,47	26
VALCEA	5,89	20	17	26	2,65	25
VASLUI	5,80	20	16	27	2,61	25

Emissions from the extraction or cultivation of raw materials **Table 5**

Maize ethanol

Typical emissions cf. Directive 2009/28/EC : 20 g $CO_{2\ ech}$ / MJ

Potential average production ± standard deviation where no irrigation

Average production recorded

1991-2008

County	Potential production				Average production recorded	
	Production t/ha	Typical emissions $gCO2_{ech}\ MJ^{-1}$			Production t/ha	Typical emissions $gCO2_{ech}\ MJ^{-1}$
	Average	Average	Range		Average 1991-2008	Average
	1	2	3		4	5
ALBA	3,61	27	21	36	2,35	33
ARAD	4,88	21	17	29	3,17	24
ARGES	3,90	21	16	30	2,53	25
BACAU	3,93	25	19	35	2,55	30
BIHOR	4,62	21	17	29	3,00	25
BISTRITA-NASAUD	3,78	25	20	33	2,46	30
BOTOSANI	4,59	23	17	33	2,99	27
BRAILA	4,78	21	15	33	3,10	24
BRASOV	4,67	21	17	27	3,04	24
BUZAU	4,87	23	17	35	3,16	27
CALARASI	5,23	20	15	32	3,40	22
CARAS-SEVERIN	4,95	20	16	28	3,22	23
CLUJ	4,18	24	19	32	2,72	29
CONSTANTA	4,42	23	17	35	2,87	27
COVASNA	4,41	22	18	27	2,87	24
DAMBOVITA	4,70	20	16	26	3,06	22
DOLJ	4,51	21	16	33	2,93	25
GALATI	4,74	22	16	33	3,08	25
GIURGIU	4,66	21	16	30	3,03	24
GORJ	4,82	21	16	31	3,14	24
HARGHITA	2,38	31	25	42	1,55	38
HUNEDOARA	4,74	22	17	30	3,08	26
IALOMITA	5,07	20	15	32	3,29	23
IASI	4,19	24	18	36	2,73	28
ILFOV	4,65	20	16	29	3,02	23
MARAMURES	4,31	20	17	26	2,80	23
MEHEDINTI	4,38	21	16	30	2,85	24
MUNICIPIUL BUCURESTI	3,76	21	17	27	2,45	24
MURES	4,03	24	20	33	2,62	29
NEAMT	4,58	22	17	30	2,98	25
OLT	4,07	23	17	36	2,64	27
PRAHOVA	5,34	21	16	30	3,47	24
SALAJ	3,85	23	19	30	2,50	27
SATU MARE	4,68	20	16	27	3,04	23
SIBIU	3,96	24	19	33	2,57	29
SUCEAVA	4,52	23	19	30	2,94	27
TELEORMAN	4,49	20	15	31	2,92	24
TIMIS	4,94	21	17	29	3,21	24
TULCEA	4,06	23	17	33	2,64	27
VALCEA	4,97	22	16	33	3,23	25
VASLUI	4,55	22	17	34	2,96	26

Emissions from the extraction or cultivation of raw materials **Table 6**

Oilseed rape biodiesel

Typical emissions cf. Directive 2009/28/EC : 29 g CO2 ech / MJ

Potential average production ± standard deviation where no irrigation

Average production recorded

1991-2008

County	Potential production				Average production recorded	
	Production t/ha	ypical emissions $gCO2_{ech}\ MJ^{-1}$			Production t/ha	ypical emission $gCO2_{ech}\ MJ^{-1}$
	Average	Average	Range		Average 1991-2008	Average
	1	2	3		4	5
ALBA	2,33	21	17	27	0,93	31
ARAD	3,12	19	16	25	1,25	25
ARGES	2,52	19	16	24	1,01	26
BACAU	2,65	20	16	27	1,06	28
BIHOR	2,90	19	16	25	1,16	26
BISTRITA-NASAUD	2,75	20	17	26	1,10	28
BOTOSANI	3,21	20	16	27	1,28	26
BRAILA	3,07	19	15	27	1,23	25
BRASOV	3,71	19	15	24	1,48	24
BUZAU	3,05	20	16	28	1,22	27
CALARASI	3,41	19	14	28	1,36	24
CARAS-SEVERIN	3,07	19	16	23	1,23	25
CLUJ	2,95	20	16	27	1,18	27
CONSTANTA	3,31	20	15	28	1,32	26
COVASNA	4,07	19	15	24	1,63	23
DAMBOVITA	2,73	19	16	25	1,09	25
DOLJ	3,00	19	16	24	1,20	25
GALATI	3,23	19	15	27	1,29	25
GIURGIU	2,83	20	15	27	1,13	26
GORJ	2,92	19	16	24	1,17	26
HARGHITA	2,45	22	18	28	0,98	32
HUNEDOARA	3,20	19	16	25	1,28	25
IALOMITA	3,34	19	15	27	1,33	24
IASI	2,80	20	16	29	1,12	27
ILFOV	2,72	20	15	27	1,09	26
MARAMURES	2,88	19	15	24	1,15	25
MEHEDINTI	2,86	18	16	23	1,14	25
MUNICIPIUL BUCURESTI	2,17	20	16	27	0,87	28
MURES	2,72	20	17	26	1,09	28
NEAMT	3,12	19	16	26	1,25	26
OLT	2,77	19	16	25	1,11	27
PRAHOVA	3,08	20	15	27	1,23	26
SALAJ	2,51	20	16	26	1,01	28
SATU MARE	2,86	19	15	25	1,14	25
SIBIU	2,79	20	17	26	1,11	28
SUCEAVA	3,57	19	16	25	1,43	25
TELEORMAN	2,95	19	15	25	1,18	25
TIMIS	3,04	19	16	25	1,22	26
TULCEA	2,95	19	15	28	1,18	26
VALCEA	3,04	19	16	24	1,22	26
VASLUI	3,02	20	15	27	1,21	26

Emissions from the extraction or cultivation of raw materials **Table 7**
Sunflower biodiesel
Typical emissions cf. Directive 2009/28/EC : 19 g CO2 ech / MJ
Potential average production ± standard deviation where no irrigation
Average production recorded
1991-2008

County	Potential production				Average production recorded	
	Production t/ha	Typical emissions $gCO2_{ech}\,MJ^{-1}$			Production t/ha	Typical emissions $gCO2_{ech}\,MJ^{-1}$
	Average	Average	Range		Average 1991-2008	Average
	1	2	3		4	5
ALBA	1,42	27	22	36	1,00	34
ARAD	1,92	19	15	26	1,34	23
ARGES	1,53	20	16	28	1,07	24
BACAU	1,55	24	19	34	1,08	30
BIHOR	1,82	20	16	27	1,27	23
BISTRITA-NASAUD	1,49	24	19	32	1,04	30
BOTOSANI	1,81	21	16	31	1,27	25
BRAILA	1,88	19	14	29	1,32	22
BRASOV	1,84	19	15	24	1,29	22
BUZAU	1,92	21	16	32	1,34	26
CALARASI	2,06	17	13	28	1,44	20
CARAS-SEVERIN	1,95	18	15	25	1,36	22
CLUJ	1,64	23	19	31	1,15	28
CONSTANTA	1,74	22	16	33	1,22	27
COVASNA	1,74	19	16	24	1,22	22
DAMBOVITA	1,85	17	14	23	1,30	20
DOLJ	1,78	20	15	31	1,24	24
GALATI	1,86	20	15	30	1,31	23
GIURGIU	1,83	19	15	27	1,28	22
GORJ	1,90	19	15	28	1,33	23
HARGHITA	0,94	31	25	42	0,66	39
HUNEDOARA	1,87	20	16	28	1,31	24
IALOMITA	1,99	18	13	29	1,40	21
IASI	1,65	23	17	35	1,16	28
ILFOV	1,83	18	14	26	1,28	21
MARAMURES	1,70	18	15	23	1,19	22
MEHEDINTI	1,72	20	15	29	1,21	24
MUNICIPIUL BUCURESTI	1,48	19	15	25	1,04	23
MURES	1,59	24	19	32	1,11	29
NEAMT	1,80	20	16	28	1,26	24
OLT	1,60	22	16	35	1,12	27
PRAHOVA	2,10	19	15	27	1,47	22
SALAJ	1,51	22	18	28	1,06	27
SATU MARE	1,84	18	14	24	1,29	21
SIBIU	1,56	24	19	32	1,09	29
SUCEAVA	1,78	21	17	28	1,24	26
TELEORMAN	1,77	19	14	28	1,24	22
TIMIS	1,94	19	15	26	1,36	23
TULCEA	1,60	21	16	31	1,12	26
VALCEA	1,96	20	15	31	1,37	24
VASLUI	1,79	21	16	32	1,25	25

Emissions from the extraction or cultivation of raw materials **Table 8**

Sugar beet bioethanol

Typical emissions cf. Directive 2009/28/EC : 12 g $CO_{2\ ech}$ / MJ

Potential average production ± standard deviation where no irrigation

Average production recorded

1991-2008

County	Potential production				Average production recorded	
	Production t/ha	ypical emissions $gCO2_{ech}$ MJ^{-1}			Production t/ha	ypical emission $gCO2_{ech}$ MJ^{-1}
	Average	Average	Range		Average 1991-2008	Medie
	1	2	3		4	5
ALBA	25,80	14	11	19	17,54	20
ARAD	34,85	9	7	12	23,70	12
ARGES	27,81	10	7	14	18,91	13
BACAU	28,05	12	10	17	19,07	17
BIHOR	32,96	9	7	12	22,41	12
BISTRITA-NASAUD	26,98	12	10	16	18,35	16
BOTOSANI	32,81	10	8	15	22,31	13
BRAILA	34,10	8	6	13	23,19	11
BRASOV	33,35	8	7	10	22,68	10
BUZAU	34,76	10	8	15	23,64	14
CALARASI	37,36	7	5	11	25,40	9
CARAS-SEVERIN	35,36	8	6	11	24,05	11
CLUJ	29,83	11	9	15	20,29	15
CONSTANTA	31,55	10	8	16	21,45	14
COVASNA	31,52	8	7	10	21,43	11
DAMBOVITA	33,57	8	6	10	22,83	10
DOLJ	32,22	9	7	14	21,91	12
GALATI	33,83	9	7	14	23,00	12
GIURGIU	33,26	8	7	12	22,62	11
GORJ	34,44	9	7	13	23,42	11
HARGHITA	17,00	16	13	22	11,56	22
HUNEDOARA	33,87	9	7	13	23,03	12
IALOMITA	36,18	8	6	12	24,60	10
IASI	29,94	11	8	17	20,36	15
ILFOV	33,21	8	6	11	22,58	10
MARAMURES	30,77	8	7	10	20,93	11
MEHEDINTI	31,29	9	7	13	21,28	12
MUNICIPIUL BUCURESTI	26,88	9	7	12	18,28	12
MURES	28,78	12	9	16	19,57	16
NEAMT	32,73	9	7	13	22,26	12
OLT	29,03	11	8	17	19,74	15
PRAHOVA	38,12	8	7	12	25,92	11
SALAJ	27,46	11	9	14	18,67	15
SATU MARE	33,44	8	6	10	22,74	10
SIBIU	28,25	12	9	16	19,21	16
SUCEAVA	32,25	10	8	13	21,93	14
TELEORMAN	32,07	8	6	13	21,81	11
TIMIS	35,28	9	7	12	23,99	12
TULCEA	29,01	10	8	15	19,73	14
VALCEA	35,47	9	7	14	24,12	13
VASLUI	32,46	10	7	15	22,08	13