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Field Burning of Crop Residues

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Summary

Emissions of greenhouse gases from field burning of crop residues have been estimated to very low levels in 2002. The emissions of CO and NOx may however be considered as not negligible. Information provided by experts support a decreasing trend of field burning as an agricultural practice, but there are only usable activity data for one single year (1997).

Due to lack of activity data from beginning of the nineties and very low emission levels, the study concludes that Sweden should report trace gas emissions from field burning of crop residues as not occurring "NO" in the emission inventories.

1. Introduction

Burning of crop residues in the fields is an agricultural practice, which causes emissions of methane, carbon monoxide, nitrous oxide and nitrogen oxides. But because it is non-fossile it is not treated as a net source of carbon dioxide by IPCC.

According to the IPCC Guidelines[1] and the Good Practice Guidance[2], emissions of CH_4, CO, N2O and NOx from field burning of agricultural residues should be reported in the CRF table 4F.

Field burning has been considered as very rare in Sweden, and therefore, by using the decision tree in IPCC Good Practice Guidance, chapter 4.6, Figure 4.6, this source has been reported as not occurring (NO) in the Swedish greenhouse gas inventory.

1.1 Aim of study

The aim of this study was to investigate whether Sweden should include emissions from field burning of crop residues in the international reporting of emissions to air. Sweden has up to date not calculated these emissions because they have been considered as negligible. The collected data should include the whole time series from 1990- 2003. The findings should thereafter serve as a basis for a decision whether emissions from field burning of crop residues should be reported in the Swedish Submission 2005.

2. Method of analysis

Contact has been made with the Swedish Board of Agriculture, the Swedish Association of Local Authorities, Norrköping County and Hushållningssällskapet Malmöhus.

The IPCC methodology has been applied to available background data, for making a preliminary estimation of the emissions.

3. Methodology for emissions estimates

The methodology is described in the workbook of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. The emissions of different non-CO_2 trace gas emissions from burning of agricultural residues are based on the total biomass burned of each crop multiplied with the specific carbon and nitrogen content respectively.

For estimating the emissions, emission factors for CH_4 and CO are applied on the total carbon released, and emission factors for N_2O and NO_x are applied on the total nitrogen released.

[1] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories: Reference Manual 2.6.
[2] IPCC NGGIP. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 15 June 2001

When decomposing the total biomass burned, similar as in the IPCC Workbook, the formula for calculating the total emissions of for example N_2O can be stated:

$$emissions = \sum_i \mathrm{Pr}_i * FracRC_i * DM_i * FracBr_i * Ox_i * FracC_i * FracNC_i * EF_{N2O},$$

where Pr_i is the annual production in gigagrams of crop i, $FracRC_i$ the residue to crop ratio for each crop type i, Dm_i the dry matter content, FracBr the fraction burned in fields, Ox the fraction oxidised, FracC the carbon fraction, $FracNC_i$ the nitrogen-carbon ratio for each crop i, and EF_{N2O} the emission factor based on the total nitrogen released.

The activity data needed for the calculations are therefore annual crop production statistics and crop specific data on ratios of residue to crop production, fraction of residue burned, dry matter content of residue and carbon and nitrogen contents of residue.

IPCC provides selected crop statistics and default emission factors, see appendix.

According to appendix 4 A.2 of the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories the weakness in the computation is estimating the percentage of residue burned in the field. Each inventory agency has to collect activity data on disposition of each crop residue, especially the percentage of residue burned on-site, after harvest.

4. Field burning in Sweden

In the Ordinance (1988:899) concerning environmentally hazardous activities and the protection of public health[3], which is in accordance with Chapter 9 of the Swedish Environment Code, it says under Municipal regulations in section 40 that "if necessary in order to prevent the development of conditions that pose risk to human health within its boundaries, a municipality may specify regulations concerning … burning of straw on cropland". This means that if no regulations are specified it is possible to burn straw on cropland.

However there does not seem to exist a complete list of the municipality regulations. Searching the Internet by www.google.se indicates that there seems to be regulations at least in Skåne and Halland.

According to an advisor at Malmöhus Hushållningssällskap[4] field burning of crop residues is very rarely practiced and is becoming more and more unusual in Skåne, which is one of the most important cereal growing counties in Sweden. Norrköping Municipalities responsible inspector for agriculture shares this view and states that it is very rare that the farmers practice field burning.[5] Also staff at the Swedish Board of Agriculture[6] and the Swedish Association of Local Authorities[7] considered field burning

[3] http://www.notisum.se/rnp/sls/lag/19980899.htm
[4] Johansson 046-71 36 07, June 2004
[5] Båld 011-15 14 93, June 2004
[6] Alfredsson 036-15 61 58, June 2004
[7] Edholm 08-452 78 61, June 2004

to be carried out only in exceptional cases and that the use is less frequent today than earlier.

The above mentioned view expressed by various actors that field burning of crop residues is very uncommon in Sweden today can be verified through a survey carried out 1997 by Statistics Sweden[8]. According to the survey on utilization of straw and tops from agriculture crops in 1997 one per cent of the harvest residues from cereals were burnt on the field. This is the only availably source of ratios of residue to crop production for Sweden. Since that time burning has become even more rare as mentioned above.

5. A preliminary calculation

The emissions of trace gases from agricultural residue burning in Sweden have been preliminary calculated on crop level. The major crops, of which a minor fraction was burned on fields in 1997[9], are stated in the activity data in table 1 below. All data, except for "Carbon fraction" and the fraction of residue burning, are background data used in the calculations of N2O-emissions from crop residues left on fields (CRF Table 4D1 "Direct soil emissions"). For estimating "Carbon fraction" IPCC default values on the specific crop, or a similar crop, were used, see appendix.

Table 1. Activity data for estimating emissions from field burning of crop residues in Sweden.

Crop	Area 2002, ha	Standard yield 2002, kg/ha	Fraction residues in relation to harvest, (FracResidues)	Dry matter content, fraction	Residue burning in 1997, %	Fraction oxidised	Carbon fraction, % of dm	Nitrogen fraction, % of dm
	"Pr_i"		"$FracRC_i$"	"DM_i"	"$FracBr_i$"	"Ox_i"	"$FracC_i$"	"$FracN_i$"
Winter wheat	285249	6351	1,3	0,85	2	0,9	0,4853	0,71
Spring wheat	54350	5176	1,1	0,85	1	1,9	0,4853	0,82
Winter rye	24395	5448	1,4	0,85	2	2,9	0,4853	0,82
Spring barley	410456	5448	0,9	0,85	1	3,9	0,4567	0,94
Triticale	30809	6351	1,3	0,8	1	4,9	0,4567	0,82

The calculated emissions of the green house gases CH4 and N2O from field burning are very small. Compared with Sweden's greenhouse gas inventory for the agricultural sector in 2002, the total CH4 emission from field burning amounts to 0.002% and the total N2O emission amounts to 0,04 %. See table 2 below. The emissions of CO and NOx are small, but however of the same magnitude as some emissions from other sources reported to LRTAP and UNFCCC.

Table 2. Estimated carbon and nitrogen released from agricultural residue burning and trace gas emissions in 2002

Crop	Total carbon released,Gg	Total nitrogen released, Gg	Emissions of CH_4, Gg	Emissions of CO, Gg	Emissions of N_2O, Gg	Emissions of NOx, Gg
Winter wheat	0,175	0,256	0,001	0,010	0,002	0,031
Spring wheat	0,024	0,041	0,000	0,001	0,000	0,005

[8] MI 63 SM 9901 Utilization of straw and tops from agriculture crops in 1997
[9] Ibid

Winter rye	0,045	0,075	0,000	0,003	0,001	0,009
Spring barley	0,305	0,627	0,002	0,018	0,004	0,076
Triticale	0,046	0,082	0,000	0,003	0,001	0,010
Total	**0,594**	**1,081**	**0,003**	**0,036**	**0,008**	**0,131**

6. Results

- The investigation confirms that field burning is very rare in Sweden. A one time study of utilization of straw and tops from agriculture crops in 1997 shows that in this year only small fractions (0-1 %) were burned, which has been confirmed by contacts with experts.
- Field burning is not prohibited in Sweden, but there are examples of local regulations.
- There are no statistics confirming a trend, but information gathered from several independent sources supports a decrease of field burning.
- A preliminary calculation confirms that emissions from field burning of crop residues are very low (0,002% of the total CH_4 emissions and 0.04% of the total N_2O emissions) and thus do not contribute significantly to the emissions level. The emissions of CO and NOx are small, but however of the same magnitude as emissions from other sources reported to LRTAP.

7. Discussion

The study shows that it would be possible to estimate and include the very low estimates in the GHG inventory, by using a one time study of utilization of straw and tops, which would mean low quality activity data for the other years. The calculated emissions of green house gases according to field burning of crop residues are very low, which justifies the decision taken to report the emissions as not occurring (NO). The emissions of CO and NOx may however be considered as not insignificant.

Information provided by experts indicates a decrease in field burning of crop residues over time in Sweden, there are however no statistics confirming this. Such information is failing to enable a reliable estimate for the base year 1990.

A new survey of utilization of straw and tops would probably confirm that the field burning is negligible. Good estimates of small fractions may however be hard to obtain by standard surveys. It is hence recommended that the emission source of field burning from agricultural soils is reported as not occurring (NO) also in next submissions.

8. Appendix

Data from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Workbook.

TABLE 4-15
SELECTED CROP RESIDUE STATISTICS

Product	Residue / Crop Ratio	Dry Matter Fraction	Carbon Fraction	Nitrogen-Carbon Ratio
Wheat	1.3	0.78-0.88	0.4853	0.012
Barley	1.2	0.78-0.88	0.4567	
Maize	1	0.30-0.50	0.4709	0.02
Oats	1.3			
Rye	1.6			
Rice	1.4	0.78-0.88	0.4144	0.014
Millet	1.4			0.016
Sorghum	1.4			0.02
Pea	1.5			
Bean	2.1			
Soya	2.1			0.05
Potatoes	0.4	0.30-0.60	0.4226	
Feedbeet	0.3	0.10-0.20[a]	0.4072[a]	
Sugarbeet	0.2	0.10-0.20[a]	0.4072[a]	
Jerusalem artichoke	0.8			
Peanut	1			

Note: Crop statistics in this table are not complete. For values not specified you should use values for the most similar crop type as defaults.

See the *Greenhouse Gas Inventory Reference Manual* for sources.

[a] These statistics are for beet leaves.

TABLE 4-16
DEFAULT EMISSION RATES FOR AGRICULTURAL RESIDUE BURNING CALCULATIONS

Gas	Ratios	
	Default	Range
CH_4	0.005	0.003-0.007
CO	0.06	0.04-0.08
N_2O	0.007	0.005-0.009
NO_x	0.121	0.094-0.148

Note: Ratios for carbon compounds are mass of carbon released as CH_4 or CO (in units of C) relative to mass of total carbon released from burning (in units of C); those for the nitrogen compounds are expressed as the ratios of mass of nitrogen compounds released relative to the total mass of nitrogen released from the fuel.

See the *Greenhouse Gas Inventory Reference Manual* for sources.