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SCIENTIFIC COMMITTEE ON TOXICITY, ECOTOXICITY AND THE ENVIRONMENT (CSTEE)

Opinion on

'Member State assessments of the risk to health and the environment from cadmium in fertilizers'

Opinion expressed at the 33rd CSTEE plenary meeting

Brussels, 24 September 2002

OPINION OF THE CSTEE ON
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Background

The Commission is currently considering a proposal for a Regulation on the question of cadmium in fertilizers, against the background of the fact that the derogation currently applying to Austria, Finland and Sweden is expiring.
Directive 76/116/EEC, which establishes a single market in fertilizers, contain no upper limit for cadmium in fertilizers. The countries mentioned above were granted a derogation allowing them to maintain the national limits for cadmium in fertilizers that were in force at the time of accession. These national limits are intended to protect human health and the environment. The three countries consequently do not permit the import of most EC fertilizers.
To assess the risk to human health and the environment arising from cadmium in fertilizers, risk assessments have been carried out by eight Member States (plus Norway) according to an agreed common methodology.

The CSTEE is requested to review the Member States' risk assessments in order to establish a sound scientific basis for decision making.

Questions to the CSTEE

Despite the differences in assumptions made by Member States for values of input variables (especially in the selection of an appropriate algorithm to represent the cadmium soil/water distribution coefficient), is it scientifically justified to conclude that the modeling of cadmium accumulation in agricultural soils in the various assessments suggests the following consistent trends:

- For low fertilizer cadmium concentration (between 1 to 20 mg/kg P_2O_5), cadmium in soil tends to accumulate relatively slowly, or decreases after 100 years of application due to net removal rates (leaching, crop uptake) exceeding inputs.
- For fertilizers with Cd concentrations of 60 mg/kg P_2O_5 and above, accumulation in agricultural soils over 100 years is relatively high (ranging between 40 and 125%, equivalent to 0.4-1.25% on annual basis).

General comments

From the terms of reference it is clear that this opinion will focus on the long-term accumulation of Cd in soils through application of Cd-containing inorganic fertilizers. Although the above mentions risk assessments performed by member states include the assessment of (environmental and human health) effects and consequently a risk characterisation, the questions posed to the CSTEE are specific to the accumulation (exposure) in soil. Therefore we will consider only the latter aspect in the formulation of the opinion.
Nevertheless, the CSTEE must express concerns on the accuracy and validity of the effect assessments and the exposure assessment. The conclusions of the member states risk assessments find that there is no urgent nor acute risk to human health, this aspect was not included in the terms of reference and therefore is not commented upon in this opinion. Therefore we recommend an overall in-depth revision of these evaluations. The comprehensive risk assessment of Cd and CdO presently ongoing in the context of the EU Existing Chemicals Regulation could provide valuable information.

Our analysis has focussed on the individual risk assessment reports prepared by the different countries. The main difficulty in comparing the conclusions of these reports is the lack of harmonization between the approaches employed in the different reports. The CSTEE was already concerned on this issue when consulted on the ERM report that forms the basis of the individual assessments (CSTEE opinion, 5-09-2000). The main sources of variability among the reports include: the selection of estimation algorithms and parameters, considerations of additional Cd-input and the selection of local or generic scenario's. Additionally most reports have used, to varying extent, national conditions (soil characteristics, weather conditions, agricultural practices, etc) to perform their assessments. The CSTEE supports the use of this latter approach, i.e. the variability associated with national/regional conditions, but considers that the former sources of variability should have been limited.

The amount and type of information presented in the different documents submitted to the CSTEE varies considerably. Some reports are too brief to allow peer review and therefore have not been considered in this opinion.

The basic methodology for assessing soil accumulation was the mass balance approach. The routes for Cd output (from the soil) were accumulation in crops and leaching. The main uncertainty associated with the mass balance approach is the estimation of the leaching output. The variability associated with the crop output has been considered, to a certain extent, through the inclusion of different crops. The mass balance approach has, to our knowledge, not been validated. Efforts towards validation should be encouraged; e.g. by using historic data on soil Cd content.

Based on the reported results, it is clear that even for the same Cd concentration in fertilizer, there is a significant variability (sometimes leading to opposing trends) in the predicted long-term soil accumulation. In some cases this is due to soil characteristics, climatic conditions and agricultural practice. In other cases this is caused by the type of algorithm and parameters used in the assessment.

In their assessment of this issue, the CSTEE performed soil mass balance calculations predicting % change in Cd after 100 years of constant input. Model parameters were varied over a wide range to cover most agro-climatical conditions in the EU. Algorithms as reported by the member states were applied. The outcome of this is that fertilizer Cd concentrations

of 20 mg Cd/kg P_2O_5 yields, in most scenarios without additional Cd sources, no increase in soil Cd. At 60 mg Cd/kg P_2O_5 accumulation is predicted in most of the scenarios (Annex 1).

Responses to the questions

First bullet:
Despite the differences in assumption made by Member States for values of input variables (especially in the selection of an appropriate algorithm to represent the cadmium soil/water distribution coefficient), is it scientifically justified to conclude that the modeling of cadmium accumulation in agricultural soils in the various assessments suggests the following consistent trends:

- *For low fertilizer cadmium concentration (between 1 to 20 mg/kg P_2O_5), cadmium in soil tends to accumulate relatively slowly, or decreases after 100 years of application due to net removal rates (leaching, crop uptake) exceeding inputs.*

Answer: Based on the evidence presented in the reports and some additional calculations (presented in Annex 1) fertilizers containing <= 20 mg Cd/kg P_2O_5 are, in most soils, not expected to result in long-term soil accumulation, if other Cd inputs are not considered.

Second bullet:
Despite the differences in assumption made by Member States for values of input variables (especially in the selection of an appropriate algorithm to represent the cadmium soil/water distribution coefficient), is it scientifically justified to conclude that the modeling of cadmium accumulation in agricultural soils in the various assessments suggests the following consistent trends:

- *For fertilizers with Cd concentrations of 60 mg/kg P_2O_5 and above, accumulation in agricultural soils over 100 years is relatively high (ranging between 40 and 125%, equivalent to 0.4-1.25% on annual basis).*

Answer: Based on the evidence presented in the reports and some additional calculations (presented in Annex 1) fertilizers containing >= 60 mg Cd/kg P_2O_5 are, in most soils, expected to result in long-term soil accumulation.

Conclusions and Recommendations

Both the results from the reports and the additional analysis performed indicate that accumulation can occur in some soils even when fertilizers containing very low Cd concentrations and will not be observed in some soils even when using fertilizers with high Cd levels. The CSTEE considers that the limit of Cd in fertilizers could be established on amore solid basis using probabilistic assessment techniques. In our opinion the information contained in the reports together with information on the soils, climatic and agricultural conditions in Europe should allow an assessment estimating the likelihood of Cd accumulation in European soils for different levels of Cd in fertilizers.

The CSTEE has been requested to produce and opinion on the acceptable limit of Cd in phosphate fertilizers based on the likelihood for accumulation of cadmium in soil. The CSTEE recognised that this approach, aimed on avoiding a long-term increase in Cd levels in agricultural soil, could avoid a further increase from the current situation.

However, a derivation of a limit of Cd in fertilizers which is exclusively based on soil accumulation, does not take into account the level of risk for human health and environment associated to the current situation and that expect after the implementation of the limit.

The CSTEE is of the opinion that a limit for Cd in phosphate fertilizers should be derived based on a risk assessment approach (i.e. comparison of exposure and effects profiles) and taken all cadmium sources into account.

Annex 1:

Additional calculations on Cd soil accumulation made by the CSTEE Working Group

Table 1. Parameters in the soil mass balance calculations in different scenario's embracing most conditions as reported in assessments of different member states. Scenario's calculated for all combinations of parameters

Parameter	values	comments
Cd input		
Cd concentration in fertiliser (mg Cd/kg P_20_5)	20, 40, 60	designed to assess effects of a proposed threshold
Fertiliser rate (kg P_20_5/ha/y)	23, 69	30 is realistic worst case for continuous annual input
Other diffuse Cd sources (g Cd/ha/y)	0, 3	3 is realistic worst case for atmospheric deposition
Cd output		
Drainage (D=precipitation - evapotranspiration; m/y)	0.1-0.4	
Kd models	model 1 and 2	model 1 from *in situ* (pore-water) K_D, n=100, based on unpolluted agricultural and forest soils from the Netherlands; Römkens and Salomons, 1998 model 2 from metal concentration in water extract; n=33 based on contaminated soils from various sources, McBride et al., 1997
soil pH	5.5, 6.5, 7.5	
% organic matter	1%, 4%	
offtake with plant at t=0 (g Cd/ha/y)	0.3	corresponding to wheat/corn rotation; realistic worst case (low value); value changes proportionally with soil Cd concentration
Other parameters		
Wsoil depth (m)	0.25	
soil weight (ton/ha)	3000	
soil Cd at t=0 (mg Cd/kg)	0.3	

Table 2.The percentage increase in soil Cd after 100 years of constant input at fertiliser Cd concentration of **20 mg Cd/kg $P_2 0_5$**. D is the annual drainage (m/y).

	pH 5.5		pH 6.5		pH 7.5	
soil	model 1	model 2	model 1	model 2	model 1	model 2
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-31	-7	-9	-1	-1	1
OM=4%;D=0.4	-31	-3	-9	0	-1	1
OM=1%;D=0.1	-78	-20	-34	-9	-10	-2
OM=4%;D=0.4	-78	-16	-34	-4	-10	0
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-23	3	1	9	9	11
OM=4%;D=0.4	-23	7	1	10	9	11
OM=1%;D=0.1	-73	-21	-26	0	0	8
OM=4%;D=0.4	-73	-7	-26	5	0	10
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-4	24	22	31	31	33
OM=4%;D=0.4	-4	29	22	33	31	34
OM=1%;D=0.1	-62	-1	-7	22	21	30
OM=4%;D=0.4	-62	14	-7	28	21	32
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	4	34	32	41	41	43
OM=4%;D=0.4	4	39	32	43	41	44
OM=1%;D=0.1	-57	-36	1	10	31	33
OM=4%;D=0.4	-57	-8	1	25	31	38

Table 3.The percentage increase in soil Cd after 100 years of constant input at fertiliser Cd concentration of **40 mg Cd/kg $P_2 0_5$**. D is the annual drainage (m/y).

	pH 5.5		pH 6.5		pH 7.5	
Soil	model 1	model 2	model 1	model 2	model 1	model 2
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-27	-2	-4	4	4	6
OM=4%;D=0.4	-27	2	-4	5	4	6
OM=1%;D=0.1	-76	-25	-30	-4	-5	3
OM=4%;D=0.4	-76	-12	-30	1	-5	5
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-10	17	15	24	23	26
OM=4%;D=0.4	-10	21	15	24	23	26
OM=1%;D=0.1	-66	-8	-14	14	14	23
OM=4%;D=0.4	-66	7	-14	20	14	25
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	0	29	27	36	36	38
OM=4%;D=0.4	0	34	27	38	36	39
OM=1%;D=0.1	-59	3	-3	27	26	35
OM=4%;D=0.4	-59	18	-3	32	26	37
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	17	48	46	56	56	58
OM=4%;D=0.4	17	53	46	58	56	59
OM=1%;D=0.1	-49	20	13	45	45	55
OM=4%;D=0.4	-49	36	13	52	45	57

Table 4.The percentage increase in soil Cd after 100 years of constant input at fertiliser Cd concentration of **60 mg Cd/kg $P_2 0_5$**. D is the annual drainage (m/y).

	pH 5.5		pH 6.5		pH 7.5	
Soil	model 1	model 2	model 1	model 2	model 1	model 2
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	-23	3	1	9	9	11
OM=4%;D=0.4	-23	7	1	10	9	11
OM=1%;D=0.1	-73	-21	-26	0	0	8
OM=4%;D=0.4	-73	-7	-26	6	0	10
atmospheric Cd deposition 0 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	2	31	29	38	38	41
OM=4%;D=0.4	2	36	29	40	38	41
OM=1%;D=0.1	-58	5	-1	29	28	37
OM=4%;D=0.4	-58	20	-1	35	28	39
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 23 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	4	34	32	41	41	43
OM=4%;D=0.4	4	39	32	43	41	44
OM=1%;D=0.1	-57	7	1	31	31	40
OM=4%;D=0.4	-57	23	1	37	31	42
atmospheric Cd deposition 3 g Cd/ha/y annual fertiliser application 69 kg $P_2 0_5$/ha/y						
OM=1%;D=0.1	29	63	60	71	71	73
OM=4%;D=0.4	29	68	60	72	71	74
OM=1%;D=0.1	42	32	25	60	59	70
OM=4%;D=0.4	42	50	25	66	59	72