Scientific Committee on Health and Environmental Risks

SCHER

OPINION ON

CADMIUM IN FERTILISERS – ADDITIONAL REQUEST ON THE RISK ASSESSMENT REPORT FROM THE KINGDOM OF SWEDEN (HUMAN HEALTH)

The SCHER adopted this opinion via written procedure on 24 October 2012

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SCHER

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All Declarations of working group members are available at the following webpage:
http://ec.europa.eu/health/scientific_committees/environmental_risks/members_wg/index_en.htm

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TABLE OF CONTENTS

1. BACKGROUND

Further to the earlier request from DG Enterprise and Industry of 9 November 2011 on the risks to the environment identified by Sweden as a justification for its request for authorisation to lower the national limit value for cadmium in fertilisers in accordance with Article 114(5), SCHER issued an opinion on 5 March 2012. SCHER concluded that while the data provided by the Swedish authorities were of good quality, uncertainties remained regarding several key assumptions used by the Swedish authorities to conclude that there is a risk to aquatic organisms in small brooks in Sweden. The Commission, therefore, adopted a Decision extending the period for examination of the request by 6 months, and, by letter of 27 April 2012 informed the Swedish authorities about the opinion of SCHER, inviting them to submit additional information by 16 July 2012 at the latest.

In their response of 2 July 2012, the Swedish authorities did not provide any new information or reaction to the comments of SCHER, but expressed the opinion that the term environment in Article 114(5) actually includes human health i.e. that the examination of risks to human health should also be considered under Article 114(5).

Without prejudice to the correct legal interpretation of Article 114(5), DG Enterprise and Industry is prepared to extend the analysis and also consider the possible risks posed by cadmium in fertilisers to the Swedish population via the environment, i.e. notably through dietary intake.

2. TERMS OF REFERENCE

SCHER is asked the following question:

Have the Swedish authorities demonstrated that there is a risk to human health from Cd in phosphate fertilisers that is specific to Sweden and has arisen after the adoption of the harmonised measure in 2003?

3. OPINION

The documents submitted by Sweden in October 2011, referred to below as the "Swedish report", were examined to determine whether there is recent evidence (after 2003) specific to Sweden regarding the need to protect human health from cadmium in phosphate fertilisers. The opinion is broken down according to the four steps in the chain of soil-crops-diet-humans.

3.1.Predicted cadmium concentrations in soil.

Cadmium has a long half-life in soil (over 100 years) because annual leaching and removal by crop is small. Current Cd levels in soil originate significantly from past application of phosphate fertilisers. The Swedish report, Annex IV, analyses the relationship between Cd added via fertilisers and total Cd in soil, and estimates (models) the expected change in soil Cd over 100 years. The mass balance calculations predict a net change in soil Cd of between -6% (depletion) to +16% accumulation if the cadmium concentrations in fertilizers were always at the limit of 46 mg Cd/kg P (i.e. 20 mg Cd/kg P_2O_5, Table 13 in Annex IV of the Swedish report). The range of change represents different fertiliser application rates currently in place in Sweden depending on land use and soil phosphate status. Based on the production areas described in Annex IV (Figures 3&4), it is estimated that about half of the agricultural production will have a net positive increase (lower P status, hence higher P application rate) while the remaining will have a net depletion (higher P status, lower P application rate). Note that the current

accumulation of Cd is lower than these estimated changes because current fertiliser Cd concentrations in Sweden are below the limit value of 46 mg Cd/kg P.

With regard to the question whether this situation is different in Sweden compared to the rest of Europe, SCHER notes that Swedish soils have relatively low soil Cd compared to the rest of Europe (Table 15), and that soil pH is somewhat lower in Sweden than in the remainder of Europe (p.36). Cadmium removal from soil by leaching is clearly greater at lower pH since the soil pH affects leaching of Cd (more leaching at lower pH). This is acknowledged in the Swedish report (page 23, bottom of Annex IV) which also states that leaching is one of the most important factors determining the net trend of soil Cd in the next 100 years (Annex 1 within the Annex IV document). This means that in Sweden, the net soil Cd accumulation is lower, and not higher, than in most parts of Europe at equal Cd input, i.e. at comparable fertiliser application rates and equal Cd concentrations in the fertiliser. In that respect, SCHER questions the statement in the summary on page 41 in Annex IV that "*one unit lower pH in Swedish soils... could be slightly more vulnerable to increased input of Cd*". SCHER agrees that the lower pH increases the Cd bioavailability. However, if that low pH is maintained, the future trends in crop Cd concentrations are smaller (lower increase) in Sweden compared to most other trends in Europe because soil Cd increases at a lower rate. Most importantly, the parameter values used to estimate the net trend in soil Cd over the next 100 years are included in the much wider range of the scenario which the CSTEE used to estimate the soil Cd accumulation in Europe (CSTEE, 2002). This scenario also serves as the basis of the draft proposal for the Cd limits. Hence, conditions relevant to Sweden (pH, fertiliser application rates, and atmospheric deposition) were well covered in the range of scenarios considered by CSTEE in 2002. Most critical in this respect is that the highest fertiliser application rates considered in the Swedish report (22 kg P/ha/y, equivalent to 52 kg P_2O_5), are lower than the highest application rates used in the CSTEE report for Europe (69 kg P_2O_5/ha/y). In addition, the Cd input via atmospheric deposition in Sweden (less than 0.5 g Cd/ha/y) is lower, and not higher, than that used in the CSTEE report for Europe (3 g Cd/ha/y).

With regard to the question whether the new (after 2003) information provided suggests that the current situation is different from that previously known, SCHER notes that input data have been updated in the Annex IV (e.g. atmospheric deposition), but the committee again points to the fact that the current scenarios for mass balance calculation were already included in the scenarios considered in the 2002 opinion of the CSTEE.

Conclusion: Annex IV does not provide arguments to support the conclusion that the soil Cd increases to a larger extent in Sweden than in the remainder of Europe at an equivalent input of Cd via phosphate fertilisers. On the contrary, it is even conceivable that the opposite may be true. There is no new information suggesting that the scenarios covered in the 2002 opinion of CSTEE would no longer be applicable. SCHER also notes that the Swedish report itself (summary of Annex IV) supports SCHER's conclusion, as it states: "*It was difficult to unambiguously show whether there are specific conditions in Sweden that make Swedish soils more vulnerable to Cd input than those in Central Europe*." (p.4).

3.2.Soil-plant transfer of Cd in Sweden.

Table 16 in Annex IV of the Swedish report shows that concentrations of Cd in Swedish wheat are similar to those in most other EU countries. Indeed, Swedish mean and upper concentrations are within the means and ranges of other EU countries. The soil Cd concentration in Sweden is somewhat lower; hence, it is correct to point out that the soil-plant transfer of Cd may be greater in Sweden than in the rest of Europe, i.e. the soil Cd bioavailability to wheat is higher. No such conclusion can be made for potatoes. The estimates of national average cadmium concentrations in certain crops after 100 years of using mineral fertilisers containing 20 mg Cd/kg P_2O_5 shows a slight increase of 0.003 mg

Cd/ kg dw (dry weight) in wheat grains. The predicted Cd in wheat grain over 100 years (0.052 mg/kg dw, Table 20) would still be below the current average content of wheat grain in France (0.058 mg/kg dw) or the UK (0.077 mg/kg dw; Table 16). High bioavailability of soil Cd in Sweden, however, does not mean that soils are more vulnerable to Cd input, i.e. the net effect of Cd input on future trends in crop Cd (i.e. % increase) is not greater compared to other European countries since the predicted change in soil Cd (% increase) is not greater in Sweden compared to the rest of Europe.

With regard to new information, Annex IV shows that data from measurements of cadmium in winter wheat, spring barley and oats between 1988 and 2007 in Sweden does not lead to conclusive trends (Annex IV – page 12/13). If anything, more recent trends in winter wheat Cd show a significant decreasing trend, likely as a result of reduced atmospheric deposition (some grain Cd is derived from the atmosphere), or as a result of better soil liming, potentially somewhat decreasing soil Cd (Figure 2).

Conclusion: SCHER agrees with the conclusion in the Swedish report, annex IV, that the soil Cd availability to wheat is somewhat greater than in most European countries. However, the new data presented is within the same range as the data which were considered during the preparation of the CSTEE opinion. Therefore, SCHER notes that this does not mean that crop Cd will have a greater percentage increase in the future at equal input because the net soil Cd accumulation in Sweden is not expected to be greater than in the rest of Europe.

3.3.The dietary exposure to cadmium.

In Annex VI, the Swedish study reports dietary intake values of the general population, estimated using a dietary assessment model. Depending on the assessment considered, the median dietary cadmium intake in Sweden is 1.0 µg Cd/kg b.w./day (males and females, 17-84 years of age, unpublished data of the National Food Administration in Sweden), 1.4 µg Cd/kg b.w./day (women, 56-70 years of age, Amzal et al. 2009). This difference has been attributable to an actual difference in food consumption between the two populations being investigated and to the application of a different methodology. There is no indication that dietary exposure has increased or that alarming trends are emerging in Sweden.

When EFSA estimated the dietary cadmium intake for the different Member States, separate to the establishment of the TWI, the median intake for Sweden was estimated as 1.7 µg Cd/kg b.w./day (EFSA 2009). The report does not give information to evaluate the intake statistics in Sweden relative to that in other countries. EFSA (2009) reports that the dietary intake in Sweden is relatively high, but not the highest when compared with other countries (Table 16 in EFSA, 2009); however, there is no reference provided in the EFSA report for these figures, and the mean values are, surprisingly, almost twofold greater in the EFSA 2009 report than those in the national statistics of Sweden.

By using the lower median dietary cadmium intake (1.0 µg Cd/kg b.w./day), the median fraction of the Swedish population exceeding the TWI is relatively low (2.8% at the 90% confidence interval), in agreement with the fact that a small percentage of the Swedish population has urinary cadmium concentrations higher than 1 µg/g creatinine (Åkesson and Vahter, 2011). In addition, the surveys of blood Cd concentrations in the general population, indicating current Cd exposure in Sweden, are documented in Annex III of the Swedish report. Between 1987-2009, there is no significant trend in the non-smoking population and no trend has emerged in the subset of 1996-2009 (Table 2 of Annex III). Overall, the Annex III concludes that "*there is no decreasing trend in Cd exposure*". SCHER notes that no increasing trend is reported either, except for one trend in urinary Cd in the younger bracket of the Stockholm population (p.20; no statistics are provided).

SCHER notes that with respect to the fertiliser regulations, the CSTEE opinion of 2002 did not use the human health limits in its analysis, but only used the 'stand-still' principle of Cd, i.e. not allowing further increase.

Conclusion: the Swedish report does not provide data suggesting that dietary exposure to Cd is greater in Sweden than in the rest of Europe, neither at the mean nor at the upper percentiles of exposure. Recent trends do no suggest an increasing trend in dietary exposure, including body burden Cd in the general population.

3.4.Human health effects of Cd in relation to fertiliser use.

It is well established that food is the main source of cadmium exposure for the non-smoking general population (EFSA 2009, 2011). After dietary exposure to cadmium, absorption of Cd from the gastrointestinal tract in humans is relatively low (<10%); however, its biological half-life ranges from 10 to 30 years, being efficiently retained in the kidney and liver.

The kidney is the critical target organ for dietary exposure to cadmium: so far adverse effects on the kidney have been used as the basis for reference value derivation for Cd. Renal damage is characterised by cadmium accumulation in convoluted proximal tubules, leading to cell dysfunction and damage, which may progress to a decreased glomerular filtration rate, and eventually to renal failure after prolonged and/or high exposure.

Cadmium levels in urine are widely accepted as a measure of the body burden and the cumulative amount of Cd in the kidneys. Following a meta-analysis of the available data set, the EFSA CONTAM Panel concluded that increased excretion in the urine of the low molecular weight protein beta-2-microglobulin (B2M) can be considered the most reliable biomarker for tubular effects (EFSA, 2009). On the basis of the data on B2M meta-analysis (including 35 studies), a benchmark dose (BMDL5) was derived, which adjusted for inter-individual variation within the study populations, lead EFSA to identify 1 µg Cd/g creatinine as the critical level in urine. This value is supported by NHANES data on 5426 subjects, published after the EFSA opinion, indicating that a cadmium concentration >1 µg/g creatinine in urine was associated with a statistically significant increased risk of albuminuria, although due to the cross-sectional design of the study, a causal relation between urinary Cd and albuminuria cannot be established.

In order to estimate the dietary cadmium exposure that corresponds to the critical urinary cadmium concentration, toxicokinetic modelling between dietary intakes and urinary cadmium was used, based on a population-based Swedish cohort study (Amzal et al., 2009). The study provided individual data on urinary cadmium concentrations and median daily dietary cadmium intake (1.4 µg/kg b.w.) in 680 women of 56-70 years age who had never smoked. It was estimated that the average daily dietary cadmium intake should not exceed 0.36 µg Cd/kg b.w., corresponding to a weekly dietary intake of 2.52 µg Cd/kg b.w.(TWI). The TWI would result in a urinary concentration lower than the critical value (1 µg Cd/g creatinine) for 95% of the women by age 50 (as the most susceptible group). Although in 2010 the Joint FAO/WHO Expert Committee on Food Additives (JECFA, 2010) established a provisional tolerable monthly intake (PTMI) of 25 µg Cd/kg b.w., corresponding to a weekly intake of 5.8 µg/kg b.w., in 2011 EFSA confirmed the TWI (EFSA, 2011).

In addition to kidney damage, exposure to Cd has been associated with bone demineralisation: although the possibility of an indirect effect related to cadmium induced renal dysfunction (tubular dysfunction, hypercalciuria, impaired hydroxylation of vitamin D) is plausible, a direct effect of cadmium on bones is also possible. Among the studies

cited by the Swedish report (Annex III Table 6, page 47), most of which were previously discussed (i.e. EU RAR, 2007; EFSA, 2009), a benchmark dose is derived from data on the Swedish population, which is equal to or higher than the one for the renal effects (i.e. ≥ 1 µg Cd/g creatinine). The other studies did not provide clear reference values, including a recent Swedish study (Engström et al.,2011), which is not described in detail in the Report, indicating that non-smoking women with 0.50-0.75 µg Cd/g creatinine had more than twice the risk of osteoporosis at the femoral neck level, and twice the risk of fractures, compared to women with <0.50 µg/g creatinine. It should be underlined that among those who had never smoked, only 6% of the total enrolled population had urinary Cd levels >0.50 µg/g creatinine (see Annex III-Table 1). Therefore, a definite set of data demonstrating a lower threshold for Cd-induced effects is not available, at least for the moment.

Annex III (figure 8 on page 36) of the report shows that the probability of hip fractures is somewhat higher in Northern Europe than in the rest of Europe. The reasons for this higher occurrence of osteoporosis in the Nordic countries (except for Finland) are not well understood, although causes such as early menopause, family history of osteoporosis, deficiency of Vitamin D and calcium due to climate conditions and dietary habits cannot be ruled out. Since the fracture incidence in Sweden has increased substantially beginning in the 1950s, the influence of population aging is another factor to be carefully considered. Furthermore, a recent systematic review of hip fracture incidence and probability of fractures worldwide found marked variations in hip fracture rates and in the 10-year probability of major osteoporotic fractures. The variation is sufficiently large to preclude an explanation based on the often multiple sources of error in the ascertainment of cases or the catchment population (Kanis et al. 2012).

Therefore, since exposure to Cd in Sweden is not significantly different from other EU countries in relation to fertiliser use, it remains to be demonstrated that the Swedish population is more sensitive to Cd exposure than other populations in Europe as a means to explain the higher probability of hip fractures.

SCHER agrees that data available on a possible association between dietary exposure to cadmium and other health effects (i.e. cardiovascular diseases, diabetes, hormone-related cancer, reproductive and developmental outcomes, neurotoxicity) are for the moment not sufficiently sound to be used for risk assessment purposes.

Conclusion: The Swedish report provides further evidence that effects of Cd on human health are not limited to kidney damage, but effects on bone are also relevant. However, it does not provide evidence that a lower threshold for Cd-induced effects is identified, nor that the Swedish population is more sensitive or became more sensitive to Cd than those in other European countries.

3.5.Overall conclusion.

The Swedish report contains a detailed and updated assessment of long-term effects of fertiliser Cd on human health via the food chain. The SCHER notes that the report does not provide convincing arguments to show that the Swedish case is a unique one or that data which appeared after the adoption of Regulation (EC) No 2003/2003 suggest specific reasons for additional concern. If anything, it emerges that the Swedish situation is one where soil and food chain Cd may be expected to increase to a lesser extent in the future (at equal Cd input via phosphate fertilisers) than in most other European countries. The crop Cd may respond similarly. Although body burden may respond differently depending on food habits, no increasing trend in Cd exposure was evidenced in Sweden.

The report provides evidence that Cd-induced effects on bones are relevant, although the data available do not indicate the need for a lower reference value. On this basis, it remains to be demonstrated that the Swedish population is more sensitive to Cd exposure than other populations in Europe.

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