Guidelines for a Banded Pesticide Tax Scheme, Differentiated According to Human Health and Environmental Risks

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Technical update (translation of health hazard statements according to previous regulation, into corresponding classification under the current Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures)

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1. Background

As a follow-up of the Action Plan for Reduced Risk of Pesticide Use (1998-2002), a banded tax scheme for pesticides was introduced in 1999, based on differentiated human health and environmental risks. An internal committee in the Norwegian Agricultural Inspection Service assessed this system in 2003. In a report (Landbrukstilsynet 2003a), the committee concluded by making the following suggestions for improvements:

- Adjust the criteria for the tax bands with regard to health effects, in accordance with the health risk indicator.
- Include the exposure to pesticides during the handling of treated plant material in the part of the tax scheme related to human health.
- Base the tax bands for seed dressings on human health hazard, since exposure and the substances' intrinsic properties can vary significantly.
- Include relevant metabolites in the health classification. In some cases, metabolites may present a greater health risk than the active ingredients.
- Change the guidelines for environmental aspects of the banded tax scheme, to a system that takes more consideration to the total environmental hazard of pesticide use.
- Revise the guidelines for determining the standard area dose (maximum application rate in the or those crop(s) accounting for 50 % or more of the product's total application), in order to improve their user-friendliness.
- Increase the number of health and environmental categories for products used by certified applicators. This will lead to an improved differentiation between products with low or high risk, and less differences between categories. This should perhaps result in a larger number of tax bands.

This report takes the above-mentioned items into consideration. For health-related issues, the report is only a revision and an adjustment of the previous guidelines (Landbrukstilsynet 2003b). For environmental issues, a whole new system was devised, which resembles a revised version of the risk indicator scheme. The revised guidelines for standard area doses are published in a separate report (Planteforsk 2003).

2. New tax bands

Each product is assigned to one of three health categories and one of three environmental categories. Previously, there were only two categories for each. Based on this classification, products are assigned to one of the tax bands presented in the table below. These tax bands form the basis for the calculation of environmental taxes.

Tax band 1 (0.5 x base rate):
Products with a low health and environmental risk.

Tax band 2 (3 x base rate):
Products with a low health risk and medium environmental risk, or medium health risk and low environmental risk.

Tax band 3 (5 x base rate):
Products with a low health risk and high environmental risk, or medium health risk and medium environmental risk, or high health risk and low environmental risk.

Tax band 4 (7 x base rate):
Products with a high health risk and medium environmental risk, or medium health risk and high environmental risk.

Tax band 5 (9 x base rate):
Products with a high health and environmental risk.

Tax band 6 (50 x base rate):
Concentrated consumer products.

Tax band 7 (150 x base rate):
Ready-for-use consumer products.

The total number of tax bands remains unchanged at seven, but the number of bands for products used by certified applicators is increased from three to five in order to enable a better differentiation. The number of bands for consumer products (previously numbers 5 and 6, now 6 and 7) remains the same. The former tax bands 0 for adjuvants and 1 for seed dressings are removed. Adjuvants will remain to be exempt from pesticide taxes, and are not included in the scheme. Seed dressings and microbiological agents are placed in the lowest environmental category, but can be moved to a higher health category depending on the product's health risk.

3. Tax Burden

A condition for the reorganisation of the environmental tax scheme was that the total tax burden should not be changed. The factors for the various tax bands are thus set to achieve this objective. The base tax rate remains the same at NOK 25 per hectare. For products used by certified applicators, the tax for products with a low health and environmental risk is halved (factor reduced from 1 to 0.5), while the tax for products with a high health and environmental risk is raised by 12.5 % (factor increased from 8 to 9.). The tax for consumer products has not been changed.

4. Calculating the Tax

The environmental tax is acreage-based. The tax for a specific pesticide per hectare (ha) is calculated by multiplying the base rate (NOK 25) with the factor for the tax band in question (0.5 - 150):

Tax per hectare = 25 x factor for tax band

This is converted to tax per kg or litre by multiplying with 1000 and dividing by the standard area dose (grams or ml/ha):

Tax per kg or litre = 25 x factor x 1000 / standard area dose

5. Human Health

When assigning products to the three health categories, consideration is taken to intrinsic properties, exposure during mixing and exposure during spraying.

5.1. Intrinsic properties

Based on the products' intrinsic properties, they are classified into four groups for potential health hazard, in accordance with the health hazard labelling.

Group 1: Products with a low potential health hazard:

- Products without health hazard statements.

Group 2: Products with a medium potential health hazard:

- Products not included in group 3, but labelled for acute toxicity category 4 (H302, H312 and/or H332).
- Products labelled for aspiration hazard (H304)
- Products labelled for skin- and/or eye irritation (H315, H319), for serious eye damage (H318) and/or for skin sensitisation (H317).
- Products labelled for respiratory sensitisation (H334)
- Products labelled for respiratory irritation (H335).
- Products labelled for drowsiness or dizziness (H336).
- Products containing sensitising substances which must be declared on the product label (EUH208).
- Products labelled H362 May cause harm to breast-fed children

Group 3: Products with a high potential health hazard:

- Products labelled for acute toxicity category 1-3 (H300, H301, H310, H311, H330, H331)
- Products labelled for skin corrosion (H314)
- Products labelled with one of the following health hazard statements:

H340 May cause genetic defects
H350 May cause cancer.
H350i May cause cancer by inhalation
H351 Suspected of causing cancer.

H360d May damage the unborn child
H360f May damage fertility.
H361d Suspected of damaging the unborn child.
H361f Suspected of damaging fertility.
H370 Causes damage to organs
H371 May cause damage to organs
H372 Causes damage to organs through prolonged or repeated exposure.
H373 May cause damage to organs through prolonged or repeated exposure.

Group 4: Products with a very high health hazard:

- Products marked with two or more of the following health hazard statements:
  H300 Fatal if swallowed
  H301 Toxic if swallowed
  H310 Fatal in contact with skin
  H311 Toxic in contact with skin
  H330 Fatal if inhaled
  H331 Toxic if inhaled
  H340 May cause genetic defects
  H350 May cause cancer
  H350i May cause cancer by inhalation
  H351 Suspected of causing cancer
  H360d May damage the unborn child
  H360f May damage fertility
  H361d Suspected of damaging the unborn child
  H361f Suspected of damaging fertility
  H370 Causes damage to organs
  H371 May cause damage to organs
  H372 Causes damage to organs through prolonged or repeated exposure
  H373 May cause damage to organs through prolonged or repeated exposure.

5.2. Exposure

Users are typically exposed to pesticides during such operations as mixing and diluting, application (often spraying) and handling treated crops. Exposure during mixing depends on the concentration of the active ingredient in the product, the number of dilutions and the type of formulation. The latter is of major importance. The degree of

exposure during application depends on such factors as the concentration of active ingredient in the diluted liquid, treatment dose, treated area and especially the application method.

The tax scheme takes the type of formulation and application method into consideration. Mixing is given more weight, since users are working with concentrated products when mixing, and pesticides are easily spilled.

With regard to exposure during mixing, products can be divided two groups depending on the type of formulation: low exposure (factor 1) and high exposure (factor 3).

- Examples of products that can give low exposure during mixing: Seed dressings used in approved facilities, ready-to-use solutions, granules, water-soluble pellets and water-soluble bags.
- Examples of products that can give high exposure during mixing: Emulsions, powders, suspensions and other soluble concentrates.

With regard to exposure during application, products can also be divided in two groups, depending on the application method: low exposure (factor 1) and high exposure (factor 2). The method of application depends on such factors as the type of crop in which the pesticide is used. For products approved for several crops, the same method as for the calculation of standard area doses is used, i.e., the or those crops accounting for 50 % or more of the product's total application. In cases where there are several major crops, the selected application method is based on the crop with the highest potential degree of exposure.

- Examples of application methods that can give low exposure: Seed treatment in approved facilities, mist blowers, fumigation, granular pesticide application, tunnel spraying in forest nurseries.
- Boom field or field crop sprayers are classified in relation to their operating pressure. High pressure gives small particles, which are easily stirred up, thus resulting in a high degree of pesticide exposure among applicators. Such assessments are made on a case-to-case basis.
- Examples of application methods that can give high exposure: Knapsack (mist) sprayers, tractor-mounted mist sprayers, manual pressure sprayers.

5.3. Total score for human health

Based on the pesticide's intrinsic properties and the considerations to exposure presented above, the total scores for human health are presented in the table below. The total exposure is obtained by multiplying the factors for "during mixing" and "during spraying". The total score for human health (H) is obtained by multiplying total exposure by the factor for intrinsic properties. The respective factors are shown in parentheses.

Intrinsic properties	**Total exposure**	
	During mixing	
	Low (1)	High (3)

	During spraying		*During spraying*	
	Low (1)	High (2)	Low (1)	High (2)
Low (1)	1	2	3	6
Medium (2)	2	4	6	12
High (4)	4	8	12	24
Very high (8)	8	16	24	48

5.4. Categories for human health

Based on the system described above, products are classified into three health categories:

Health category	**Total score for human health**
Low	<8
Medium	8-16
High	>16

Exceptions:

- Greenhouse pesticides or seed dressings that are acutely toxic in contact with skin or by inhalation (acute toxicity, category 1-3), or that present a danger of serious irreversible effects, or present a risk of cancer, impaired fertility, harm to the unborn child or genetic damage (H370, H351, H350, H340, H372, H373, H350i, H360, H360d, H361f, H361d, H371). These products are to be classified in the 'medium' health category, due to the risk of damage to human health during handling of treated plant material or treated seed, and when cleaning seed treatment machinery.
- Products with active ingredients that are degraded to metabolites which may cause irreversible damage, cancer, impaired fertility, harm to the unborn child or genetic damage (H370, H351, H350, H340, H372, H373, H350i, H360, H360d, H361f, H361d, H371). (This applies to cases in which the hazard classification of metabolites is not shown in the labelling of the active ingredient). These products are to be classified in the 'medium' health category.

6. Environment

6.1. Total score for environment

The total score for environment is calculated for each active ingredient in each product in accordance with the equation below. In other words, a substance found in several different products will achieve different scores in the various products, depending on the respective dosage and application.

Total score for environment = Te + Ta + Tb + A + L + P + B + F

Te = Score for earthworms
Ta = Score for bees and other arthropods

Tb = Score for birds
A = Score for aquatic organisms
L = Score for leaching potential
P = Score for persistence
B = Score for bioaccumulation
F = Score for formulation type

For products containing several active ingredients, the highest score for each of the above-listed parameters is used to determine the product's total score.

In case of missing or insufficient documentation, a high score can be assigned to a substance.

Certain products have so specific areas of use or properties, that the equation is not suited for use. Examples hereof include seed dressings only used in approved facilities, greenhouse pesticides and microbiological products. The environmental hazard of these products is considered to be so insignificant, that they are given a score of 0 without any further calculations.

6.2. Score for the individual organisms/parameters

Earthworms (Te)
The European Union's working group FOCUS (1997) proposed a simple model for the estimation of pesticide concentration in the soil immediately after spraying (predicted initial environmental concentration, PIEC). 50 % plant cover is chosen as a standard scenario. The toxicity exposure ratio (TER) for earthworms is thereafter calculated by dividing toxicity (14-day LC_{50}) by PIEC.

For earthworms, the European and Mediterranean Plant Protection Organisation (EPPO) defined a threshold value of 100 for acute TER, whereas the EU (Uniform Principles) defined a threshold value of 10. On the basis of the TER, the Te score (Terrestrial earthworm) is determined, according to the table below:

TER based on 14d LC_{50}	Te
>100	0
10-100	2
<10	4

Bees and other arthropods (Ta)
For bees, EU's Uniform Principles define Hazard Quotients for oral exposure (Qho) and for contact exposure (Qhc), as dose (g/ha) divided by oral or contact toxicity (LD_{50}, µg/bee), respectively. The threshold value is set at 50. Based thereupon, the highest hazard quotient is used to determine the Ta-score (Terrestrial – arthropod), according to

the table below. Two additional points are added if the product is classified “toxic for insects” in accordance with separate labelling criteria.

Qho or Qhc	Ta without labelling for insect toxicity	Ta with labelling for insect toxicity
<50	0	2
50-1000	1	3
>1000	2	4

Birds (Tb)
In the EU’s (2002) guidance document for birds and mammals, several steps are defined for risk assessment of birds. Here, we only use step 1, which is a standardised, realistic ”worst case” with a standard exposure scenario for herbivorous birds. We selected medium-sized birds with a body weight of 300 g as the standard. The bird’s daily intake of a substance is given by the following equation:

ETE = FIR/body weight x C

ETE = Estimated daily intake
FIR = Food Intake Rate
C = Concentration of the substance in the diet (mg/kg)

According to Table 4 of the guidance document, the FIR/body weight ratio for the above-mentioned standard bird size is 0.76. RUD (residue unit dose) is used to calculate pesticide residues in the diet from dosage per unit area. In the table, RUD is set at 87 for our scenario. To obtain the concentration C (mg/kg), RUD is multiplied with dosage as kg/ha. Thus, we obtain the following equation:

ETE = 0.76 x 87 x dose = 66.12 x dose

ETE corresponds to PIEC, which is used to calculate TER by dividing acute oral toxicity (LD_{50}) by PIEC. For birds, EU’s Uniform Principles define a threshold value for TER of 10 from acute and sub-acute studies. The lowest TER value, determined for the most sensitive species, is used to define the Tb score (Terrestrial bird), according to the table below:

TER	Tb
>10	0
5-10	1
1-5	2
0.1-1	3
<0.1	4

Aquatic organisms (A)
Sources of pesticides in surface water are mainly spray drift, surface runoff or discharge via drainage systems. The EU working group FOCUS (2002) recommended three steps for the calculation of pesticide concentrations in surface water and sediments. We have chosen to use step 1, which combines spray drift, surface runoff, erosion and/or drainage, and use these parameters to estimate the predicted initial environmental concentration (PIEC). To prevent the scheme from becoming too complex, we chose to disregard repeated treatments, and only to consider the aquatic phase (not sediments).

In connection with pesticide registration, effect studies of algae, pelagic invertebrates (*Daphnia*) and fish must be submitted. In addition, studies on aquatic plants and sediment invertebrates may have been submitted. TER values for algae/aquatic plants and daphnia/fish are determined by dividing acute toxicity (LC_{50}/EC_{50}) by PIEC from the FOCUS-scenario described above.

The EU's Uniform Principles define threshold values for TER. For acute studies of daphnia and fish, the threshold value is 100. For chronic studies and algae/aquatic plant studies, the threshold is 10. On this basis, one score is determined for algae/aquatic plants and one for daphnia/fish in accordance with the table below. The highest of these scores is used as the score for aquatic environment (A).

TER based on studies on algae or aquatic plants	TER based on acute studies on daphnia or fish	A
>10	>100	0
1-10	10-100	1
0.1-1	1-10	2
0.01-0.1	0.1-1	3
<0.01	<0.1	4

Leaching (L)
The SCI-GROW model (EPA 2001) calculates a score for leaching risk, based on dosage, mobility (Koc) and persistence (DT_{50}). This is used to assign a score L for leaching in accordance with the table below:

SCI-GROW	L
<5	0
5-20	1
20-100	2
100-500	3
>500	4

Substances which are frequently detected in environmental monitoring programmes can be given a higher score than indicated by their inherent properties.

Persistence (P)
Based on half-life in soil, each substance is assigned a persistence factor (P) in accordance with the table below.

DT_{50} (days)	P
<10	0
10-45	1
45-90	2
90-180	3
>180	4

Bioaccumulation (B)
Based on log P_{ow} and half-life in soil, a score for bioaccumulation (B) is assigned in accordance with the table below.

Log P_{ow}	Half-life in soil (days)			
	<10	10-90	90-180	>180
<3	0	0	0	0
3-4	0	0	4	2
>4	1	2	3	4

Formulation type (F)
In order to take the spillage risk during the mixing of pesticides into consideration, a score for type of formulation (F) is assigned in accordance with the table below.

Formulation type	F
Water-soluble bags, water-soluble pellets, granules	0
Emulsions, powders, suspensions and other soluble concentrates	1

6.3. Choice of parameters

Dose: Standard area dose is used as dosage in all calculations.

Crop: The crop(s) on which the determination of the standard area dose is based.

Toxicity: The value for toxicity (LC_{50}/LD_{50}/EC_{50}) is based on the most sensitive standard species in laboratory studies. When not available, results from other submitted studies may be used.

Adsorption in soil: The average of all results from standard laboratory studies is used to determine Koc. Results from soil types which clearly are not relevant for Norwegian conditions, e.g., with extremely high contents of organic matter, may be omitted.

Persistence in soil: The average of all results from standard laboratory studies at room temperature is used to determine DT_{50}. Results from soil types which clearly are not relevant for Norwegian conditions, may be omitted.

6.4. Categories for environment

Based on the products' total score they are assigned to one of three environment categories in accordance with the table below.

Environment category	Score for environment
Low	<4
Medium	4-8
High	>8

Exceptions:

- Products that, based on a general assessment, clearly represent a low environmental risk can be directly placed in the lowest environment category.
- Products with incomplete documentation, but which are suspected to represent a high environmental risk, can be classified as "medium" or "high".
- Products can be placed in a higher category than indicated by their active ingredient(s), if metabolites represent a higher environmental risk than the active ingredient(s).

Literature

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