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Reduction of environmental risks from the use of biocides: Environmental sound use of disinfectants, masonry preservatives and rodenticides

Annex V: Case study on PT 14: Rodenticides

For our Environment

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Reduction of environmental risks from the use of biocides: Environmental sound use of disinfectants, masonry preservatives and rodenticides

Annex V: Case study on PT 14: Rodenticides

by

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On behalf of the Federal Environment Agency (Germany)

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Content

List of Abbreviations

BAT	Best Available Techniques
BPR	Biocidal Products Regulation
BREF	Best Available Technique Reference Documents
CA	Competent Authority
EPA	Environmental Protection Agency
ESD	Emission Scenario Document
FGAR	First Generation Anticoagulant Rodenticide
FIOSH	German Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, BAuA)
PT	Product Type
REACH	Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals
RMM	Risk mitigation measure
SGAR	Second Generation Anticoagulant Rodenticide
STP	Sewage treatment plant
TNsG	Technical Notes for Guidance
TRGS	Technische Regeln für Gefahrstoffe (Technical Rules for Hazardous Substances)
UBA	Federal Environment Agency (Umweltbundesamt, Germany)
UK	United Kingdom
VFÖS	Verein zur Förderung ökologischer Schädlingsbekämpfung
WHO	World Health Organisation

1 Introduction

Rodenticides (PT 14) comprise products used for the control of mice, rats, voles or other rodents. The three commensal and most cosmopolitan rodent pest species are

- Ship (black, roof, fruit, house) rat - *Rattus rattus*
- Norway (brown, sewer, common) rat - *Rattus norvegicus*
- House mouse - *Mus musculus spp.*

Each species has distinct behavioural and ecological requirements that must be clearly understood if effective management is to be achieved. (EPA Pest Management Principles[1]).

2 Active Substances and target organisms

2.1 Active substances

Up to August 2013, 14 active substances of PT 14 have been approved under the EU Biocidal Products Regulation 528/2012 (BPR) (Table 1).

Table 1 Active substances of PT 14 already approved under the EU Biocidal Products Regulation 528/2012 (BPR)

Annex I			
Active substance	CAS number	Inclusion Directive	Type of rodenticide
Alphachloralose[2]	15879-93-3	2009/93/EC	Narcotic
Aluminium phosphide releasing phosphine	20859-73-8	2009/95/EC	Acute / respiratory poison
Brodifacoum	56073-10-0	2010/10/EU	SGAR
Bromadiolone	28772-56-7	2009/92/EC	SGAR
Carbon dioxide	124-38-9	2008/75/EC	Acute / respiratory poison[3]
Chlorophacinone	3691-35-8	2009/99/EC	FGAR
Coumatetralyl	5836-29-3	2009/85/EC	FGAR
Difenacoum	56073-07-5	2008/81/EC	SGAR
Difethialone	104653-34-1	2007/69/EC	SGAR
Flocoumafen	90035-08-8	2009/150/EC	SGAR

[1] http://icwdm.org/Publications/pdf/Licensing/Mississippvertebratepest1994.pdf

[2] Alphachloralose is only used for mouse control indoors and is not approved for the control of rats.

[3] Carbon dioxide was included in Annex IA to Directive 98/8/EC only for use in ready-for-use gas canisters functioning together with a trapping device (inclusion directive 2007/70/EC). An active substance listed in Annex IA should normally also be listed in Annex I. Inclusion in Annex I would cover those uses for which products may be expected to satisfy the requirements of Article 5 of Directive 98/8/EC, but not those of low-risk products. Such is the case for certain biocidal products used as rodenticides containing carbon dioxide. Carbon dioxide was therefore included in Annex I for product-type 14, in order to ensure that in all Member States authorisations for biocidal products used as rodenticides and containing carbon dioxide can be granted, modified, or cancelled in accordance with Article 16(3) of Directive 98/8/EC (inclusion directive 2008/75/EC).

Warfarin	81-81-2	2010/11/EU	FGAR
Warfarin sodium	129-06-6	2010/8/EU	FGAR
Hydrogen cyanide	74-90-8	2012/42/EU	Acute / respiratory poison
Powdered corn cob	-	2013/44/EU	Dehydration agent
Annex IA			
Carbon dioxide	124-38-9	2007/70/EC	Acute / respiratory poison
Powdered corn cob[4]	-	2013/44/EU	Dehydration agent

FGAR: First Generation Anticoagulant Rodenticide

SGAR: Second Generation Anticoagulant Rodenticide

Rodenticides are usually classified into two groups, anticoagulants and all other compounds ("non-anticoagulants").

Anticoagulant rodenticides are vitamin K antagonists, inhibiting the vitamin K-dependent steps in synthesis of a number of blood coagulation factors. Prolonged inhibition causes clotting factor deficiency, which eventually leads to haemorrhage which may be fatal. A distinction is made between first and second generation anticoagulant rodenticides, subject to the time of their synthesis. Also, both groups can be distinguished by their chemical properties.

First generation anticoagulant rodenticides (FGAR) are less toxic and rodents require consecutive intake over several days to accumulate the lethal dose. The appearance of rats which are resistant to FGAR has resulted in the development of more effective second generation anticoagulant rodenticides (SGAR). SGAR are far more toxic so that they are lethal after a single ingestion (aid Infodienst, 2012). Furthermore, SGAR persist in the environment and the body for a longer period and therefore have a high potential to bioaccumulate in biota in contrast to FGAR.

The group “non-anticoagulants” comprises rodenticides having narcotic effects such as alphachloralose and acute respiratory poisons such as aluminium phosphide releasing phosphine or carbon dioxide (aid Infodienst, 2012).

2.2 Formulations

Rodenticide active substances reviewed under Directive 98/8/EC are mainly of two formulation types, those used in baits and those applied as fumigants. Among the baits, the majority are anticoagulant rodenticides, which are very widely used in rodent control in the EU. Two other substances are less widely used as baits; these are alphachloralose and powdered corn cob (EBPF, 2012). Foam formulations are less common.

Rodenticide baits are formulated as

- loose-grain,
- pellets,
- wax blocks and

[4] Only for use in the form of pellets in dry locations.

- paste baits (= sachets).

In view of the identified risks of anticoagulant rodenticides the respective Annex I inclusion directives stipulate certain restrictions with regard to the type of formulation that shall receive an authorization by the Member States. These restrictions provide that only ready-for use products with certain threshold concentrations of the active substance shall be authorized. In addition, products shall contain an aversive agent and, where appropriate, a dye in order to avoid accidental ingestion and to make them unattractive to non-target organisms. Furthermore, products containing SGAR shall not be used as tracking powder[5]. Products containing FGAR that are used tracking powder shall only be laced on the market for use by trained professionals (e.g. chlorophacinone).

Consequently, nearly all of the above listed rodenticide baits are cereal-based (usually wheat, oat flakes or grain mixtures) ready-to-use formulations, often containing additives such as flavourings and mould inhibitors (preservatives) as well as bittering agents and dyes. (CSL 2002; aid Infodienst 2012, Killgerm product catalogue 2012; Bábolna Bio product catalogue 2012; Unichem product catalogue 2012).

Grain and pellets are either sold in loose form in plastic buckets or portion packed in sachets (paper or foil) or plastic trays covered with aroma-permeable foil. Plastic sachets can be placed unopened in wet or humid environment. This ensures that the baits remain fresh even if they are not immediately ingested by rodents. These sachets are mainly applied outdoors to control Norway rats.

Wax blocks contain a considerable percentage of fats/paraffin or other binding agents. They are highly resistant to all kinds of weather conditions. Therefore, wax blocks are suitable both for outdoor and indoor use, effective even in damp conditions such as rodent control in sewers. However, wax blocks are usually less attractive and thus less efficient than granular baits (aid Infodienst 2012; EC COM 2011)

Paste baits are delivered in cartridges (to be filled in bait boxes) or in plastic sachets. The high water content of paste bates make them attractive, especially in dry environments.

Besides ready-to use baits, rodenticide concentrates may still be on the market for professional users to prepare dry or liquid baits for special purposes, however concentrates will not get a new authorization within the near future (see above for restrictions stipulated in the Annex 1 inclusion directives, regarding concentration thresholds of active substances in the respective products).

3 User groups and mode of application

With regard to the user type of rodenticides, a general distinction is made between professional users and non-professional (amateur, general public) users.

In the Emission Scenario Document (ESD) for biocides used as rodenticides (2003) the term professional use is a term used in order to emphasise that the general public is not allowed to use a certain compound. The term, however, is not clear and concise. It only indicates that professionals are assumed to have a minimum knowledge of the substance they are handling by training or education, whereas non-professionals (or the general public) are assumed to have little or no knowledge of the substances."

[5] Rats pick up tracking powder with their fur by running over the powder and ingest it during cleaning and grooming. The products are usually scattered around burrows and on runways of rats or around bait stations.

Directive 2009/128/EC[6] defines professional users as, "any person who uses pesticides in the course of their professional activities, including operators, technicians, employers and self-employed people, both in the farming and other sectors".

To avoid possible diverging interpretations, the European Commission (2007) defines and distinguishes the following terms:

- *Professionals:* People who are required to use biocides (here: rodenticides) as part of their work.
- *Trained professionals:* People who are required to use biocides (here: rodenticides) as part of their work and have received an appropriate training to acquire competence in the use of rodenticides like pest control operators or other professionals (e.g. farmers).
- *Amateurs:* People who have neither received any specific training in the use of biocides (here: rodenticides) nor have access to personal protective equipment.

The category, "professionals" (with or without training), includes a wide range of user types: In particular, pest controllers or pest control operators are professional users of rodenticides. They conduct treatments against a wide range of different pests, including rodents. They usually work in private companies, in local governments or local authority structures, as well as in other types of commercial enterprises. Other professional users of rodenticides are managers of warehouses and storage facilities, janitors of commercial and domestic premises, farmers and gamekeepers who may be required to conduct rodent control operations as part of their job routine (EBPF 2012).

It is assumed that non-professional users (amateurs) deal with small rodent infestations in and around their own homes.

The German Federal Environment Agency (UBA) distinguishes four different user categories for the application of rodenticides (UBA 2014b):

Non-professional users: Consumers representing the general public, who would use a biocidal product in her/his private, domestic sphere. There is a high probability that the instructions for use will not be followed exactly in all cases, that the user will not have any specialised knowledge and usually and will not apply any protective equipment such as gloves.

Professional user: Uses biocidal products occasionally in the context of his occupation, which is not primarily concerned with using rodenticides. This user category refers to caretakers, specialist cleaning personnel or sewage workers, among others. Regarding the knowledge about the best practice in using biocidal products and the risks posed for humans, animals and the environment, there is hardly a difference, if any at all, between professional users without qualification and consumers.

Professional users with qualification: The latter have specialist knowledge about the handling of rodenticides and in addition, would use such products in their job on a regular basis after appropriate proofs of qualification.

[6] Directive 2009/128/EC of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides

Trained professional users: Users having a specialist qualification, e.g. in the form of an officially recognised training or advanced training in the respective field. This category of users refers to pest control operators trained for the use of rodenticides or other training recognized as equivalent.

The Confederation of European Pest Control Associations (CEPA), through its Roma Protocol, initiated a European standard for training and certification of pest control technicians on CEN/TC 404[7]. The draft standard BS EN 16636: "Pest management services. Requirements and competences (July 2013) aims to achieve a common minimum standard of professionalism at a European level for Pest Management Professionals, based on competence and knowledge (Fryatt 2012).

In order to limit the risk of primary and secondary poisoning and to avoid the development of widespread resistance to anticoagulant rodenticides, it was proposed in the inclusion directives for these actives, to restrict the user category of anticoagulant rodenticides to professionals only. However, at MS / CA level this proposal was not accepted as an appropriate measure. The main reason for the rejection of this proposal was the potential drawbacks for rodent control, especially in regions with low human population densities (Gartiser & Jäger 2010). If these drawbacks are not valid for some MS, e.g. due to a well-developed infrastructure of trained pest control operators and/or other trained professionals, these MS are able to restrict the use of the rodenticides to those professionals during the product authorization.

The mode of application mainly depends on the type of formulation described in section 2.2.

4 Possible emission routes and available ESD

One emission scenario document is available for biocides used as rodenticides, prepared by Larsen (2003). The ESD considers four main scenarios according to application surroundings:

- sewer system
- in and around buildings
- open areas
- waste dumps

Since the exposure of the environmental compartments soil, water and air is highly dependent on the formulation type, the main scenarios are subdivided into further scenarios according to application types such as wax block, pellets and impregnated grain, contact powder, liquid concentrate, bait box and gassing.

Environmental exposure may result from the release of rodenticides from its use and disposal. Direct environmental exposure may take place when rodenticides are applied in and around sewer systems, outdoors on public and private areas around buildings or constructions (farm buildings, railway stations, harbour areas etc.), on waste disposal sites and waste dumps. Indoor application may result in environmental exposure via the sewage system (e.g. during cleaning processes after a rat control operation), release of

[7] CEN/TC 404: Pest management services - Requirements and competences; http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/WP.aspx?param=792209&title=CEN/TC%20404

residues or carcasses to dumps (COWI 2009). Besides a possible exposure of environmental compartments, primary and secondary poisoning of non-target organisms need to be taken into account.

Sewer system

This scenario deals with applications below ground in sewer pipes, ducts, conduits and collecting areas (EBPF 2012). The most prominent application type in sewer systems are wax blocks or containers with impregnated grains or pellets which are typically applied, hanging in a wire tied to the wall, a few cm above the bottom of cesspools.

A maximum release to the sewer systems and finally, sewage treatment plants (STP), could come directly from residues from the applied wax blocks and impregnated grains/pellets, and indirectly from the target animals' urine, faeces and dead bodies, i.e. 100% release minus degraded/metabolised fractions.

Thereof, the main release (70 to 90%) takes place in the use phase and is dominated by the intended oral ingestion by the target organism (rats), whereas significant, unintended releases are limited to spills during the rat "attacks". Later in the use phase, unintended releases occur which are caused by degradation and disintegration of the remains of the block.

There is no primary poisoning hazard to mammals or birds because no other mammals (or birds) are living or occurring in sewers. (Larsen 2003)

In and around buildings

The term "in and around buildings" should be understood as the building itself, and the area around the building that needs to be treated in order to deal with the infestation of the building (European Commission 2007). In all EU countries baits are to be placed in bait stations or in other ways covered or hidden so as to minimise access of non-target animals (Larsen 2003). Exposure of the environmental compartment soil can be expected from spills during application, refilling and disposal operations, and, to a minor extent, from urine, faeces and carcasses of rodents. In addition, the rodents may disperse the rodenticide by carrying the bait away from the bait boxes during its use period. The exposure of air and surface water is considered as irrelevant.

Outdoor application, directly into burrows, is covered by the "open area scenario".

Residues from indoor use of baits may reach the environment from disposal by sewage system or cleaning. However, this emission is assumed to be insignificant.

Despite the use of bait boxes to minimise access of non-target animals, primary and secondary poisoning cannot be excluded, and thus needs to be considered within in this exposure scenario.

Open areas

These exposure scenarios cover the use of rodenticides to control rats and water voles in open areas away from buildings. Examples are the use of rodenticides in other open areas such as farmlands, parks and golf courses to prevent burrows and soil heaps or due to public hygiene reasons (Larsen 2003). EBPF also mention the use of rodenticides on airfields and in dykes or the use by gamekeepers in hedgerows and cover crops (EBPF 2012).

The main release to the environment is expected when baits (i.e. wax blocks, pellets and impregnated grains, contact powders) are applied to burrows and rat holes. By a spoon or a small shovel, the product is normally poured approximately 30 cm into the rat holes, depending on the slope and general accessibility of the hole.

The treated holes are closed by a stone or a board immediately after the application to prevent unintended exposure of children or non-target organisms (e.g. birds, cats and dogs).

The exposure scenarios, for open areas, include a scenario for gassing, which may be used to control water voles and rats in burrows.[8] For this purpose, gassing pellets (e.g. aluminium phosphide) are spread in the hole which is closed with a plug (e.g. grass, stone or paper). The evolved phosphine gas is heavier than air and mainly remains and spreads in the burrows.

According to the ESD soil and air might be exposed to rodenticides, whereas the exposure of STP and surface waters are considered not relevant. Primary and secondary poisoning cannot be excluded, and thus needs to be considered within in this exposure scenario.

Waste dumps/landfills

This exposure scenario covers control of rats and disposal of rats in waste dumps and landfills where the exposure is assumed to be higher than that described in the open area scenario (Larsen 2003). Mostly the use is limited to occasions of population outbreaks of rats. Often the rodenticides are deployed around the perimeter of the dump, more than in the disposal area itself. The bait may be placed at regular places in special feeding stations in order to prevent other animals from eating the bait.

The soil is potentially exposed. Apparently most of the bait is eaten and returned as urine, faeces, dead animals, etc. Exposure of STP, surface water and air are considered not relevant.

The risk of primary and secondary poisoning is regarded similar to the situation found for the use of rodenticides in open areas. However, there might be even more predators around a landfill than in the open areas, e.g. sea gulls, craws, etc.

5 Elements of sustainable use

5.1 Stakeholder survey

For the elaboration of measures on the sustainable use of rodenticides a survey among different stakeholders was conducted by means of a questionnaire. Around 32 stakeholders (manufacturer¸ formulator/retailer; associations, pest control workers, authorities, and NGOs / Universities) have been contacted from which 14 responses have been returned.

Table 2: Addressed and returns of stakeholder survey

	Addressed	Returns
Manufacturers of rodenticides	4	2
Formulators / Retailers	3	3
Associations	7	1
Users (e.g. pest control operators)	3	3
Authorities / Regulators	9	3
NGO's / Universities / Experts	6	2
Total	**32**	**14**

[8] In some EU countries the use of phosphine against water voles is prohibited.

Within the survey, the stakeholders were asked to indicate their expectation about the practicability and efficiency of measures proposed to reduce environmental impacts. These measures included aspects such as further training and education, requirements for sales and control mechanism, information and awareness raising, surveillance of applications, and measures to reduce emissions during the use phase. The evaluation of the measures ranged from highly efficient, over medium or low efficient, to not efficient at all. In addition, stakeholders were asked to put forward own proposals for adequate further measures. The results of the stakeholder survey are presented in the respective following sections, describing the elements of a sustainable use of rodenticides.

Furthermore, stakeholders were asked about their understanding on a sustainable use of rodenticides. The following overview reflects the answers of the stakeholders as given in the questionnaires:

- Use of rodenticides in such a way that rodents are controlled but impacts on the environment and non-target species are minimised.
  Expert of EU Member State Authority on Agriculture, Food and Rural Communities
- Use of an effective biocidal product to control a rodent infestation fastest possible.
  Selection of a biocidal product with the lowest (eco) toxicity.
  Integrated pest management including survey and inspection of the species involved and area/s concerned as well as habitat management.
  Pest control association expert
- The sustainable use of rodenticides comprises the following aspects:
  - Effective reduction and control of rodent infestation.
  - Efficient use of biocidal products including sufficient bait placements, regular re-placements, sufficient long bait campaigns.
  - Placement of baits in such a manner that children and non-target animals cannot gain access or access is restricted to a minimum.
  - In case of larger infestations, a planned approach is necessary considering also possible risks to the environment.
  - Resistance management.
  - Use of biocidal products with low accumulation potential – if possible with regard to resistance.
  - Collection and disposal of dead rodents.
  - Good documentation of pest control campaigns by professional users.
  - Preventive measures to avoid new infestations.
  Manufacturer and retailer of rodenticides
- Minimisation of negative impacts of biocidal products on the environment and non-target species.
  Retailer / distributor of rodenticides
- Use of rodenticides only in case of infestations, no preventive bait placements; obligatory use of bait boxes; Collection and disposal of remnant baits and dead rodents at the end of the campaign.
  Retailer / distributor of rodenticides
- Present and future use of rodenticides without negative impacts on the environment
  Manufacturer of rodenticides

- Acute and strategic rodent control to ensure human and veterinary health as well as food and feed supply. Strategic rodent campaigns in and around buildings to minimise both the danger represented by rodents and the quantity of biocidal products.
  Pest control operators
- Use as much as necessary - as little as possible to ensure human health.
  Pest control operator
- Long-term control of rodents without the need of repeated campaigns; no development of resistance; minimum exposure of non-target species and humans.
  Social dimension of sustainability: painfree death of target rodents
  Expert of EU Member State Authority
- The sustainable use of rodenticides comprises a strategy with long-term results and the optimised use of rodenticides. Important element is a target setting considering a successful campaign and the long-term results with respect to rodent population, pathogen reservoir, development of resistances and financial resources. Furthermore, sustainable use of rodenticides involves the management and surveillance by local authorities to monitor the rodent populations, control campaigns and introduce alternative measures.
  Expert of a local authority
- Use as much as necessary - as little as possible, thereby considering the principles of integrated pest management. Alternative (physical) control measures shall be preferred in order to avoid or at least to minimise the use of biocidal products. Reference is made to BPR (EC) No 528/2012 Art. 18 ‘Measures geared to the sustainable use of biocidal products’.
  NGO

5.2 Risk mitigation measures

For the evaluation of anticoagulants used as rodenticides, a guidance document on risk mitigation measures was published by the European Commission (2007). It outlines a common approach for both Annex I inclusion of active substances and product authorisations. The paper includes a number of suggestions to mitigate the risk arising from the use of anticoagulants used as rodenticides. These suggestions refer inter alia to the category of users, the area of use, the composition and formulation of the products, the packaging, pack size and labelling as well as codes of good practice. The paper furthermore concluded that the choice of the most appropriate risk mitigation measures is closely linked to the design, pack size, area of use, category of users, conditions of use and the composition of the final product. The choice of specific risk mitigations measures should therefore be deferred to the product authorisation stage when all the details of the products, to be placed on the market, are available. The objective of the Annex I inclusion should thus be to identify general risk mitigation measures, which can apply to all products, as well as specific risks/hazards to be addressed at product authorisation.

During the evaluation of the first generation anticoagulant rodenticides (FGAR) (chlorophacinone, coumatetralyl, warfarin and warfarin sodium) under the EU’s Biocidal Product Directive review, a risk has been identified for non-target animals. During the evaluation of the second generation anticoagulant rodenticides (SGAR) (bromadiolone, difenacoum, brodifacoum, flocoumafen and difethialone), a risk has been identified regarding humans (mainly accidental incidents with children), non-target animals and the environment. Despite these identified risks the Annex I inclusion was granted for FGAR and SGAR because

of their public health benefits and the lack of established alternatives which are both equally effective and less damaging to the environment. The Annex I inclusion was, however, only granted for a limited period of 5 years. In view of the identified risks for non-target animals (FGAR) and in view of the fact that the active substance characteristics render them being potentially persistent, liable to bioaccumulate and toxic, or very persistent and very liable to bioaccumulate (SGAR), all anticoagulant rodenticides are to be subject to a comparative risk assessment in accordance with the second subparagraph of Article 10(5)(i) of Directive 98/8/EC before their inclusion in this Annex is renewed.

Further to the limited inclusion period and the requested comparative risk assessment, specific risk mitigation measures are demonstrated in the Annex I inclusion directive of each FGAR and SGAR[9]. Certain general constraints such as the maximum concentration, the prohibition on marketing the active substance in products used as tracking powder, or in products which are not ready for use, and the use of aversive agents have to be imposed in all member states (MS). In detail, MS shall ensure that authorisations are subject to the following conditions:

1. The nominal concentration of the active substance in the products shall not exceed a stipulated threshold concentration (e.g. 50 mg/kg for brodifacoum or 75 mg/kg for difenacoum) and only ready-for-use products shall be authorised.
2. Products shall contain an aversive agent and, where appropriate, a dye.
3. Products shall not be used as tracking powder (SGAR) or products to be used as tracking powder shall only be placed on the market for use by trained professionals (FGAR).
4. Primary as well as secondary exposure of humans, non-target animals and the environment are minimised, by considering and applying all appropriate and available risk mitigation measures. These include, amongst others, the restriction to professional use only, setting an upper limit to the package size and laying down obligations to use tamper resistant and secured bait boxes.’

Due to the fact that the choice of the most appropriate risk mitigation measures is closely linked to specifications of the final product (see above), specific risk mitigation measures (RMM) have to be applied at product authorisation on a national level. A further point indicating the necessity of specific national RMM is the fact that there are large differences regarding the infrastructure of pest control within the different EU countries. Therefore, it was agreed that "Member States will be able to make restrictions at the product authorisation stage on the use of rodenticides containing any of the 2nd generation anticoagulants, which can go further than the risk mitigation measures explicitly set out in Annex I of Directive 98/8/EC. Such measures could include specific restrictions on outdoor use, or even ban such use, if such restrictions appear appropriate for sound scientific reasons." (European Commission 2011)

In this regard, the German Federal Environment Agency (UBA) and the Federal Institute for Occupational Safety and Health (BAuA) defined risk mitigation measures (RMM) for SGAR for their use in Germany (UBA 2014b; BAuA 2012). These RMM mainly include the restriction of the user category to trained and

[9] See links to the inclusion directives in Table 1.

licensed users, i.e. pest control operators and other trained and licensed professionals.[10] These RMM are legally binding and will be specified in the authorisation directive of each product. RMM have to be included in the instruction for use and have to be applied during the use of the products.

Other European countries (e.g. Sweden, Denmark or Norway) have set up comparable RMM. [11, 12, 13] These countries have a similar infrastructure on pest control.

5.3 Training/Education

Several European countries restrict the use of SGAR to "trained professionals/users with a license" (see sections 3 and 5.2). UBA (2014b) defines the requirements to become a trained user. This type of user needs a certificate, showing the successful participation of a training course on pest control, including inter alia knowledge on:

- Behaviour and biology of rodents
- Legal basis for the control of rats and mice
- Best practice of rodent control including integrated pest management (IPM) and resistance management
- Mode of action of rodenticides with a special focus on anticoagulant rodenticides
- Risks for human health and environment including risk mitigation measures to avoid primary and secondary poisoning of non-target organisms; handling of PBT/vPvB substances
- Application techniques and methods of treatments including documentation
- Control of rats in sewer systems

In several countries the profession, "pest controller / pest control operator" has official status, e.g. in Germany and Austria "pest controller" is an official three-year training occupation[14, 15]. Furthermore, in these countries the pest controllers are obliged to participate in regular trainings (e.g. TRGS 523/4.5 (2003); German TierSchG, Art. 11, 2a (3)). In this context the German Committee on Hazardous Substances (Ausschuss für Gefahrstoffe - AGS) has defined that "regular participation" means at least every two years.

[10] The criteria for such a licence ("certificate of competence") are specified in UBA (2014a).

[11] Denmark: Restrictions of authorisation of biocidal products containing difethialone; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:160:0019:0021:EN:PDF

[12] Sweden: Restrictions of authorisation of biocidal products containing difethialone; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:160:0025:0027:EN:PDF

[13] Norway: national restrictions concerning rodenticides, containing brodifacoum, bromadiolone, difenacoum, difethialone or flocoumafen; http://www.klif.no/no/english/english/Areas-of-activity/Regulation-of-biocidal-products-in-Norway/National-restrictions-concerning-rodenticides/

[14] http://www.gesetze-im-internet.de/bundesrecht/sch_dlbekausbv/gesamt.pdf

[15] http://www.schaedling.or.at/uploads/berufsbild.pdf

In addition, further educational structures exist, such as training seminars organised by pest control companies, manufacturers and other organisations (e.g. VFÖS[16]) or formative meeting and conferences organised by pest control associations (e.g. EUROCIDO®[17]; Grünauer Tagung[18]).

EBPF (2012) point out that training schemes are widely offered in the EU, mainly to professional pest control technicians, but these schemes need to be extended to other user groups, such as farmers and gamekeepers, and should be harmonised.

Within the stakeholder survey (see section 5.1) the participants were asked to rate the practicability and efficiency of different measures related to further training and education. Highest efficiency is attributed to the measure, "*knowledge transfer on a sustainable use of rodenticides during education and training, e.g. of pest control workers*" (see Figure 1).

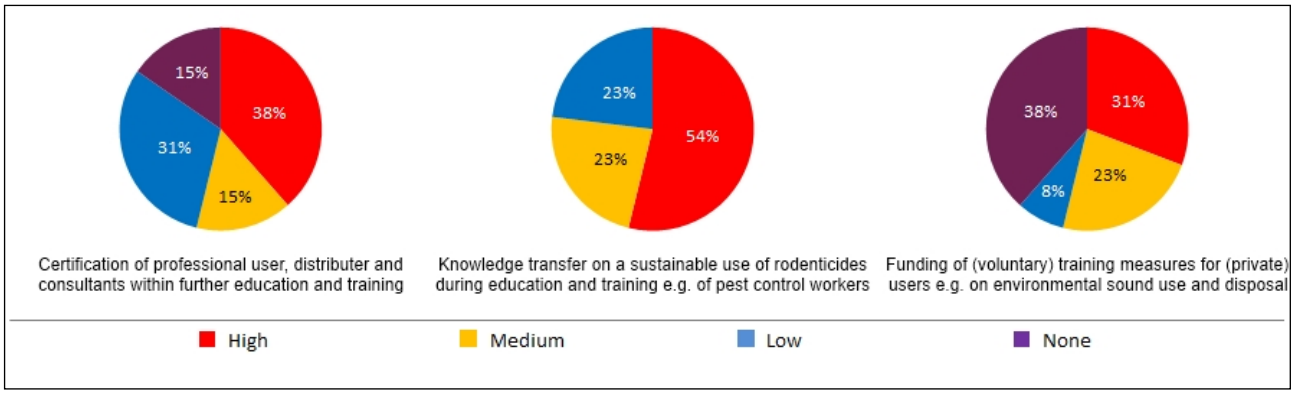

Figure 1 **Stakeholder response on the efficiency of measures related to further training and education (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)**

Measures such as, "*certification of professional users, distributers and consultants within further education and training*" and "*funding of (voluntary) training measures for (private) users, e.g. on environmental sound use and disposal*" are also considered as high or at least medium practical / efficient by the majority of the stakeholders.

5.4 Requirements for sales of biocides

5.4.1 General sales restrictions

Up to now there are no sales and distribution restrictions for biocides in Germany. Consequently, all types of rodenticides including FGAR and SGAR products are displayed for sale not only to (trained) professional

[16] VFÖS: Verein zur Förderung ökologischer Schädlingsbekämpfung e.V.; http://www.vfoes.de/verein/

[17] http://eurocido.dsvonline.net/

[18] http://www.svs.svs-sachsen.de/anmeldungsformular-gruenauer-tagung-2013.html?view=form

users but also to the general public, mainly in construction and hardware stores and via the internet. In stores rodenticides are even offered on open shelves (i.e. self–service) without sales advice by trained employees.

Thus, even though the use of SGAR is restricted to trained professional users (see section 5.2) there are no sales restrictions or requirements for sales of these products. Non-professionals (consumers) can purchase SGAR, even though they are not allowed to use them.

Since 1 January 2013, products containing the active ingredients difenacoum or difethialone require a general reference on the package that the use is not allowed by non-professional users. Nevertheless, the products can still be sold to non-professionals (consumers).

In contrast, the U.S. Environmental Protection Agency (EPA) requires sales, distribution and packaging restrictions for products containing FGAR and SGAR to prevent purchase on the consumer market (U.S. EPA 2012). The terms and conditions of registration for products containing SGAR must be amended to specify that the registrants shall not control the distribution of the products, so that they would only be distributed to or sold in agricultural, farm and tractor stores or directly to pest control operators and other professional applicators. Furthermore, the registrants shall not be allowed to sell or distribute products containing SGAR in channels of trade likely to result in retail sale in hardware and home improvement stores, grocery stores, convenience stores, drug stores, club stores, big box stores, and other general retailers. In addition, rodenticide bait products (containing both FGAR and SGAR), available for sale to consumers, are only to be sold with bait stations.

5.4.2 Packaging, design and pack size

The Annex I inclusion directive, of all SGAR, lists certain general constraints such as the maximum concentration, the prohibition on marketing the active substance in products used as tracking powder, or in products which are not ready for use (i.e. concentrates), and the use of aversive agents (see section 5.2). These measures have to be implemented in all member states (MS).

The size of the package of anticoagulant rodenticides, placed on the market, should be commensurate to the duration of the treatment and appropriate to the pattern of use of particular user groups. In this context, the European Commission proposes in the working paper on risk mitigation measures for anticoagulants used as rodenticides (2007), that the sale and/or supply of larger pack sizes should be restricted to professionals, whilst amateur users should only control small rodent infestations in limited areas, and should only be able to purchase small pack sizes.

5.4.3 Labelling

BPR Art. 69(1) stipulates that biocidal products are classified, packaged and labelled in accordance with the approved summary of biocidal product characteristics, in particular the hazard statements and the precautionary statements, as referred to in point (i) of BPR Art. 22(2), and with Directive 1999/45/EC and, where applicable, Regulation (EC) No 1272/2008. In addition, the European Commission (2007) requires that all packaging of anticoagulant rodenticides show the following standard phrases:

- Baits must be securely deposited in a way so as to minimise the risk of consumption by other animals or children. Where possible, secure baits so that they cannot be dragged away.
- Search for and remove dead rodents at frequent intervals during treatment (unless used in sewers), at least as often as baits are checked and/or replenished. Dispose of dead rodents in accordance with local requirements.

- Unless under the supervision of a pest control operator or another competent person, do not use anticoagulant rodenticides as permanent baits.
- Remove all baits after treatment and dispose of them in accordance with local requirements.
- Keep out of the reach of children.

The latter safety precaution should always be labelled on the products, whereas the others could be specified elsewhere on the packaging or on an accompanying leaflet together with the other directories for the use and disposal of the product, required by Art. 69(1) of BPR.

In addition, for products to be used in public areas, when tamper-resistant bait stations are not used, the following safety precaution shall be listed on the label of the products or elsewhere on the packaging or on an accompanying leaflet:

- When the product is used in public areas, the areas treated must be marked during the treatment period, and a notice explaining the risk of primary or secondary poisoning by the anticoagulant as well as the first measures to be taken in case of poisoning must be made available.This sheet is ought to be presented in the vicinity of the treatment area
- When tamper-resistant bait stations are used, they should be clearly marked to show that they contain rodenticides and that they should not be disturbed.

In Germany, product authorization for anticoagulant rodenticides stipulates the following requirements regarding the labelling of the products:

In general

- For all applications the “Common best practice code for the control of rodents by trained and specialized professionals using anticoagulant rodenticides” should be followed additionally to the product specific risk mitigation measures.
- The use is restricted to professionals and specialized professionals only.
- If necessary, further product specific measure, such as: The application of the bait into the soil e.g. into rat and mice holes is not allowed to protect the groundwater.

In and around buildings (bait boxes)/ Waste dumps

Products that will be applied in and around buildings and on waste dumps or landfills should be subject to the following risk mitigation measures:

- Before the product is being used, the areas treated must be marked during the treatment period and an information sheet, explaining the risk of primary or secondary poisoning by the anticoagulant, as well as indicating the first measures to be taken in case of poisoning must be made available in the vicinity of the baits.
- Baits must be securely deposited in a way so as to minimize the risk of consumption by other animals or children. This includes the use of a bait box to prevent access to the bait by children and non-target animals. If possible, baits must be secured in a way in the bait boxes so that they cannot be dragged away by the target animals. Only in areas that are not accessible to other animals or children such as pipeline systems, ducts or cavity walls the deployment of the bait without bait boxes is acceptable.

- Search for and remove dead rodents at frequent intervals during treatment, at least as often as baits are checked and/or replenished. Dispose of dead rodents in accordance with local requirements.
- Remove all baits after treatment and dispose them of in accordance with local requirements.

Open areas (bait boxes)

Products that will be applied in open areas should be subject to the following risk mitigation measures:

- Before the product is being used, the areas treated must be marked during the treatment period and an information sheet, explaining the risk of primary or secondary poisoning by the anticoagulant, as well as indicating the first measures to be taken in case of poisoning, must be made available in the vicinity of the baits.
- Baits must be securely deposited in a way so as to minimize the risk of consumption by other animals or children. This includes the use of a bait box to prevent access to the bait by children and non-target animals and to protect the groundwater. If possible baits must be secured in a way in the bait boxes so that they cannot be dragged away by the target animals.
- Search for and remove dead rodents at frequent intervals during treatment, at least as often as baits are checked and/or replenished. Dispose of dead rodents in accordance with local requirements.
- Remove all baits after treatment and dispose them of in accordance with local requirements.

Sewer systems

Products that will be applied in sewer systems should be subject to the following risk mitigation measures:

- Baits must be secured in a way so they cannot be washed away easily or dragged away rapidly by the target animals.
- Place the bait above the high water mark.

5.4.4 Result of stakeholder survey

The stakeholders of the survey (see section 5.1) proposed the following requirements for sales to reduce environmental impacts of rodenticides:

- The packages should contain detailed and particularly understandable use descriptions, either on the package itself or as accompanying leaflet. In addition, the accompanying leaflets should contain risk profiles of the biocidal product, summarizing all hazard information. On the basis of such information, users are able to compare the different products and to choose the less hazardous products.
- Biocidal products should be distributed together with harmonized instructions of sustainable rodent control.
- Sales restriction for rodenticides sold to consumers: bait products should only be sold together with bait stations; only ready-to-use products (i.e. no concentrates); small pack sizes in ready portions (i.e. no loose pellets).

When asked to evaluate the practicability and efficiency of different requirements for sales and control mechanisms, the stakeholders attributed the highest values to the regulation of product sales via internet and to the general public, e.g. limitation of the container size for private users (Figure 2). Advice to clients by manufacturers (e.g. in form of safety data sheets, technical leaflets, instructions for use) and sales advisory services by trained employees have also been considered as being efficient and practicable. In contrast, measures such as restrictions on the marketing and recording of sales volumes were considered less efficient by the stakeholders.

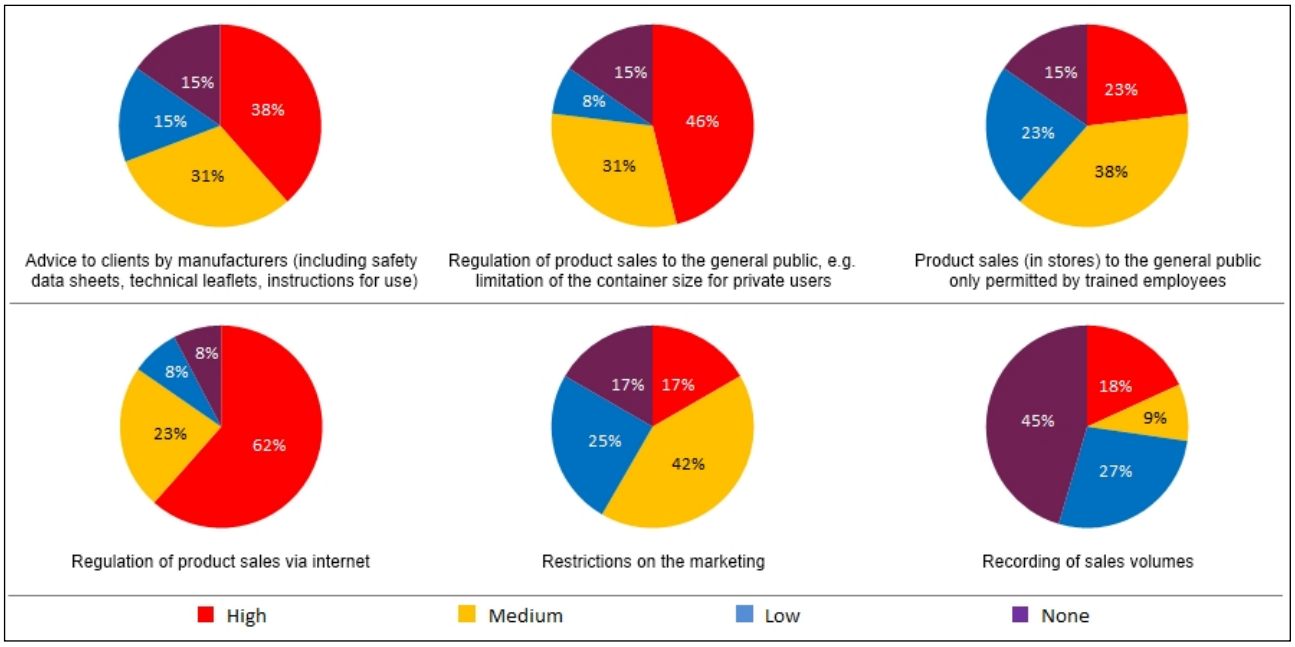

Figure 2 Stakeholder response on the efficiency of measures related to requirements for sales and control mechanisms (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)

5.5 Awareness programmes and information

A web-based information system developed and run by the German Federal Environment Agency provides information to the general public about physical, chemical and other measures as alternatives for the use of biocidal products or for minimization of their use. Its focus lies on the description of preventive measures (www.biozid.info). This information system inter alia informs about rodents including their habitats and living conditions. Furthermore, it explains preventive measures to avoid rodent infestations and the use of alternative control measures. The web-portal is continuously extended.

Some manufacturers of rodenticides provide web-based support for the performance of professional rodent campaigns by farmers, including placement, amount and frequency of baiting (e.g. BayTool)[19].

[19] http://agrar.bayer.de/farm_protect.cms

Besides web-based information systems, handbooks and leaflets are published to inform the general public on pest control in households (e.g. JKI 2012; Lebensministerium 2004).

Many fact sheets containing information about rodent control are also published on the municipal level: these fact sheets inform the general public about preventive measures to avoid rat/rodent infestations and give instructions on what to do or whom to contact in case of infestations.[20] [21][22][23]

Annual conferences and meetings organised by pest control associations (e.g. EUROCIDO®[24]; Grünauer Tagung[25]) serve as platforms for information exchange between manufacturers, professional users and authorities / academia.

Different professional journals are (monthly) published for pest control operators such as DpS[26] and Pest Control News[27] presenting all kind of information related to pest and rodent control. These journals could offer a good platform for the distribution of information on the sustainable use of rodenticides. In addition to these professional journals, other journals read by farmers, hobby gardeners or private consumers could serve as distribution pathways for the dissemination of knowledge on sustainable use.

Within the framework of the stakeholder survey (see section 5.1) participating pest control operators underlined the importance of raising the customer's awareness on integrated pest management. Many customers are still not aware of the fact that a rodent infestation requires a repeated on-site visit by the pest control operator to place, control and dispose the baits (and dead rodents). When asked to evaluate the practicability and efficiency of different requirements for information and awareness raising, the stakeholders attributed the highest values to, "Providing information on best practices and safe use", followed by the "Promotion of web-based information platforms" (see Figure 3). Most of the stakeholders consider the "Integration of environmental criteria into new or existing eco-labels and/or quality labels" as not very useful.

[20] http://www.mannheim.de/sites/default/files/page/25614/merkblatt7.pdf

[21] http://www.landkreis-oder-spree.de/media/custom/1300_4403_1.PDF?1178162435

[22] http://www.muenster.de/stadt/umwelt/pdf/tipp_rattenbekaempfung.pdf

[23] http://www.stadt-roth.de/lwwcm-rh/rh-publish.nsf/AttachmentsByTitle/Faltblatt+Ratten/$FILE/Rattenflyer.pdf

[24] http://eurocido.dsvonline.net/

[25] http://www.svs.svs-sachsen.de/anmeldungsformular-gruenauer-tagung-2013.html?view=form

[26] http://www.schaedlings.net/go/870FB913E08140F9BA27C7F6D1367162/?lang_id=1

[27] http://www.pestcontrolnews.com/deutsch.php

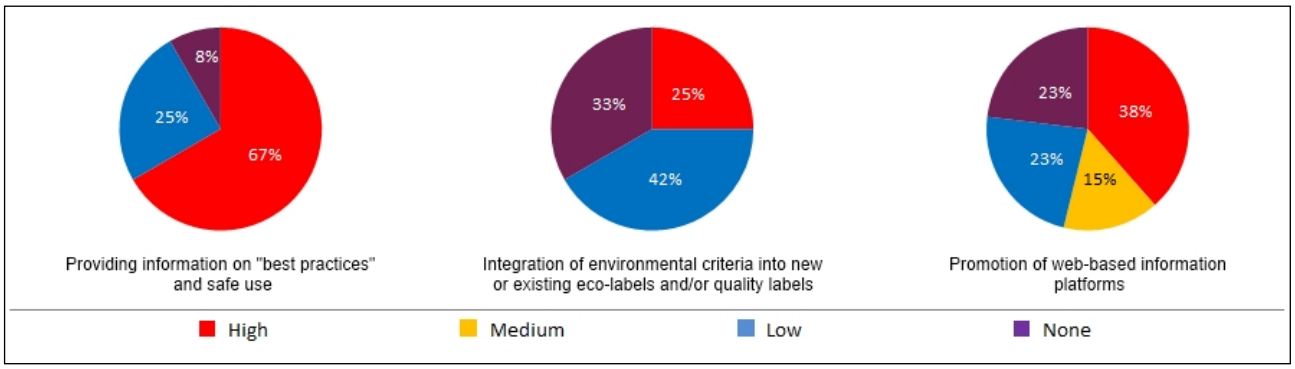

Figure 3 Stakeholder response on the efficiency of measures related to information and awareness raising (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)

5.6 Strategies and equipment for rodenticide application

Sustainable use of rodenticides depends very much on the correct identification of the species to be controlled. Each species has distinct behavioural and ecological requirements that must be clearly understood if effective management is to be achieved. The application strategy must be clearly targeted to the characteristics of the species and area concerned. Mis-identification or failure to appreciate these characteristics will reduce the chances of effective control significantly (CLI 2003; UBA 2014b; see also section 5.14 on integrated pest management and criteria of best practice).

Most rodenticides are applied as baits in the form of loose grains, pellets, wax blocks or paste baits (see section 2.2). Therefore, the method of bait placement is of great significance for a sustainable use of rodenticides. Regarding placement of baits, the EU Risk Mitigation paper (European Commission 2007) proposed that "where appropriate, the product information could include an instruction that the product may only be used in bait boxes. However, it is also recognised that there are many satisfactory ways to prevent access to baits by non-target animals, e.g. the use of tamper-resistant bait boxes. Effective rodent pest management is facilitated when tamper-resistant bait boxes are unnecessary, for example in locked buildings, with no public access and no access to non-target animals, in wall and ceiling voids and in sewers. Also, the relatively high cost of these stations may deter users from placing adequate and enough baiting points, thus affecting treatment efficacy and duration." The successor paper (European Commission 2011) comes to the conclusion that users should be able to select from manufactured plastic bait stations, home-made bait boxes and covered bait points. The key issue is that bait should be placed in such a manner to ensure that non-target animals cannot gain access or access is restricted to a minimum.

The risk mitigation measures (RMM) for the use of SGAR in Germany as defined by UBA (2014b) and BAuA (2012) include the obligation to use bait boxes. Exempted from this obligation are the uses of SGAR in sewer systems, in burrows and areas which are definitely not accessible by non-target species and children. FGAR may still be used by consumers and non-qualified professional users in indoor scenarios and immediately around buildings (UBA 2014b).

Alternatively to bait boxes, naturally occurring objects can be used to protect the bait from weathering and non-target species. Rats are particularly shy animals and nervous of strange objects that appear in their territories, therefore it is better to use existing materials, where available, rather than introduce bait containers, as long as the bait is protected adequately (HSE 1999). House mice are generally more inquisitive

and hence this problem is less likely to arise. In addition, reducing the availability of alternative food at the start of treatment, or shortly afterwards, may encourage rodents to feed on the bait.

Regardless of the container type, if the rats are not already familiar with it, they may avoid it initially, which will delay bait uptake and possibly extend treatment time. It is therefore worthwhile setting out the bait containers several days in advance of laying the bait so that the animals become familiar with their presence. Furthermore, rats are more likely to eat the bait sooner if it is laid beside runs, in holes, along walls and in sheltered places (CSL 2002).

The bait composition may also influence the environmental impact in such a way that grain baits probably pose a greater risk of primary poisoning compared to wax blocks, as wax blocks cannot be spilled like grains. However, wax blocks are often less attractive to rodents and thus less efficient than grain baits (EU Commission 2011).

The fumigants aluminium phosphide, carbon dioxide and hydrogen cyanide require specific safety measures and/or apparatus for effective and safe use as biocides (CSL 2002; aid Infodienst, 2012). Fumigants are injected or released into the burrows of the pest or are used in food-storage areas such as grain silos. Fumigation requires that the treated area is evacuated and sealed so that the airborne concentration of toxicant can reach a lethal level. The toxicant concentration must be held at this level for a specific period of time as described on the label. Afterwards, the area must be thoroughly ventilated before it is safe to enter (CSL 2002).

Within the survey, stakeholders underlined the importance of a well-planned, systematic and safe application/placement of baits at relevant points, thus avoiding a wide-spread distribution. In this context, web-based tools developed by some manufacturers may help professional and private users to plan their pest control campaign (e.g. BayTool)[28]. In addition, the use of bait boxes was considered as effective measure to reduce environmental impacts including primary and secondary poisoning. Furthermore, certain use restrictions for private users were also attributed a high efficiency, namely:

- “limitation of the container size for consumer users in order to minimize residual amounts”
- “restriction of marketing or the use of concentrates, promotion of ready-to-use formulations”
- “prohibition of certain products and applications for non-professional users (i.e. consumer)”

The same applies to the “development of standards and guidelines explaining private users when rodenticides are required and how they should be used” (Figure 4, Figure 5). However, the “development of technical standards and guidelines for the cleaning of instruments and equipment” is not relevant for the application of rodenticides.

[28] http://agrar.bayer.de/farm_protect.cms

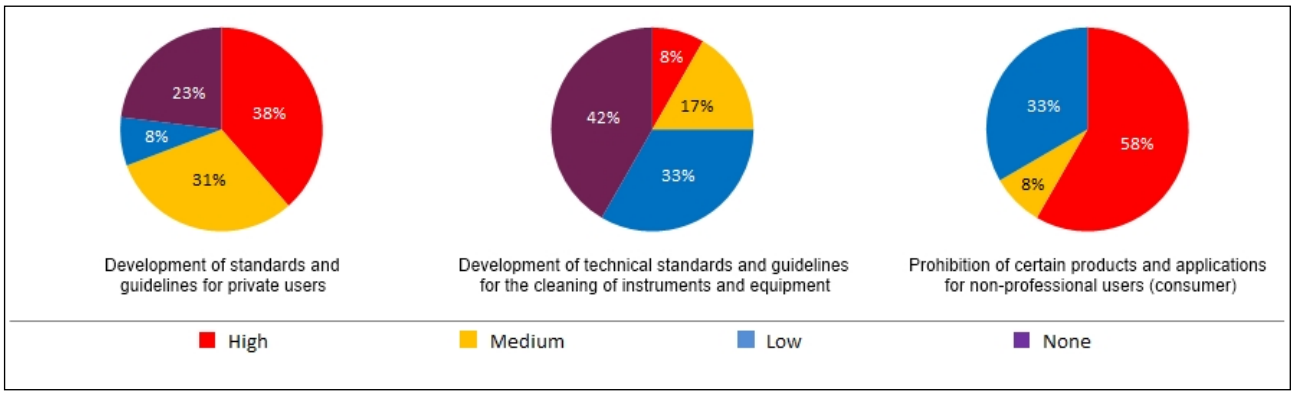

Figure 4 Stakeholder response on the efficiency of measures related to the surveillance of applications (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)

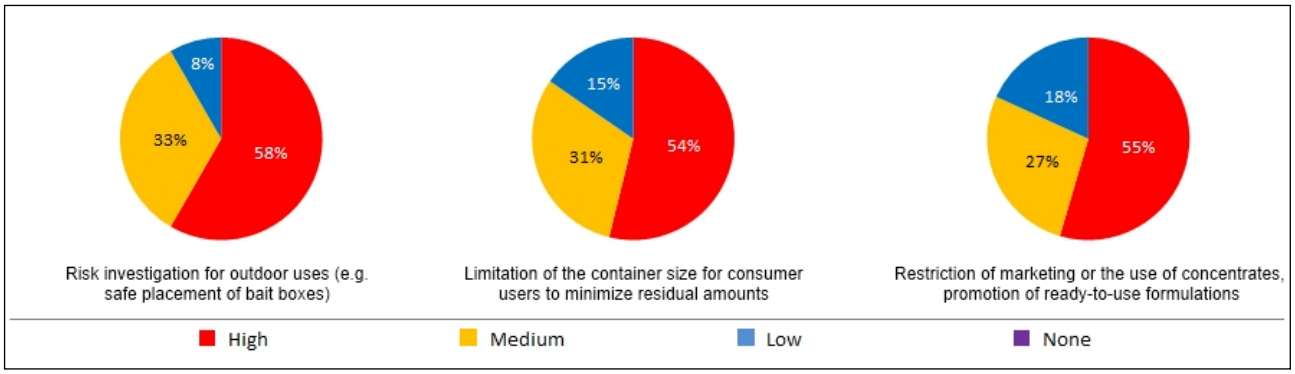

Figure 5 Stakeholder response on the efficiency of measures related to the emission during the use phase (part I) (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)

5.7 Further measures to reduce emission during the use phase

When asked for further measures to reduce emissions during the use phase of rodenticides most stakeholders emphasized the importance of an "adequate disposal of dead rodents and remnant baits after the treatment campaign" (see also section 5.9).

As can be seen from Figure 6, stakeholders are generally less consistent in how they rank the efficiency of the following measures:

- Establishment of collection systems for residues by the manufacturer / distributor,
- Establishment of buffer and safeguard zones along surface waters,
- Use restrictions in sensitive areas (e.g. public parks and gardens, drinking-water protection areas, etc.).

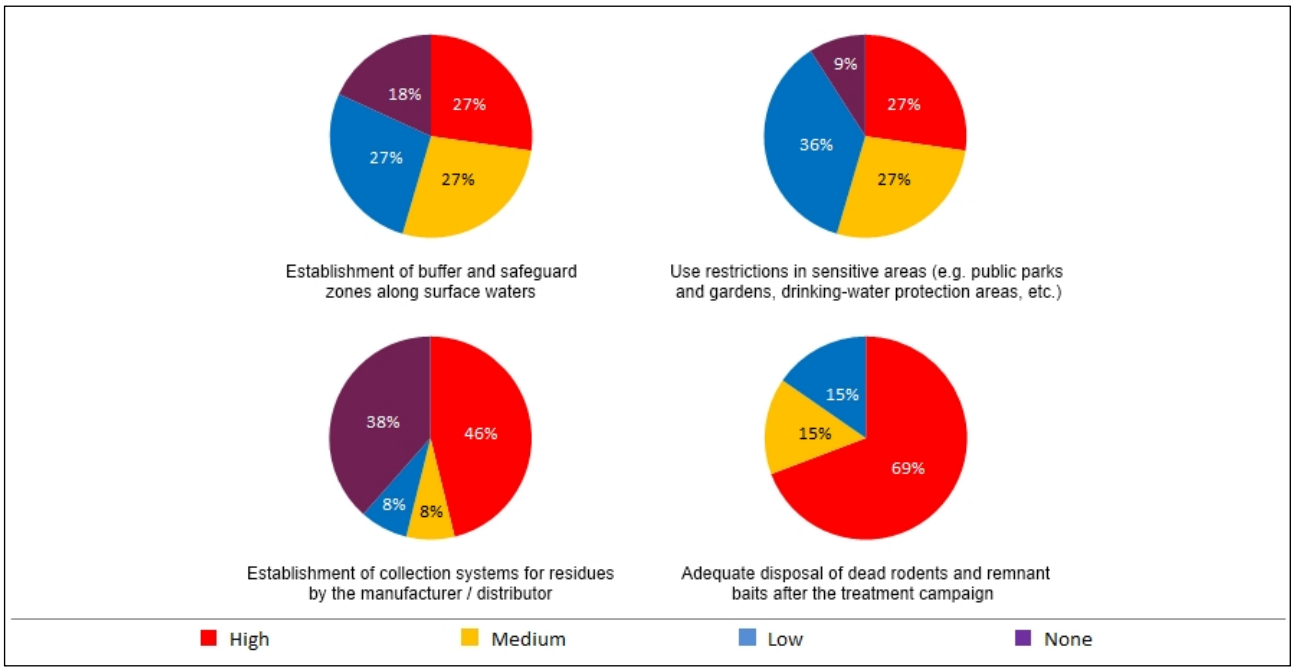

Figure 6 Stakeholder response on the efficiency of measures related to the emission during the use phase (part II) (percentages refer to the number of stakeholders considering a measure as high, medium, low or not efficient)

Further proposals to reduce emissions during the use phase include the following measures:

- No preventive permanent baiting with anticoagulant baits.
- No monitoring (for signs of (re)infestation) with anticoagulant baits. Instead, non-toxic baits, traps or monitoring devices should be used for rodent monitoring (UBA 2014b).

5.8 Measures to reduce emission during service life

No specific emissions resulting from the service life of rodenticides have been identified. All emissions are attributed to the use phase during application and the end-of-life stage. See also section 5.6 on strategies and equipment for biocide application.

5.9 Measures to reduce emission during restore and end-of-life stage

The safe disposal of rodenticides (i.e. remnant baits) and rodent bodies is an important aspect of any pest control operation. The adequate disposal is even considered as one of the most efficient measures to reduce negative environmental impacts by rodenticides (see also section 5.7).

Professional user should dispose of contaminated rodent bodies (carcasses) via rendering plants. Amateurs and private users may dispose of contaminated rodents (wrapped in a plastic bag) via normal household waste or – if possible – rendering plants. Remnant baits (collected after the treatment campaign or unused in the product package) shall be disposed of via the local/municipal “harmful substance collection system”. (www.biozid.info).

5.10 Specific measures to protect the aquatic/terrestrial environment and non-target organisms

With regard to the use of rodenticides the protection of non-target organisms and wildlife predators has a great significance. Several studies show residues of SGARs and to a much lesser extent also to FGARs not only in non-target rodents but also in a wide array of wildlife predators due to secondary exposure (Hughes et al. 2012; Albert et al. 2009).Up to 80% of animals analysed for rodenticides in the UK contained one or multiple SGARs and that incidence rate is still increasing (van den Brink & Elliott 2012).

Measures described in the previous sections such as the use of bait boxes or the inclusion of bittering agents and dyes help to protect the terrestrial environment and non-target organisms from primary poisoning. However, secondary poisoning of wildlife predators who feed on (poisoned) rodents cannot be prevented by these measures, if anticoagulant rodenticides are used outdoors.

5.11 Specific measures to avoid resistance

The before mentioned RMM (see section 5.2), together with the codes of good practice for the responsible use of rodenticides (see section 5.14), aim both to protect children and non-target species, and to avoid resistance of rodents against rodenticides.

Some rats and mice have become resistant to anticoagulant rodenticides, especially to FGAR. This means that the rodents can eat the anticoagulant baits without being killed. Resistance to rodenticides should be suspected if the bait is eaten regularly but the same or a greater number of rodents, holes, droppings, etc. continue to be seen (U.S. EPA 1997; CLI 2003). Resistance is often restricted geographically.

Resistance management strategies involve the identification of strategies for avoiding the development of resistance in susceptible rodent populations and for managing resistance to the anticoagulants when it is suspected or identified. Various documents and leaflets describe resistance management strategies (CLI 2003; FARR 2012; JKI 2012).

Advice and information on anticoagulant resistance in a particular area can be obtained from the national rodenticide resistance expert committees or action group (e.g. in Germany: Fachausschuss „Rodentizid-resistenz“of the Julius Kühn-Institut; see JKI 2012) . These sources are able to give general advice about tackling resistant rats and more specific advice about what anticoagulant baits will work best.

5.12 Reduction of biocides use in sensitive areas

See also section 5.6 on strategies and equipment for biocide application.

5.13 Handling and storage of biocides and their packaging and remnants

See section 5.9 on measures to reduce emission during restore and end-of-life stage.

5.14 Integrated pest management (IPM) and alternative control measures

5.14.1 Integrated pest management (IPM) and Good Practice

There is a multitude of documents describing the elements of integrated pest management (IPM) and criteria of good practice for the use of baits in rodent control (UBA 2014b; CLI 2003; CSL 2002; U.S. EPA 1997).

Integrated Pest Management (IPM) involves the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations. This should keep pesticides and other interventions to levels that are economically justifiable and reduce or minimize risks to human health and the environment (FAO definition[29]).

In this regard, the effective control of rodent infestations should not be treated simply as a question of killing the rodents. The control strategy should be developed both in terms of extinction of the rodent population but also in terms of managing the environment. This will not only prevent the development of the rodent population but also prevent rodents within that environment coming into conflict with mankind and his interests (CLI 2003). Consequently, integrated pest management (IPM) for rodents incorporates

- Survey and inspection of the species involved and area/s concerned
- Habitat management
- Control of rodent movement through proofing
- Control of the rodent population using appropriate chemical and physical control measures.

The good practice in rodent control mainly covers the following measures (UBA 2014b):

1. Consider prevention and alternative (physical) control measures according to integrated pest management (IPM); see below for further details.
2. Consider the use of non-biocidal alternatives before the use of biocidal products. Especially with regard to the control of house mice, voles and single rats the use of traps should be preferred over the use of biocidal products.
3. Limit the use of biocidal products to the strictly necessary. Rodent control with anticoagulant rodenticides has to follow the criteria and measures of good practice for the use of baits in rodent control.
4. If the use of biocidal products cannot be avoided, the use of FGAR (chlorophacinone, coumatetralyl, warfarin and warfarin sodium) should be preferred as long as no resistance to these active ingredients is known on the local level. In case of resistance problems SGAR are to be used.

Beyond these general measures of good practice, the German UBA has published detailed criteria to be followed for the use of anticoagulant rodenticides in rodent control (UBA 2014b).

The rodenticide industry in the UK initiated the Campaign for Responsible Rodenticide Use (CRRU)[30]. Key to the campaign is a code of good practice for the responsible use of rodenticides in rural areas. The aim of this code is to ensure that effective and sustainable rodent control is carried out by all users and that exposure and negative impacts to non-target species are avoided or at least minimised.

[29] Food and Agriculture Organization of the United Nations: http://www.fao.org/agriculture/crops/core-themes/theme/pests/ipm/en/

[30] http://www.thinkwildlife.org/

The CRRU code involves the following seven points:

- Always have a planned approach
- Always record quantity of the bait used & where it is placed
- Always use enough baiting points
- Always collect and dispose of rodent bodies
- Never leave bait exposed to non-target animals and birds
- Never fail to inspect baits regularly
- Never leave bait down at the end of the treatment

Within the framework of the stakeholder survey, participating pest control operators underlined the importance of raising the customer's awareness on integrated pest management. Many customers are still not aware of the fact that a rodent infestation requires a repeated on-site visit by the pest control operator to place, control and dispose the baits (and dead rodents) (see section 5.5).

5.14.2 Prevention and alternative (physical) control measures

IPM involves the use of appropriate chemical and physical control measures. This implies that besides the use of biocides alternative (i.e. non-biocidal) measures play an important role in sustainable rodent control.

Different alternative control measures to biocides exist for the management of rodent infestations. These alternatives fall into two categories; those that aim to trap or kill rodents (e.g. traps) and those intending to restrict either their population size (habitat modification) or access of populations to vulnerable areas (proofing/ exclusion) as well as sanitation. These methods provide useful complementary techniques to the use of biocides for controlling rodents and thus, they are essential in IPM rodent control strategies (EBPF 2012). It is the goal of a baiting campaign to completely eradicate the target rodents in the infested area/building (UBA 2014b).

Traps

Different types of traps are available for rat and mouse control including snap traps (spring or break-back traps) and live-capture traps. In contrast to the latter, snap traps are designed to kill rodents. Live-capture traps have the advantage that captured non-target animals can be released unharmed provided that the traps are checked frequently.

Glue- or sticky-boards are not considered as acceptable in terms of animal welfare, the more as their use is illegal in several countries including Germany.

Traps are especially effective in situations where infestations are small. To be most effective, traps should be placed along normal runways. If traps are used in areas where they are accessible to children or pets, they should be put in large bait boxes or similar containers.

Trapping is more time-consuming than chemical control methods, especially when dealing with a larger number of rodents rather than occasionally occurring individuals. Traps must be checked and serviced frequently. First of all because they need to be prepared each time they have tripped, and secondly, so that animals captured, but not killed, may be humanely dispatched (EBPF 2012; EPA Pest-Management

Principles). The advantage of traps is that rodents are immediately killed or captured and thus prevented from invading buildings.

Habitat modification

A sustainable rodent control should always involve an assessment of the surrounding of the infested area. Generally, it is very important to change the physical environment that is supporting rodents (i.e. modify the habitat). Otherwise, if only rodents are killed, but habitat and food are still available, it is very likely that the treated area will be re-infested. Therefore, it is essential to prevent the availability or access to food and water as well as to minimize areas where rodents may make burrows and take refuge. It is not recommended to clean up the infested area before treatment. This only disturbs the rodent population, making bait acceptance more difficult to achieve. As far as possible, obvious food such as spilled grains should be removed and any food sources should be covered. After the operation the area should be modified, e.g. by placing barriers, to prevent re-infestation.

Rodent proofing

The exclusion of rodents from buildings, storage areas or any other area to be protected by preventive and structural on-site measures, i.e. proofing is the basis of any reliable rodent control. The use of biocides can be minimized if proofing engineering solutions are utilized (EBPF 2012, Meyer 1994). To exclude rodents from areas to be protected, openings need to be sealed with appropriate materials (e.g. heavy gauge sheet metal, heavy wire screen, metal plates, concrete, etc.), (EPA Pest-Management Principles; Bell 2012).

Sanitation

Poor sanitation and the presence of food and garbage both attract rats and help them to survive in residential areas. This in turn means that good sanitation effectively limits the number of rodents in and around buildings. Good sanitation involves inter alia proper storage and handling of food materials, clean and orderly storage areas, elimination of weeds, shrubs, and vines that provide shelter and hiding places for rodents, and proper disposal of garbage.

5.15 Existing guidance documents on best practices and standards

Table 3 Best practice guidelines for PT 14 biocides currently available in the EU (compiled by EBPF 2012, supplemented)

Organisation	Guideline / Best practice document / standard	Country	Link
Defra, Welsh Assembly Government and The Scottish Government (UK)	Code of Practice for the prevention and control of rodent infestations on poultry farms (Apr. 2009)	UK	http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/atoz/zoonoses/documents/reports/salrodent.pdf
British Pest Control Association (BPCA)	Guidelines for the Safe Use of Anticoagulant Rodenticides by Professional Users (2001)	UK	http://adlib.everysite.co.uk/resources/000/044/207/rodenticides.pdf
Chartered Institute of Environmental Health (CIEH)	Pest Control Procedures in the Food Industry (Jan. 2009). Pest control procedures in the housing sector (Jan. 2010). Pest control procedures in the social care sector (Feb. 2011)	UK	http://www.cieh.org/uploadedFiles/Core/Policy/Publications_and_information_services/Policy_publications/Publications/Pest_control_food_industry.pdf http://www.cieh.org/uploadedFiles/Core/Policy/Environmental_protection/Pest_management/NPAP/pest_control_procedures_in_the_housing_sector.pdf http://www.cieh.org/WorkArea/showcontent.aspx?id=39642
Chartered Institute of Environmental Health (CIEH)	Pest Control Procedures Manual: Rodents (May 2009)	UK	http://www.cieh.org/uploadedFiles/Core/Policy/Publications_and_information_services/Policy_publications/Publications/Pest_control_procedures_manual_-_rodents_MAY_2009.pdf
World Health Organization	Pesticides and Their Application for the Control of Vectors and Pests of Public Health Importance (2006)	Worldwide	http://whqlibdoc.who.int/hq/2006/WHO_CDS_NTD_WHOPES_GCDPP_2006.1_eng.pdf
Natural England	Rats: Options for Controlling Infestations (Jan. 2012)	UK	http://publications.naturalengland.org.uk/publication/33014
Natural England	Rats: Control on Livestock Units (Jan. 2012)	UK	http://publications.naturalengland.org.uk/publication/34014
Health and Safety Executive (HSE)	Safe use of Rodenticides on Farms and Holdings (Aug-99)	UK	http://www.poultrypassport.org/wp-content/uploads/2013/03/HSE-Rodenticides.pdf
Health and Safety Executive (HSE)	Urban Rodent Control and the Safe Use of Rodenticides by Professional Users (Nov-03)	UK	http://www.hse.gov.uk/press/2003/e03212.htm
Campaign for Responsible Rodenticide Use Code	The Campaign for Responsible Rodenticide Use Code (2010)	UK	http://www.thinkwildlife.org/
Food and Environment Research Agency (Fera) Central Science Laboratory (CSL)	The Control Of Rats With Rodenticides: A Complete Guide To Best Practice (Nov-02)	UK	http://www.naturalengland.org.uk/Images/ratcontrolguidelines_tcm6-11216.pdf
Julius Kühn-Institut (JKI)	Ratten und Hausmäuse – Sachgerechte Nagerbekämpfung (2012) AID-Verlag	DE	http://shop.aid.de/1517/ratten-und-hausmaeuse-sachgerechte-nagetierbekaempfung

Organisation	Guideline / Best practice document / standard	Country	Link
TRNS Teil I (Technical rules and standards for pest control)	Technische Regeln und Normen der Schädlingsbekämpfung Teil 1 Gesundheits- und Vorratsschutz. German Pest Operator Association	DE	http://www.dsvonline.de
DIN 10523.	Lebensmittelhygiene – Schädlingsbekämpfung im Lebensmittelbereich (Juli 2005)	DE	
General information for the control of rodents Schutzleitfaden BP100	Allgemeine Informationen zur Bekämpfung von Schadnagern. Gute fachliche Praxis für Biozid-produkte (draft 2012) Federal Institute for Occupational Safety and Health (BAuA)	DE	http://www.baua.de/de/Forschung/Forschungsprojekte/f2308.html
Schutzleitfaden BP100	Ausbringung von Formködern und Pasten zur Bekämpfung von Schadnagern. Gute fachliche Praxis für Biozid-produkte (draft 2012)	DE	
Schutzleitfaden BP100	Ausbringung von schüttfähigen Ködern zur Bekämpfung von Schadnagern. Gute fachliche Praxis für Biozid-produkte (draft 2012)	DE	http://www.baua.de/de/Forschung/Forschungsprojekte/f2308.html
Schutzleitfaden BP100	Ausbringung von Schäumen und Streupulvern zur Bekämpfung von Schadnagern. Gute fachliche Praxis für Biozid-produkte (draft 2012)	DE	
Bodenschatz, W. Behr's Verlag	Manual -Pest Control Measures and Methods including Legal Requirements (2009)	DE	
Industrieverband Agrar	IVA-Mustergebrauchsanweisungen für nicht-agrarische Schädlingsbekämpfungsmittel für den privaten Gebrauch.	DE	
Niedersächsisches Landesamt für Verbraucherschutz und Lebensmittelsicherheit	Leitfaden zur großräumigen Rattenbekämpfung in Niedersachsen (4th edition 2014)	DE	http://www.laves.niedersachsen.de/download/87139
aid Infodienst	Ratten und Hausmäuse: Sachgerechte Nagetierbekämpfung (2nd edition 2012)	DE	http://www.aid.de/presse/archiv.php?mode=beitrag&id=5856
JKI Julius Kühn Institut	Leaflet „Ratten erfolgreich bekämpfen - Resistenz erkennen“ (April 2013)	DE	http://www.jki.bund.de/de/startseite/institute/pflanzenschutz-gartenbau-und-forst/arbeitsgruppen/wirbeltierforschung/rodentizidresistenz.html
JKI Julius Kühn Institut	Hausmäuse erfolgreich bekämpfen - Resistenz erkennen (July 2013)	DE	
Lauenstein, G.	Bekämpfung von Ratten und Hausmäusen in der	DE	

Organisation	Guideline / Best practice document / standard	Country	Link
	Landwirtschaft		
CLI Crop Life International	Technical Monograph on anticoagulant resistance management strategy for pest management professionals, central and local government and other competent users of rodenticides	EU	http://www.rrac.info/downloads/technical_monograph_2003_ARM.pdf
European Commission	Risk Mitigation Measures for Anticoagulants used as Rodenticides CA-March07-Doc.6.3-final	EU	https://circabc.europa.eu/sd/a/e8d74f8c-5e03-4540-8fd7-13cbc6a40c86/CA-May09-Doc.3.6c%20-%20Risk%20Mitigation%20Measures%20Anticoagulants-Final.doc
Pestcontrolmedia.com	Les ravageurs des bâtiments d'élevage, comment s'en protéger?	FR	
Pestcontrolmedia.com	Guide pratique de l'applicateur	FR	http://www.pestcontrolmedia.com/insectes/35-guide-pratique-de-l-applicateur.html
Ministry of Health, 2001	Guide of Best Practice for Pesticides Use in Public Health	ES	
Valencia Local Government, 2004	Phytosanitary Applications/Official License Manual	ES	
Pest Control Association. ANECPLA, 2003	Manual of Procedures for Urban Pest Control	ES	

6 Indicators

In the stakeholder survey (see section 5.1), the following potential indicators, for observing the progress obtained in sustainable use of rodenticides, have been indicated (by order of priority):

1. Indication of poisoning cases of non-target organisms
2. Enquiry on the proportion of consumer uses of rodenticides
3. Survey among professional / consumer users
4. Biocide specific monitoring of effluents from sewage treatment plants
5. Biocide specific monitoring of residues in food and feed
6. Collection of consumption data for specific product types
7. Biocide specific monitoring of surface water
8. Biocide specific surveillance of ground and drinking water (e.g. number of values exceeding 0.1 µg/l)
9. Survey about the number of (certified, trained) professional users
10. Survey about the number of advanced training events and participants
11. Inquiry of the waste amounts (product remains)
12. Inquiry of the recycling quote of packages and remains
13. Survey about the resource allocations for research and development spent for risk reduction (e.g. for technical solutions)
14. Survey about the number of certified salespersons of rodenticides
15. Survey about the number of certified consultants for rodenticide application
16. Hit rates on specific information web portals (e.g. www.biozid.info)

In addition to the above mentioned indicators, some stakeholders proposed further ones to control the effectiveness of the measures for a sustainable use of rodenticides:

- Decline in number/ magnitude of residues in environmental media
- Biocide specific monitoring in predators and environmental media
- Collection of carcasses (outdoor) and subsequent residue analysis (as already done in the UK)
- Evaluation of statistics on poisoning cases of non-target organisms and resistances
- Indication of human poisoning cases (accidental intake by children, poisoning of workers in production units, accidental poisoning during incorrect application/disposal)
- Collection of sales data of rodenticides (both to professionals and non-professional users (amateurs))
- Number of candidates for substitution / substituted cut-off rodenticides

7 Recommendations and package of measures

The package of measures to reduce environmental impacts by the use of rodenticides consists of stipulated risk mitigation measures (RMM), already established measures including best practice (i.e. status quo) and further measures proposed by different stakeholders. The various measures may be allocated to the different aspects or categories described in sections 5.2 to 5.15.

Risk mitigation measures (provided by Annex I inclusion directives)

Specific risk mitigation measures are set out for all anticoagulant rodenticides (both FGAR and SGAR) which have been included in Annex I so far. These RMM intend to control the identified risks for human health, environment and non-target animals:

- Upper concentration limits of the active substances in products
- Restriction to ready-for use products
- Prohibition of tracking powder or restriction of their use to professional users only
- Requirements for aversive agents and where appropriate dyes

Further risk mitigation measures may be set out on a national level at product authorization. These include, amongst others:

- Restriction to (trained) professional users (with license) only
- Limitation of the package size
- Obligations to use tamper resistant and secured bait boxes

In addition to the above listed RMM other requirement, restrictions and/or activities supporting a sustainable use of rodenticides have already been established in at least some MS. These already established measures and proposals for adequate further measures are compiled in the following as package of measures to reduce environmental impacts by the use of rodenticides:

Category "Further training and education"

- Training courses on pest control to become a trained/certified professional user
- Harmonized training schemes for other user groups such as farmers and gamekeepers
- Funding of (voluntary) training measures for (private) users, e.g. on environmental sound use and disposal
- Further educational structures such as training seminars organised by pest control companies, manufacturers and other organisations, or formative meetings and conferences organised by pest control associations
- Knowledge transfer on a sustainable use of rodenticides during education and training, e.g. of pest control workers

Category "Requirements for sales and control mechanism"

- Regulation of product sales to the general public/private user:
  - sales restrictions of products containing anticoagulant rodenticides (especially SGAR);
  - only ready-to-use products (i.e. no concentrates);
  - limitation of the container size for private users (to minimize residual amounts);
  - bait products only in combination with bait stations
  Reference on the package that the use of SGAR is not allowed by non-professional users
- Regulation of product sales via internet
- Sales advisory services by trained employees
- Distribution of biocidal products only with detailed, but easy understandable use descriptions and harmonized instructions of sustainable rodent control (e.g. in form of safety data sheets, technical leaflets, instructions for use)
- Standard phrases on the label, packaging or accompanying leaflets of biocidal products containing anticoagulants

Category "Information and awareness raising"

- Information to the general public such as web-based information systems, handbooks and/or leaflets providing information on pest control in households including best practice and safe use as well as on alternative measures (e.g. www.biozid.info)
- Information for pest control operators/farmers, such as web-based support/information systems and professional journals providing all kind of information related to pest and rodent control including recommendations for the performance of professional rodent campaigns
- Annual conferences and meetings organised by pest control associations providing the opportunity for information exchange between manufacturers, professional users and authorities / academia.
- Journals read by farmers, hobby gardeners or private consumers as distribution pathways for the dissemination of knowledge on sustainable use
- Raising the awareness on IPM

Category "Surveillance of applications"

- Mandatory use of tamper-resistant and secured bait boxes
- Well-planned, systematic and safe application/placement of baits at relevant points, e.g. with the help of web-based tools such as BayTool)[31].
- Consideration of the principles of IPM and criteria of best practice

[31] http://agrar.bayer.de/farm_protect.cms

Category "Measures to reduce emissions during the use phase

- Risk investigation for outdoor uses (e.g. safe placement of bait boxes)
- Adequate disposal of dead rodents and remnant baits after the treatment campaign
- No preventive permanent baiting with anticoagulant baits.
- No monitoring (for signs of (re)infestation) with anticoagulant baits. Instead, non-toxic baits, traps or monitoring devices should be used for rodent monitoring.
- Establishment of buffer and safeguard zones along surface waters
- Use restrictions in sensitive areas (e.g. public parks and gardens, drinking-water protection areas, etc.).

Category "Measures to emission during restore and end-of-life stage"

- Adequate disposal of dead rodents and remnant baits after the treatment campaign
- Establishment of collection systems for residues by the manufacturer / distributor

Category "Specific measures to avoid resistance"

- Compliance with (local) resistance management strategies

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