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### 03 - Stored product protection in grain storage with special regard to phosphine fumigation

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#### Abstract

In Germany stored product protection belongs until now to the legislation field of plant protection. All stored product protection products used for controlling insect- and other pests require a legal approval of the plant protection authority. Roughly, the pesticides for stored product protection in grain storage can be divided into three groups:

- contact insecticides (spraying, fogging, powdering insecticides)
- fumigants
- rodenticides

In the last decade, the decrease of available active ingredients and compounds for stored product protection is quite obvious. Especially in grain storage more and more problems arise due to phase out and disappearance of these products. Several issues like ineffective control of pests or insect resistance against few remaining compounds contribute to the pressure in this context especially for the grain storage industry and difficulties in controlling pests. An update of all products and active ingredients that have an approval in 2009 are presented.

During the last few years considerable changes have taken place in stored product protection throughout Europe. Well-proven active ingredients disappear one by one because they do not meet the new legal requirements set up by the European Union. The situation in stored product protection as it presents itself for grain storage in Germany will be set out below.

According to German law stored product protection is part of the sector plant protection. Products used for the control of stored product pests are permitted and registered under plant protection regulations. The products used for storage protection in Germany can be roughly divided up into three groups:

- contact insecticides (sprays, fogging preparations, powders)
- fumigants
- rodenticides.

When comparing the present situation for the entire field of stored product protection regarding the number of registered active ingredients with that of the year 2000 we find that nine years ago there were 6 active ingredients for contact insecticides as to 4 today. For fumigants 5 are left against the 7 in previous years and for rodenticides the ratio is 4 to 10. The amount of registered products on the market today is as follows: while in 2000 there were 20 contact insecticides, 25 fumigants and 65 rodenticides the numbers in 2009 are only 6, 18 and 10 respectively.

As regards rodenticides the significantly reduced amount of active ingredients and preparations is due to the fact that this section will gradually be placed under a different branch of law. Therefore less and less registrations for stored product protection will be sought under plant protection legislation. The products are now generally considered preparations for the control of hygiene pests and therefore placed under biocidal legislation and are thus still available for stored product protection.

In the field of contact insecticides and fumigants the drop in the number of registered active ingredients and all its unpleasant consequences becomes plainly perceptible. When viewing the situation in grain storage with regard to the preparations still available for stored product protection the result is as follows. For contact insecticides only diatomaceous earth, pyrethrins and pirimiphos-methyl remain, and for fumigants hydrogen phosphide, carbon dioxide and sulfurlyl difluoride.

Insecticides with the active ingredients dichlorvos and phoxim and fumigants with bromomethane, hydrogen cyanide, carbon dioxide and nitrogen disappeared since 2000.

Since diatomaceous earth, carbon dioxide and sulfurlyl difluoride can for various reasons only be used for special fields of application the result is that for the control of storage pests in grain only one active ingredient for a fumigant (hydrogen phosphide) remains, also one only for fogging preparations (pyrethrin – generally for the control of storage moths) and pirimiphos-methyl as a spray.

What are the consequences of this shortage of active ingredients and preparations? Apart from the problem that efficient products for the control of a number of pests are lacking it often leads to misuse of the preparations still available. To fill the gaps of missing substances those available are often used for applications for which they are not approved so that neither efficacy nor the residue question are verified.

Due to the shortage of active ingredients available a change is also not given. Therefore the danger of resistance development is greatly increased and even more so by the already mentioned incorrect use and misuse of the products available.

A further negative aspect of the shortage of active ingredients is that heavier infestation and thus increased contamination of foodstuffs must be expected due to the unavailability of sufficient preventive control measures. Furthermore, there is the risk of a rise of chemical residues in the stored goods due to too frequent application of available preparations or the use of forbidden products because the number of effective and registered preparations is so limited.

The examples below show the consequences of the loss of the active ingredient dichlorvos in grain storage with a view to the resulting "gaps in control measures", "misapplication of available products", "danger of resistance building", and "contamination of foodstuffs":

Gaps in control measures: Up to 2008 dichlorvos preparations were successfully used as evaporators for the prevention of moth infestations and as a fogging preparation against storage moths. After removal of this active ingredient an evaporation product is no longer available which means that there is no possibility of combating the infiltration of moths with any suitable preparation. Only products based on pyrethrin are still available whose efficacy is often inadequate for heavy infestations.

Misapplication of available products: Due to the lack of alternatives the air space above the stored grain is often fumigated with hydrogen phosphide in low dosages without any sealing measures in order to kill the moths flying around there. Apart from health and safety concerns during such an un-workmanlike use of the gas there exists the additional danger of increased resistance-building in the pests. The low gas concentrations are generally not enough to kill all existing development stages so that there is always the possibility of survivors of these non-lethal gas concentrations.

**Danger of resistance building:** As outlined above resistance building can be fostered by misapplication on the one hand, on the other hand the small number of active ingredients available presents a problem in itself. Since no possibility of a change of active ingredient exists a preventive resistance management cannot be effected.

**Contamination of foodstuffs:** Due to the lack of effective control possibilities heavier moth infiltration often results in excessive contamination of the grain with insects and their residues (bodies, cocoons, excreta etc.). And as mentioned above these misapplications of stored product protection preparations carry the risk of substantial residues in the grain.

When considering these facts the question arises whether the reduction in the number of active ingredients for plant protection preparations does not achieve the opposite of what is intended. It should be considered whether the current problem does not stand in contrast with the ever stricter foodstuff regulations on the European level.

What possibilities remain for successful stored product protection in the future? Preventive measures like prophylactic hygiene, monitoring or biological pest control are instruments at whose research and promotion should be worked with full force. But despite all efforts in these areas an effective stored product protection as we demand it can hardly become possible without efficient preparations.

A further problem must be pointed out which may possibly contribute to the decrease of the amount of preparations for stored product protection. In Germany stored product protection will in future be placed somewhere between plant protection and biocidal legislation as regards approval and registration. Although originally entirely falling under plant protection, the control of pests in stored unprocessed agricultural commodities but also goods following simple processing (e.g. flour in a mill) will then be under plant protection legislation while the control of the same organisms in foodstuffs and animal feeds will be handled under biocidal law. Small wonder that some border areas arise here causing a lot of ambiguity. For instance, will grain used as animal feed be handled according to biocidal legislation and has to be treated with a biocide or is it an unprocessed agricultural commodity to be treated with a plant protection preparation? When is a rat a storage pest (plant protection), when is it a hygiene problem (biocide)? Is flour in the mill a basically processed agricultural commodity falling under plant protection legislation or is it a foodstuff and has to be treated with biocides in the case of infestation? Is muesli with oats, nuts and raisins still an agricultural commodity (plant protection) or is it a processed food (biocide)?

These examples demonstrate what kind of difficulties may arise. To ensure that the application of a preparation is legally safe registrations for both plant protection preparations and biocide products must be available for the same product in the same commodity. Below the example of the application of hydrogen phosphide in grain: the substance must be registered as a plant protection product for stored product protection as well as a biocide in the product groups "insecticide" and "protection for foodstuffs and animal feeds". Because of the high costs of such double registration many companies will have to consider whether it will be economically reasonable to pursue the defense of active ingredients and further product registrations in all areas respectively.

Conclusively a proposition which may be worthy of some discussion: Would it not make sense to implement a clear division and to integrate stored product protection entirely into biocidal law? Harvest time may be the right moment to draw the separation line. In simple words: "before harvest is plant protection and after harvest the goods are protected under biocidal law".

#### **04 - Adoption of sulfuryl fluoride for the control of stored product insects in Europe and future development**

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#### **Abstract**

The strong commitment to protect the ozone layer by European governments has resulted in the complete phase out of methyl bromide (MB) use in the flour mills and food processing plants. Following the phase out the industry has successfully adapted, maintained its production capacity, hygiene standards and economic viability. This has been achieved through increased focus on sanitation and utilizing alternatives control procedures such as fumigation with sulfuryl fluoride (SF) with the tradename ProFume containing 99.8%. The fumigation is frequently accompanied by additional heating. Recent research on stored product pest insects in treated flour mills confirmed long lasting control effects 8 to 12 weeks after the fumigation. ProFume gas fumigant is now established as an alternative fumigant to MB. It has been granted registration for the control of SPIs in structures in ten European countries. Since its first approval in 2003, the number of ProFume fumigations has increased each year. In 2008, over 200 fumigations were completed in Europe and due to performance satisfaction, the growth trend is expected to