EURL for Cereals and Feeding Stuff
National Food Institute
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Cereals and feeding stuff – production, consumption and pesticides

(Version 5)

Appendix 5

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1. Introduction

One of the most important tasks of the EU Reference Laboratory (EURL) for Pesticides in Cereals and Feeding stuff (EURL-CF) is to give advice to the Commission on prioritisation of the work on method development. To enable this prioritisation, various information has been collected and evaluated. The information concerns the following subjects within the Member States (MS):

- Production
- Consumption
- Pesticides authorised for use in cereal production
- MRLs for pesticide in cereal and toxicological data on the authorised pesticides, e.g. ADI and ARfD
- Intake of pesticides from cereals
- Feasibility to include the pesticide in multi residue methods

The first version of this document was prepared in 2007. The present version is the fifth version.

The analysis of undesirable contaminants in various food and feed samples is nowadays a problem of primary concern for quality control laboratories due to human and animal health risks associated with the accumulation of these substances. Contaminants in animal feeding stuff can cause harmful health effects in the animals and may be harmful to humans through secondary exposure of consumers to contaminants deriving from these animals. In the European Union (EU), feeding stuffs are subject to legislation covering their composition, manufacture, storage, transport and usage[1]. Because of the above, the third version of this document was extended with a chapter on feeding stuff including sections on consumption of feeding stuff and imports of feeding stuff as preparation for a future monitoring programme on feeding stuff.

Monitoring and control of pesticide residues in feeding stuff is still in the early stages. However, some data is available in the literature and some of these were included in the fourth version of this document.

In this fifth version we have included more information on rice. Information on authorised uses in Italy, France and India is presented and also some data on which pesticides are actually found in rice. Information on authorised uses and frequently found pesticides in pesticide control has been used by the EURL to select pesticides for method validation by the QuECheRS method for cereals (incl. rice) in 2010.

2. Cereals

The MS with the largest production of cereals in 2008 were France, Germany, Poland, Spain and the United Kingdom. The total cereal production in these countries amounted to 62, 44, 22, 21 and 19 million tonnes, respectively. The main producers of wheat were France, Germany, the UK, Poland and Romania. The production figures for cereals in 2008 are presented in more detail in Table 2-1 (the figures are from the European Commission - Eurostat[2]). The production figures are presented for the five largest producers of cereals in total, and for selected countries' production of wheat, barley, oat, rye, maize and rice.

Table 2-1. Production figures for EU-27[a] and the five largest producers of cereals in total, wheat, barley, oat, rye, rice, and maize in the European Union in 2008[2] (million tonnes).

	Cereal in total [b]	Common Wheat	Durum wheat	Barley	Oat [d]	Rye [c]	Maize	Rice
EU-27[a]	314.0	140.4	10.0	65.6	13.0	9.6	63.0	2.5
Austria			0.8			0.2		
Czech Rep.						0.2		
Finland					1.3			
France	70.4	37.0	2.1	12.3			16.0	0.1
Germany	50.1	26.0		12.0	0.9	3.8	5.1	
Greece			1.4					0.2
Hungary							9.0	
Italy			5.1				9.5	1.3
Poland	27.7	9.3		3.6	4.7	3.7		
Portugal								0.1
Romania							7.8	
Spain	23.3	5.6	1.1	11.2	1.2	0.3		0.6
Sweden					0.9			
UK	24.3	17.2		6.1				

[a]: EU-25: Including 27 Member States. [b]: Total cereal production not including rice. [c]: including meslin. [d]: including mixed cereals.

The rice produced in Europe makes up around two-thirds of the quantity we consume. This is supplemented by imports of different varieties, mainly long-grain rice such as basmati, while some EU rice – in particular round or medium-grain japonica rice - is exported. Most EU imports come from Thailand, India and Pakistan.[3]

2.1. Consumption of cereals in EU Member States

Various consumption data are available from different countries' consumption surveys, but unfortunately not all countries have consumption data available. In 2006 EFSA initiated "The temporary MRL exercise". The goal of this exercise was to identify the highest reported national MRL (Maximum Residue Limits) for each combination of active substance/commodity, and to set harmonized temporary EU MRLs to these highest figures. Before this was possible the temporary EU MRLs had to be risk assessed.

To be able to perform a risk assessment covering all EU citizens', consumption data from all EU MS were collected and reported[4]. The consumption data include consumption rates reported by different MS and consumption rates according to different WHO diets. In Table 2-2 the highest chronic consumption rates for the different types of cereals are presented, as well as from which models/MS they originate and the average consumption of all the reported data for the different types of cereals.

Table 2-2. **The highest chronic consumption of the different types of cereals reported for an EU-citizen and the average consumption of all reported consumptions.**

Commodity	Highest reported consumption (g/kg bw/day)	Model/Reporting MS	Average of all reported consumption (g/kg bw/day)
Cereals (total)	11.89	WHO Cluster diet B	4.71
Barley	1.24	IE adult	0.17
Buckwheat	0.28	IE adult	0.02
Maize	2.47	WHO Cluster diet B	0.31
Millet	0.09	WHO Cluster diet D	0.01
Oats	0.40	DK child	0.07
Rice	0.79	PT general population	0.30
Rye	4.42	DK child	0.38
Sorghum	0.02	DE child	0.001
Wheat	8.54	WHO Cluster diet B	3.33
Other cereal	1.50	IT kids/toddler	0.08

In Table 2-3 the chronic dietary pesticide intake of cereals in g/person/day for a few MS is presented. The EU citizens represented here both in Table 2-2 and Table 2-3 consume more wheat than any of the other types of cereals. The average of all reported consumption of wheat (3.3 g/kg bw/day in Table 2-2) corresponds to the average of the chronic intakes reported by the different MS (Table 2-3). According to the Danish and German consumption data, rye accounts for the second largest fraction of total daily

cereal consumption. Rice accounts for the second largest fraction of total daily cereal consumption for the data covering France and UK.

Table 2-3. The chronic dietary intake of cereals in g/person/day according to models often used for risk assessment of dietary intake.

	Consumption (g/kg bw/day)							
	Cereals in total	**Barley**	**Buck-wheat**	**Maize**	**Oat**	**Rice**	**Rye**	**Wheat**
Denmark[5]								
Adults (74 kg bw)	2.89				0.11	0.086	0.68	2.0
Children (22 kg bw)	10.41				0.40	0.10	4.42	5.51
France[6]								
General population (60 kg bw)	3.52	0.01				0.11		3.28
Toddler (10.6 kg bw)	2.98					0.36		2.62[a]
Germany[7]								
Children Age 2-5 (16.5 kg bw)	5.45	0.01	0.01	0.15	0.2	0.26	0.78	4.04
UK[8]								
Adults (76 kg bw)	2.09	0.003	L/C	0.003	0.02	0.37	0.01	1.67
Young children/Toddler (14.5 kg bw)	4.55	0.01	L/C	0.01	0.05	0.58	0.01	3.94

[a]: The type of commodity stated in the reference is ”bread” and it is assumed that all the bread is wheat bread.

Thus, since the cereal consumed in largest amounts is wheat, wheat could also be the type of cereal contributing most to the human exposure to pesticide residues. However, this depends on the frequency and amounts with which residues are found in wheat compared to the other cereal types.

2.2. Pesticides authorised for use in cereals

When prioritising work on method development, it is relevant to consider which pesticides are authorised for use on cereal commodities since residues of these pesticides can be expected. A complete list of all authorised uses in the different MS would be a helpful tool. However, such a list is not available. Lists of which pesticides are authorised for use in the MS are available on the EU CIRCA Database. Unfortunately, this list does not include information on which crops the pesticides are authorised for and it is therefore not possible to evaluate which pesticides are authorised for which types of cereals in which MS. Additionally, no information is given on how frequently the pesticides are actually used on cereals.

Information on authorisations is available; however, this information is non-exclusive since it only includes information about some MS or for only some of the pesticides available on the European market.

As part of a project financed by the Danish EPA the Faculty of Agricultural Sciences, Aarhus University, Denmark has compiled lists of pesticides authorised for use in wheat and four other commodities in the different northern and central EU MS. The report was published in Danish by the Danish EPA in 2007[9]. Table 2-4 contains a list of pesticides authorised for use in wheat in [1)] more than 14 MS and [2)] more than nine but less than 14 MS of the total 17 MS evaluated. Data on the frequency or amounts of the pesticides used are not available.

From Table 2-4 it can be seen that triazoles are a commonly authorised fungicide in the northern and central European MS. For herbicides, the sulfonyl urea type are widely represented. The list of authorised insecticides varies from MS to MS which results in only one insecticide authorised in 14 or more of the 17 MS. The most frequently authorised type of insecticide was the pyrethroids. In the 17 MS only seven different plant growth regulators were authorised for use on wheat. The plant growth regulators authorised in most MS were chlormequat, trinexapac and ethephon. These plant growth regulators were authorised for use on wheat in 15, 14 and 12 of the 17 MS, respectively. Only two types of insecticides are authorised for use in wheat in France. These are not represented by the active substances authorised for use in more than nine other MS.

In connection with the work performed by EFSA on setting TMRLs, information on authorised uses of 77 pending substances from 20 MS has been collected. Authorised uses have been collected for e.g. wheat (including spelt and triticale), oat, rye, rice, maize and barley. The collected data include information on authorised uses from 13 northern European MS and seven southern European MS. The complete lists are available on the CIRCA database[10].

Table 2-5 and Table 2-6 list the top three most commonly authorised pesticides for each of the cereal types; wheat, oat, rye, rice, maize and barley. In many cases more than one pesticide is authorised in equally many MS. More than one pesticide can therefore occur in
Table 2-5, as e.g. the second most often authorised pesticide. The number of MS in which the top three pesticides are authorised is presented in brackets in the tables.

Table 2-4. A summary of data[9] on which fungicides, herbicides, insecticides and plant growth regulators are authorised for use on wheat in [1)] 14 or more and [2)] more than 9 but less than 14 of 17 northern and central European Member States (including southern France).

	Pesticide authorised for use in wheat	
	≥14 MS	**14 > MS > 9**
Fungicides	Azoxystrobin	Carbendazim
	Epoxiconazole	Carboxin
	Fenpropidin	Chlorothanlonil
	Fenpropimorph	Cyproconazole
	Kresoxim-methyl	Difenoconazole
	Prochloraz	Fludioxonyl
	Propioconazole	Fluoxastrobin
	Spiroxamine	Flutriafol
	Tebuconazole	Guazatine
	Trifloxystrobin	Mancozeb
		Metconazole
		Picozystrobin
		Prothioconazole
		Pyraclostrobin
		Triadimenol
		Triticonazole
Herbicides	2,4-D	Bentazone
	Amidosulfuron	Carfentrazone-ethyl
	Dichlorprop-P	Dicamba
	Fenoxaprop-P	Diflufenican
	Florasulam	Flupyrsulfuron methyl
	Fluroxypyr	Isoproturon
	Glyphosate	Metsulfuron
	Iodosulfuron-methyl-sodium	Propoxycarbazone
	MCPA	Thifensulfuron
	Mecoprop-p	Triasulfuron
	Pendimethalin	Tribenuron
	Sulfosulfuron	
Insecticides	Lambda-Cyhalothrin	Alpha-cypermethrin
		Deltamethrin
		Esfenvalerate
		Pirimicarb
Plant growth regulators	Chlormequat	Ethephon
	Trinexapac	

Table 2-5. The group of most commonly authorised pesticides for use on cereals in 13 northern European MS. The brackets show the number of MS in which the pesticide(s) are authorised for use on cereals[10].

List of authorised pesticides in NORTHERN[a] European MS.			
	1	**2**	**3**
Wheat	Fenpropidin (11)	Metconazole Tebuconazole (10)	Cyproconazole Epoxiconazole Fludioxonyl (9)
Oat	Tebuconazole (7)	Carboxin Fludioxonyl Pirimicarb (6)	Epoxiconazole Zeta-cypermethrin (5)
Rye	Fludioxonyl (9)	Epoxiconazole Tebuconazole (8)	Cyproconazole Flusilazole (7)
Rice[b]			
Maize	Fludioxonyl Terbuthylazine (5)	Carboxin (4)	Glufosinate (3)
Barley	Fenpropidin Tebuconazole (10)	Cyproconazole Epoxiconazole Fludioxonyl Metconazole (9)	Flusilazole Flutriafol (8)

[a] Including Austria, Belgium, Czech republic, Denmark, Estonia, Germany, Latvia, Luxembourg, Poland, Slovak Republic, Sweden, The Netherlands and the UK.

[b] Only few pesticides authorised for use in the UK. No pesticides are authorised for use in the other northern Member States.

Table 2-5 and Table 2-6 show that the triazole type pesticides are often authorised for use on cereals. This is especially true for wheat, oat, rye and barley. Many of the pesticides are authorised for use both in northern and southern EU. Even though a pesticide is authorised for use, this does not necessarily mean that residues will be found.

Table 2-6. The group of most commonly authorised pesticides for use on cereals in 7 southern European MS. The brackets show the number of MS in which the pesticide(s) are authorised for use on cereals[10].

List of authorised pesticides in SOUTHERN[a] European MS.			
	1	**2**	**3**
Wheat	Tebuconazole (6)	Diclofop Epoxiconazole Flusilazole Pirimicarb (4)	Cyproconazole Diniconazole Fenbuconazole (3)
Oat	Pirimicarb (4)	Cyproconazole Epoxiconazole Tebuconazole (3)	Carboxin Metconazole (2)
Rye	Cyproconazole Epoxiconazole Pirimicarb Tebuconazole (3)	Metconazole (2)	
Rice	Oxadiazon (5)	Propanil (4)	Tebufenozide (2)
Maize	Tefluthrin Terbuthylazine (5)	Ethoprophos Fludioxonyl Zeta-cypermethrin (3)	Carboxin Malathion Trichlorfon (2)
Barley	Tebuconazole (5)	Diclofop Epoxiconazole Flusilazole Pirimicarb (4)	Cyproconazole Diniconazole Tetraconazole (3)

[a] Including Greece, France, Hungary, Italy, Portugal, Slovenia and Spain.

[b] Other authorised pesticides only authorised in one MS.

2.3. Pesticides authorised for use on rice

The consumption of rice accounts for 1% to 18% of the daily consumption of cereals (according to consumption data presented in Table 2-3). There is a production of rice in southern EU. However, about two-thirds of the rice consumed in the EU is imported. Most EU imports come from Thailand, India and Pakistan. Some of the rice produced in the EU, in particular round or medium-grain japonica rice, is exported[11]. As mentioned earlier, the EU imports rice from countries outside the EU. It is therefore of interest to gain knowledge on use patterns not only within the EU but also from the countries exporting rice to the EU.

France and Italy are two of the producers of rice in the EU. Table 2-7 lists the pesticides authorised for use on rice in these two MS. The information on authorisations is from pesticide-online[13] for Italy and from a French governmental website[12]. Primarily herbicides (H) are authorised for use on rice in these two MS. Only five insecticides and three fungicides are included on the list.

Table 2-7: Active compounds authorised for use on rice in France and Italy according to information available on a French governmental website[12] (9 Feb. 2011) and pesticides-online[13] (27 July 2010), respectively. F: fungicide H: herbicide, I: insecticide.

Active compounds authorised for use on rice in France	Active compounds authorised for use on rice in Italy
Alpha-cypermethrine (I)	Bensulfuron-methyl (H)
Azimsulfuron (H)	Benthiocarb (H)
Azoxystrobin (F)	Cinosulfuron (H)
Bensulfuron-methyl (H)	Dalapon (H)
Bentazone (H)	Glyphosate (H)
Cycloxydime (H)	Iprodione (glycophene) (F)
Cyhalofop butyl (H)	MCPA (H)
Deltamethrine (I)	Oxadiazon (H)
MCPA (H)	Pendimethalin (penoxalin) (H)
Oxadiazon (H)	Pirimiphos-methyl (I)
Penoxsulame (H)	Pretilachlor (H)
Piperonyl butoxide (non PPP, I synergist)	Propanil (H)
Pirimiphos-methyl (I)	Propiconazole (F)
Sodium Trichloroacetate (H)	Quinclorac (H)
Tebufenozide (I)	Thiobencarb (H)
	Triclopyr (H)

India has a governmental website which allows citizens to look for information on pesticide uses and recommended uses. Table 2-8 has been compiled from the information on this website. The list includes both active compounds included in lists of recommended uses[14] and active compounds listed as active compounds in products of major use[15]. Active compounds stated in green occur both on the lists of recommended uses and lists of major uses. Active compounds stated in blue only occur on the lists of major uses. Active compounds stated in black only occur on the lists of recommended uses.

The list of pesticides which can be used on rice is significantly longer for rice growers in India (87 compounds) than in France and Italy (15-18 compounds). The list for India also includes many more insecticides and fungicides than for France and Italy. In July 2010 we received a list of active compounds authorised for use on rice in South Korea. This list includes 186 compounds. Since South Korea is not one of the primary suppliers

of rice to the EU we have chosen not to present this list here, but it can be obtained by contacting the EURL for Cereals and Feeding Stuff.

Table 2-8: Active compounds recommended for use on rice and paddy in India according to information available on National Portal of India[14] (15 Feb. 2011) and active compounds listed as major uses on rice and paddy in India [15]. Active compounds stated in green occur both on the lists of recommended uses and lists of major uses. Active compounds stated in blue only occur on the lists of major uses. Active compounds stated in black only occur on the lists of recommended uses. F: fungicide H: herbicide, I: insecticide, PGR: plant growth regulator.

Active compound	
2,4-D (H)	Hexaconazole (F)
Acephate (I)	Imidacloprid (I)
Aluminium phosphide (I)	Iprodione (F)
Anilofos (H)	Isoprothiolane (F)
Aureofungin (F)	Kasugamycin (F)
Azadirachtin (I)	Kitazine (F)
Benfuracarb (I)	Kresoxim-methyl (F)
Bensulfuron methyl (H)	Lambda-cyhalothrin (I)
Bispyribac Sodium (H)	Lindane (I)
Bromadiolone (R)	Malathion (I)
Buprofezin (I)	Mancozeb (F)
Butachlor (H)	MCPA (H)
Carbaryl (I)	Metaldehyd (I)
Carbendazim (F)	Methyl Bromide (I)
Carbofuran (I)	Metsulfuron methyl (H)
Carbosulfan (I)	Monocrotophos (I)
Carpropamid (F)	Oxadiargyl (H)
Cartap (I)	Oxadiazon (H)
Chlorantraniliprole (I)	Oxydemeton methyl (I)
Chlorimuron Ethyl (H)	Oxyflourfon (H)
Chlorpyriphos (I)	Paraquat (H)
Cinmethylin (H)	Parathion methyl (I)
Clomazone (H)	Pencycuron (F)
Clothianidin (I)	Pendimethalin (H)
Copper hydroxide (F)	Phenthoate (I)
Cyhalofop (H)	Phorate (I)
Cypermethrin (I)	Phosalone (I)
Deltamethrine (I)	Phosphamidon (I)
Dichlorvos (I)	Pretilachlor (H)
Difenoconazole (F)	Propiconazole (F)
Edifenphos (F)	Propineb (F)
Endosulfan (I)	Quinalphos (I)

Active compound	
Ethofenprox (I)	Streptomycin Sulphate (Bactericide) + Tetracycline Hydrochloride 90:10 (Bactericide)
Ethoxysulfuron (H)	Tebuconazole (F)
Ethylene dichloride and Carbon tetrachloride (I)	Thiachloprid (I)
Fenitrothion (I)	Thiamethoxam (I)
Fenobucarb (I)	Thifluzamide (F)
Fenoxaprop-p-ethyl (H)	Thiram (F)
Fipronil (I)	Triacontanol (PGR)
Flubendiamide(I)	Triazophos (I)
Flufenacet (H)	Tricyclazole (F)
Flusilazole (F)	Validamycin (F)
Formothion (I)	Zineb (F)
Gibberellic Acid (PGR)	

2.4. Pesticides often found in cereals in the EU coordinated programme

Each year the EU monitoring programme includes at least one type of cereal crop and this is changed each year. In 2008 it was rice[17], 2007 it was rye/oat[16] and in 2006 it was wheat[20]. Table 2-9 presents in percent the results obtained for cereals in the EU monitoring programme 2006-2008. The results are presented as a percentage of samples without detectable residues, with residues below or at MRL and with residues exceeding the MRL.

Table 2-9. Results of the coordinated EU monitoring programme for rice (2008) [17], rye/oat (2007) [16] and wheat (2006)[20].

	Without detectable residue (%)	With residues below or at MRL (%)	With residues above MRL (%)	Number of samples analysed
Rice (2008)	84	14	2.4	1060
Rye/oat (2007)	78	19	2.9	843
Wheat (2006)	73	27	0.1	1531

More wheat samples are found to contain residues below or at MRL compared to rye/oat. On the other hand residues above MRL were found more often for rye/oat compared to wheat. Since rye and oat are also used as feeding stuff and residues are found in quantities similar to wheat, monitoring these crops would be of interest for a

future monitoring programme for feed. Rice has a similar distribution of the results as rye and oat.

The participating states in the EU control programme have reported the ten most frequently found pesticides. In 2008[17], rice was included in the control, and for this commodity the ten most frequently found pesticides where primarily insecticides. In 2007 rye and oat were on the sampling plan and for rye insecticides also dominated the ten most frequently found pesticides. For oat, insecticides accounted for half of the most frequently found pesticides and the rest were fungicides and plant growth regulators. The specific pesticides are listed in Table 2-10.

Several of the pesticides often found in the EU control programme (Table 2-10) are also represented in the tables of commonly authorised pesticides (Table 2-4, Table 2-6). These are e.g. azoxystrobin, chlormequat, deltamethrin, spiroxamin, and tebuconazole. Only 13 of the 57 the pesticides authorised for use in more than nine MS (Table 2-4) were included in the 2008 EU control programme. Of the 87 pesticides authorised for use in India (Table 2-8), only 20 were included in the 2008 annual programme. A higher degree of correlation between the lists of authorised uses and pesticides found in the control could appear if the number of pesticides being investigated in the coordinated programme were expanded. However, although some pesticides are authorised for use in many MS, they may never be found in the control since they leave no detectable residues, e.g. because of application early in the growing season or because the effective dose is very low. For example glyphosate is the only herbicide on the list of most commonly found pesticides. Herbicides are often applied early in the growing season and will seldom occur at detectable levels in the crop at harvest.

Pesticide-online.com contains residue data on specific crops and pesticides. The data is uploaded by the users and they are not quality checked. The data can however be used for inspiration and identifying trends. A long list of results appears if a search for residues found in rice samples is made. The majority of these are results from samples taken in 2005. In these rice samples residues of the pesticides listed in Table 1 were found. In many cases information on the origin of the samples has not been specified, or a country not producing rice is stated (e.g. Germany). The first two columns of Table 2-11 present two total lists of pesticides found in rice samples regardless of origin. Countries like Guyana, India, Italy, Portugal, Thailand and the Americas (North or South America) have been stated as origin of some of the rice samples. Twelve of the samples from 2005 have been reported to contain residues exceeding the MRL. The third column of Table 2-11 is a list of pesticides found in samples of rice from known EU rice producers. The majority of the pesticides included in Table 2-10 as the most frequently found pesticides in rice are also represented on the list of pesticides found in rice according to data on the pesticide-online database (Table 2-11).

Table 2-10. Most frequently found residues on rice, rye, oat and wheat. Based on the results from the EU co-ordinated monitoring programme 2008[17],2007[16] and 2006[20], respectively. F: fungicide, H: herbicide, I: insecticide, PGR: plant growth regulator, MRM: multi residue methods, SRM: single residue methods.

Rice 2008	Rye 2007	Oat 2007	Wheat 2006	
Pirimiphos-methyl (I) Carbendazim/benomyl (F) Tebufenozide (I) Deltamethrin (I) Tebuconazole (F) Imidacloprid (I) Azoxystrobin (F) Malathion (sum) (I) Chlorpyrifos (I) Hexaconazole (F)	Chlormequat (PGR) Pirimiphos-methyl (I) Malathion (I) Dichlorvos (I) Chlorpyrifos-methyl (I) Bifenthrin (I) Tebuconazole (F) Carbendazim/benomyl (F) Pyrethrins (I) Deltamethrin (I)	Chlormequat (PGR) Pirimiphos-methyl (I) Chlorpyrifos-methyl (I) Dichlorvos (I) Tebuconazole (F) Dithiocarbamates (F) Spiroxamine (F) Chlorpropham (PGR/H) Malathion (I) Diazinon (I)	**By MRM:** Pirimiphos-methyl (I) Chlorpyrifos-methyl (I) Deltamethrin (I) Malathion (I) Dichlorvos (I) Chlormequat (PGR) Piperonyl-butoxide (I) Chlorpyrifos (I) Permethrin (I)	**By SRM:** Chlormequat (PGR) Hydrogen phosphide (I) Mepiquat (PGR) Glyphosate (incl. AMPA)(H) Bromide (I) Benomyl group (F) Spiroxamine (F) Dithiocarbamates (F) Trinexapac-ethyl (PGR) Phophine (I)

Table 2-11: Pesticides found in rice samples taken in 2005 derived from the pesticid-online.com database

Pesticides in rice (all samples of all origins (incl. EU produce))		Pesticides found in rice produced in the EU
Acetamiprid	Fenitrothion	Azoxystrobin
Azoxystrobin	HCH, gamma- (Lindan)	Bromide (inorg.)
Bromide (inorg.)	Hexaconazole	Carbendazim
Buprofezin	Hymexazol	Chlormequat
Carbendazim (sum)	Imidacloprid	Chlorpyrifos
Carbendazim	Iprodione	Copper
Carbofuran	Malathion (sum)	Cyprodinil
Carbofuran (sum)	Malathion	Diazinon
Chlormequat	Mepiquat	Dithiocarbamates det. as CS2
Chlorpropham	Methamidophos	Hexaconazole
Chlorpyrifos	Myclobutanil	Iprodione
Copper	Orthophenylphenol	Malathion
Cypermethrin (sum)	Parathion	Orthophenylphenol
Cyprodinil	Phosmet	Phosmet
Deltamethrin	Piperonyl Butoxide,	Piperonyl Butoxide
Diazinon	Pirimiphos-Methyl	Pirimiphos-Methyl
Dichlorvos	Propiconazole	Propiconazole
Diphenylamine	Pyrifenox	Quinclorac
Dithiocarbamates det. as CS2	Quinclorac	Tebuconazole
Diuron	Tebuconazole	Tebufenozide
Endosulfan (sum)	Tebufenozide	Tricyclazole
Endosulfan, alpha-	Thiophanate-Methyl	
Endosulfan, beta-	Triazophos	
Endosulfansulfate	Trichlorfon	
Endrin	Tricyclazole	
Epoxiconazole	Vamidothion	
Fenarimol		

2.5. Intake of pesticides from cereals

Intake calculations are not available for many European countries and if they are available they often cannot easily be analysed to the intake of pesticides from cereals. Focus is often on the intake from fruit and vegetables since the primary intake is from these food items.

The intake of pesticide residues from cereals has been evaluated on the basis of Danish consumption data and on the results of the Danish monitoring programme[18]. The total intake of pesticide residues from cereals was estimated at 18 µg/day/person in 2007. The intake from wheat alone was estimated at 15.4 µg/day/person. The estimated intake from cereals accounted for 21% of the estimated total intake of pesticide residues from food and beverages of 83 µg/day.

Calculations of intake from cereals based on cereal consumption data and monitoring data from European countries besides Denmark are a challenge and have been lacking in previous versions of this document. The reason for this is that results from the EU coordinated monitoring programme and the MS national programmes are reported by the individual MS in intervals and intake calculations cannot be calculated on such intervals.

Earlier in this document it was concluded that EU citizens in general consume more wheat than any of the other types of cereals. It has also been concluded that the consumption of wheat for an average EU citizen is in the same order as for a Danish citizen. So if it could also be documented that the residues found in Denmark and other EU MS are similar (quantitatively and qualitatively) the intake of pesticides from cereals by EU citizens could be estimated to be similar to the estimated Danish intake.

The studies available in the literature are case studies reporting the intake of a certain group of pesticides[19], e.g. organochlorine pesticides or dithiocarbamates. The results in the EU monitoring report from 2006[20] can be used and these have been compared with the monitoring data used to estimate the Danish intake. In 2006 a total of 1531 samples of wheat were analysed, 1112 samples were without detectable residues (73%), 417 samples were with residues below or at MRL (40.8%), and two were with residues above MRL (0.1%). The most frequently occurring pesticide-commodity combination was chlormequat in wheat and pirimiphos-methyl in wheat, in 36.41% and 10.27% of wheat samples, respectively (all other pesticides occurred in ≤ 5% of the samples).

In comparison, data from the Danish monitoring programme revealed that chlormequat and pirimiphos-methyl were found in 33% and 17.5% of the wheat samples. This should be compared to the average consumption of wheat for an EU citizen of 3.3 g/kg bw/day and a Danish citizen of 2.0 g/kg bw/day, Table 2-3. For many years Danish people have

eaten less wheat than the average EU citizen, instead they eat more rye and oat. However, in 2007, wheat was the second most important crop for the intake of pesticides in Denmark and rye bread was only number 20 on that list, which means that in this perspective the Danish diet is more similar to the European diet than before. Because the most frequently found pesticides are the same for Europe and Denmark, and found with same the frequency, and because the consumption of wheat is also in the same order, it would be expected that the estimated intake for Danish citizens is similar to the average intake by EU citizens.

3. Feeding stuff

Within the EU-25 about 450 million tonnes of feeding stuffs are consumed by livestock each year. Of this quantity 215 million tonnes mostly are roughages grown and used on the farm of origin. The balance, i.e. 235 million tonnes of feed, includes cereals or other feeding stuff grown and used on the farm of origin (51 million tonnes) and feed purchased by livestock producers to supplement their own feed resources (either feed materials or compound feed)[21].

The market for feeding stuffs depends on the market for livestock products and vice versa. In 2006, the EU-25 livestock population produced 45 million tonnes of meat (including 8 million tonnes of beef, 21 million tonnes of pork and 11 million tonnes of poultry meat), 131 million tonnes of milk and 6 million tonnes of eggs. Average per capita consumption of meat in 2006 was 93.4 kg, compared to only 50 kg in the EC-6 during the late 1950s. The value of livestock production - amounting to €130 billion - accounts for 42% of the overall EU-25 agricultural output amounting to €309 billion in 2006.

Germany is the leading cattle meat producer, Spain is now the leader for pig meat and France clearly breaks away from the other countries for poultry meat production[22]. The primary producers of milk in the EU are Germany and France. The countries having a large production of meat, milk or other animal products must also have a high production/import of feeding stuff.

3.1. Consumption of feeding stuff in EU

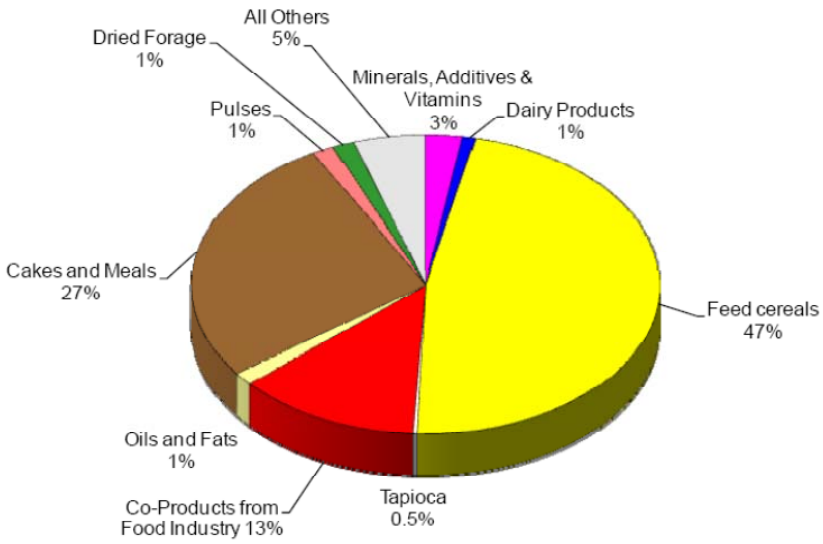
Feeding stuff may comprise a wide range of ingredients. Council Directive 92/25/EC of 29 April 1996 presents a non-exclusive list of the main feed materials. This list includes cereal grains, a wide range of by-products from different cereal processing, e.g. cereal bran and middling, a wide range of different by-products from manufacturing oil (e.g. rapeseed, palm kernel, soybeans, cotton seed, sunflower seeds, linseeds, cocoa bean),

sugar (e.g. sugar beet pulp and molasses), different potato products (e.g. pulp, starch, protein, flakes), and fruit juice (e.g. citrus pulp, tomato pulp). The list also includes legume seeds, alfalfa, clover, grass and cereal straw[23].

Some of the information and illustrations in the following are from a presentation by Finn Vestergaard from DLG given at the EURL workshop in Copenhagen in 2008. The presentation is available at http://www.eurl-pesticides.eu.

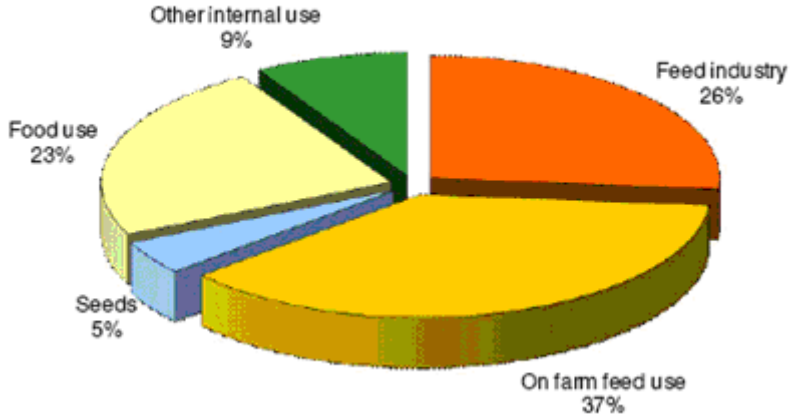
Figure 3.1 shows feed material consumption by the EU compound feed industry. The proportion of feed materials per category has remained relatively stable (47% for cereals, 27% for oilseed meals) compared to previous years[24], and feed cereals account for almost half of the raw materials in the production of compound feed.

Figure 3.1. Feed material consumption by the compound feed industry in 2007 in the EU-27[25].



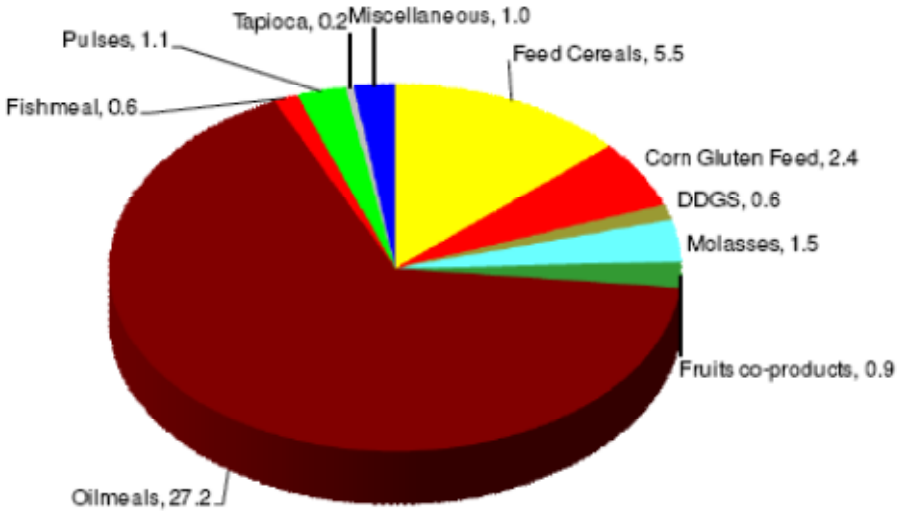
The production of feed accounts for a large part of the agricultural activity in the EU. Approximately 120 million tonnes of feeding stuffs are produced in the EU each year[26]. In 2007, production of cereals could be broken down between food uses and feed as described in Figure 3.2. The term ‘on farm feed use’ means that the farmer uses his own crop to feed his animals, which means that the feed never leaves the farm. Thus by far the largest percentage of the cereal use in EU is for feed.

Figure 3.2: Usage of cereals in the EU27 in 2007-08[19].



Some important ingredients which cannot be grown in the EU are imported from third countries. These diverse sources of raw material supplies are an important factor in industry's ability to manufacture feeds of high quality and at competitive prices for livestock farmers. Figure 3.3 shows imports of feed materials to the EU from 2000-2005. As it is seen from the figure primarily oil meals, including soy meals, are imported to the EU.

Figure 3.3. Imports of feed materials to the EU-25 in 2006[19].



To a large extent the EU is self sufficient in production of cereals (Table 3-1), which means that a monitoring programme for cereals should focus on cereals produced within the EU. In contrast, the EU is very dependent on imports of soy (only between 6% and 18% comes from the EU itself), so for this crop focus should be outside EU.

Table 3-1. Self sufficiency in production of cereals[27]

	Total cereals	Common wheat	Durum wheat	Barley	Rye	Maize	Oat[a]
Human consumption (%)	23	40	87	0.7	42	6	17
Animal feed (%)	63	49	4	75	30	83	75
EU Self sufficiency (%)	98	101	88	106	89	92	89

[a]: Including mixed corn summer cereals

Soybean has the highest content of proteins of all grain and it is the fourth most produced grain in the world, after maize, wheat and rice. Besides the potential of soybean as a nutrient for both humans and animals, this legume also enriches the soil with nitrogen through biological processes. Only four countries, the USA, Brazil, Argentina and China, are responsible for approximately 90% of world production and these countries also supply almost all the EU's soybean and soy meal imports. Over recent years, there has been an increase in worldwide soybean production, as well as in imports/exports and processing of soybeans. Brazil is the second largest producer of soybeans in the world. Much of the soybean production in Brazil, around 19 million tonnes of the 2004/2005 crop, is exported to several countries on different continents[28]. The degree of self-sufficiency in the EU varied between 6% (soy meal) and 18% (soy oil) in 1998/99[29].

3.2. Composition of feed

When establishing a pesticide control for feed, an evaluation of the division between human consumption/animal feed versus the daily feed ration for animals is needed to estimate which feeding stuff to attach importance in the control. A starting point could be to focus on the crop/products which make up the largest fraction of an average feed ration for a given type of livestock. An important crop for animal feed is maize. Table 3-1 shows that Europe is almost self sufficient and that animals consume 83% of the production of maize. An example is given in Table 3-2, where almost half of the daily feed ration for a Danish dairy cow is maize silage. Besides maize, half of the EU wheat production is consumed by animals and 75 % of barley and oat production. But the production of barley and oat is smaller than the production of maize, wheat, and rice.

According to Table 3-3 the proportion of soy in animal feed can be 10-30% of the dry matter, depending on the livestock species. For a diary cow this means that up to 6 kg dry matter per day can be accounted for by soy cake and meal.

Table 3-2. Daily ration for a Danish dairy cow[19].

	Kg Dry matter
Clover grass silage	3.5
Maize silage	9
Straw	0.5
Minerals	0.2
Compound feed	7
Total	20.2

Levels exceeding MRLs in soy products from the UK monitoring are listed in the Annual Report of the Pesticide Residues Committee 2006 of samples collected throughout 2006. The main findings were:
- Out of 60 samples of soy milk, five samples contained endosulfan.
- Out of 60 samples of soy pieces and tofu, 11 contained residues of glyphosate, five contained residues of endosulfan and one contained residues of diazinon[30].

In the Guidance document for Directive 91/414, Appendix G a table gives examples of the composition of feed for pigs, beef cattle, dairy cattle and hens. The table is included in this document as Table 3-3. According to this table beef and dairy cattle can be fed on 100% grass, silage or hay. A major constituent in feed for pigs can be grain (up to 80%) and root and tuber vegetables (e.g. sugar beet) (up to 60%).

From the information presented here it can be argued that residues occurring in feed materials such as grass, silage, hay and cereals are of great relevance if the residues in feed are to be monitored.

Table 3-3. Maximum feed intake expressed as percentages for certain feeding stuffs frequently used for four indicator livestock species. The table is from the Guidance document for Directive 91/414, Appendix G: Livestock feeding studies.

		% Dry Matter (DM)	Chicken	Dairy Cattle	Beef Cattle	Pig
Body weight Daily Maximum Feed (Dry Matter) DM			1.9 kg 120 g	550 kg 20 kg	350 kg 15 kg	75 kg 3 kg
Maximum Percentage			% DM	% DM	% DM	% DM
Group	Crop/ Commodity					
I	Green Forage (include. Hay)					
	Grasses	20	-	100	100	-
	Alfalfa/Clover	20	-	40	40	15
	Forage Rape	14	-	-	35	15
	Kale/Cabbage	14	5	35	35	15
	Sugar Beet leaves and tops	16	-	30	30	25
	Silage (Clover, Grasses (...)	20	-	100	100	15
	Fruit Pomace (Apples, Citrus)	23	-	10	30	-
	Hay	85	-	100	100	15
II	Grains					
	Grains except Maize	86	70	40	80	80
	Maize	86	70	30	30	40
	Bran (Wheat and Rye)	89	15	20	20	20
III	Straws (cereals)	86	_	20	50	-
IV	Pulses	86	30	20	20	40
V	Root and Tubers (e.g. Potatoes,	15	20	30	60	60
	Swede/Turnip/	10	20	30	60	60
	Sugar and Fodder Beet	20	20	30	60	60
VI	Oil Seed (Meal, Cake) (eg Soya bean, Peanuts, Rape seed, Sunflower seed, Linseed	86	10	30	30	20

3.3. Pesticides authorised for use in feeding stuff

The difficulties with pesticide residue analysis of animal feed samples are caused by the fact that these matrices are burdened with large amounts of interfering matrix in the extracts. Animal feeds can be complex mixtures that include constituents such as grains, milling by-products, added vitamins, minerals, fats, and other nutritional and energy sources. Even less complex cereal matrices contain more co-extracts than typical matrices with high water content, such as fruits and vegetables. Additionally, the exact composition of the sample is often unknown to the testing laboratory.

The report published by the Danish EPA in 2007 mentioned in section 2.2 above also includes information on pesticides authorised for use in rapeseed and maize[31]. Rapeseed

and maize are potential feeding stuff constituents. Meal cake of rapeseed and other by-products from the rapeseed oil production is also used as feeding stuff. The information on pesticides authorised for use on rapeseed and maize is summarised in Table 3-4 and Table 3-5.

Barley is also a potential feeding stuff constituent and
Table 2-5 indicates that analysis of e.g. several triazoles could be of relevance when analysing barley.

The pesticides included in the list of the top 3 pesticides authorised for use in maize (Table 3-5) are not all included in the list of most commonly authorised pesticides in Table **2-5**. This indicates that several of the most commonly authorised pesticides for use in maize are not included in the list of the 77 substances pending in the EU authorisation system.

The use of pesticides may involve risks and hazards for humans, animals and the environment, especially if placed on the market without having been officially tested and authorised, and if incorrectly used. Imported crops from third countries can be problematic in this regard. For example if pesticides which are not allowed in the EU (annex 1, 91/414) are not stated in the application for export, and if the same pesticides are not included in the monitoring programmes, then the respective pesticides are not kept under surveillance. Finn Vestergaard from Danish Cooperative Farm Supply listed a provisional list of problematic pesticide/crop combinations for Argentina under EU Regulation 396/2005. All of these pesticides have not been included in Annex I of Directive 91/414 and are therefore not allowed in the EU, but they could be relevant to monitor with regard to illegal use and imported feed.

Table 3-4. Pesticides authorised for use in rapeseed in ten or more of 17 MS and in less than 10 but more than 5 MS.

	Pesticides authorised for use in rapeseed	
Field of use	**≥10 MS**	**10 > MS > 5**
Fungicides	Iprodione	Azoxystrobin
	Metconazole	Carbendazim
	Prochloraz	Fludioxonyl
	Tebuconazole	Metalaxyl-M
		Procymidone
		Thiram
		Vinclozolin
Herbicides	Clomazone	Dimethachlor
	Clopyralid	
	Cycloxydim	
	Diquat (dibromide)	
	Fluazifop-P	
	Glufosinate	
	Glyphosate (incl trimesium aka sulfosate)	
	Haloxyfop-R	
	Metazachlor	
	Napropamide	
	Propaquizafop	
	Propyzamide	
	Quinmerac	
	Quizalofop-P	
	Trifluralin	
Insecticides	alpha-Cypermethrin (aka alphamethrin)	Esfenvalerate
	beta-Cyfluthrin	Methiocarb (aka mercaptodimethur)
	Cypermethrin	Phosalone
	Deltamethrin	Pirimicarb
	Imidacloprid	tau-Fluvalinate
	lambda-Cyhalothrin	Thiacloprid
	zeta-Cypermethrin	Thiamethoxam
Plant growth regulators	Chlorpropham (only 3 MS)	
	Trinexapac (only 3 MS)	

Table 3-5. Pesticides authorised for use in maize in ten or more of 17 MS and in less than 10 but more than 5 MS.

	Pesticide authorised for use in Maize	
Field of use	**≥10 MS**	**10 > MS > 5**
Fungicides		Fludioxonyl Metalaxyl-M Thiram
Herbicides	Bentazone Bromoxynil Clopyralid Dicamba Fluroxypyr Foramsulfuron Mesotrione Nicosulfuron Pendimethalin Rimsulfuron (aka renriduron) Terbuthylazine Thifensulfuron (aka thiameturon)	2,4-D Glyphosate (incl trimesium aka sulfosate) Dimethenamide Linuron Isoxaflutole S-Metholachlor Iodosulfuron-methyl-sodium
Insecticides		Carbofuran Deltamethrin lambda-Cyhalothrin alpha-Cypermethrin (aka alphamethrin) Imidacloprid Chlorpyrifos
Plant growth regulators	Dimethipin (only 1 MS) 2,4-D (only 1 MS)	

Table 3-6. List of problematic pesticide/crop combinations for Argentina[19].

Soybean	Sunflower	Maize
Acifluorfen	benazolin	atrazina
Benazolin	fenoxaprop	fentoato
Fenpropatine	fenpropatina	fenvalerato
Fentoato	fentoato	imazetapyr
Fenvalerato	fenvalorato	metolacloro
Fluazifop	Fluazifop	permetrina
Fluoroglicofen	haloxyfop	primisulfuron
Haloxyfop	metolacloro	setoxydim
Imazetapyr	permetrina	dalapon
Metolacloro	profenofos	simazina
Naptalan	prometrina	endosulfan
Permetrina	setoxydim	
Profenofos	endosulfan	
Prometrina		
Setoxydim		
Endosulfan		

3.4. Pesticide residues in animal feeding stuff

Plant protection products may be ingested or absorbed by livestock in three ways:
- following direct application of the product to the animal
- through residues in feeding stuff
- as a result of treatment of their accommodation.

The usual source of residues is through the legitimate use of pesticides (herbicides, insecticides and fungicides) in the production of crops used in preparation of feeds. The need for information relevant to the conduct of risk profiles or for management of residues will always remain.

Published data on feed are very scattered and not easy to find. The results are not necessarily published and a compilation of feed monitoring data is still in the early stages. The following section contains pesticide residues in animal feed from three different countries, the USA, Denmark, and the Netherlands. The USA and the Netherlands have collected feed samples from crop/products which include feed rations for a most types of livestock. The data from Denmark consist of cereal samples for feed uses.

Feed samples analysed by the Danish Plant Directory

The Danish Plant Directory controls Danish-produced cereals for feeding for pesticide residues. During the last 3 years, 165 samples (104 samples in 2007, 30 in 2008, and 31 in 2009) have been analysed for 25 pesticides, of which 15 were the most commonly applied pesticides on Danish cereals. In 2008 and 2009 chlormequat, mepiquat and glyphosat were added to the list. The samples were collected at farmers and companies. The cereals analysed were wheat, barley, oat, rye, and triticale. The pesticides analysed are shown in Table 3-7.

Table 3-7. The pesticide list of the Danish Plant Directory.

Pesticides		
2-4-5-T	Dimethoat	MCPB
2-4-5-TP-Fenoprop	Epoxicinazole	MCPP-Mecoprop
2-4-D	Fenoxaprop-p-ethyl	Mepiquat
2-4-DB	Fenpropidin	Pendimethalin
2-4-DP-Dichlorprop	Fenpropimorph	Prochloraz
Azoxystrobin	Flamprop-M-isopropyl	Propiconazole
Bentazone	Fluroxypyr	Prosulfocarb
Bromoxynil	Glyphosate	Tebuconazole
Chlormequat	Ioxynil	
Dicamba	MCPA	

Table 3-8. Cereal samples from 2009 with pesticide residues.

Food	Pesticide Residue	Result mg/kg	MRL mg/kg
Barley	Epoxiconazole	0.014	1
Barley	Glyphosate	1.44	20
Barley	Fenpropidin	0.02	0.5
Barley	Propiconazole	0.01	0.2
Wheat	Chlormequat	0.197	2
Wheat	Chlormequat	0.205	2
Wheat	Chlormequat	0.561	2
Wheat	Chlormequat	0.649	2
Wheat	Chlormequat	1.66	2
Wheat	Glyphosate	0.71	10
Wheat	Glyphosate	0.28	10
Wheat	Glyphosate	0.18	10
Wheat	Glyphosate	0.3	10
Wheat	Glyphosate	0.05	10

None of the samples analysed in the three-year period contained residues above the MRLs. Out of the 31 samples analysed in 2009, 10 samples contained residues (32%). Table 3-8 shows the cereal samples from 2009 that contained pesticide residues, all below MRL.

In 2008, 15 out of 30 samples (50%) contained pesticide residues. The pesticides were primarily chlormequat (9 samples) and glyphosate (6 samples) found in triticale, barley and wheat. In addition to this, one oat sample contained residues of tebuconazole, and fluroxpyr was found in a barley sample.

Feed samples analysed by the Institute of Food Safety, Netherlands

In the Netherlands the Food and Consumer Product Safety Authority (VWA) is the competent authority for the official control of feed. As part of this control, feed samples are taken at feed producers and at border control. The animal feed samples were collected from 2006-2009, and the samples were analysed by RIKILT, Institute of Food Safety, by a multi-residue method for pesticide residues.

In the four-year period, the RIKILT institute analysed 840 samples. The type of feed samples analysed covered a large variety of animal feed ranging from cereals, grains and seeds, to more complex mixtures of compound feed along with by-products from the food industry. The type of feeding stuff analysed also covered the four most important livestock species, pig, beef cattle, dairy cattle and hens (see Table 3-3 in section 3.2 Consumption of feed). The type and number of feed samples are listed in Table 3-9.

A total of 272 (32%) of the 840 samples analysed had detectable residues. The percentage of samples with detectable residues varied a great deal depending on the type of food. The highest percentage of residues was found in milk products (100%), compound feeding stuffs (80%), milk substitutes (65%), and by-products of the food industry (61%). So far no MRL for animal feed has been defined, except for feed that is also used as food, e.g. cereals.

The frequency of the eight most frequently found pesticides is shown in Figure 3.4. A total of 53 different pesticides were found. Pirimiphos-methyl and ethoxyquin were the pesticides most frequently found and were detected in 124 (15%) and 46 (6%) samples, respectively, out of the 840 samples analysed. The highest concentration of a pesticide residue was 211 mg/kg of ethoxyquin in salmon oil analysed in 2006.

A large part of the most frequently found pesticides are only found in very few commodities.

Table 3-9. Samples with detectable residues in feed samples from the Netherlands.

Type of feed	Number of samples analysed	Samples with detectable residues	%
COMPOUND FEEDINGSTUFFS	95	76	80
BY-PRODUCT OF FOOD INDUSTRY	62	38	61
CEREAL GRAINS, THEIR PRODUCTS AND BY-PRODUCTS	96	41	43
FAT/OIL VEGETABALE AND ANIMAL MIXED	6	1	17
FISH, OTHER MARINE ANIMALS, AND BY-PRODUCTS (FAT/OIL)	10	5	50
FORAGE AND ROUGHAGE	89	2	2
LAND ANIMAL PRODUCTS (FAT/OIL)	72	1	1
MILK PRODUCTS	2	2	100
OIL SEEDS, OIL FRUITS, THEIR PRODUCTS AND BY-PRODUCTS	154	18	12
OIL SEEDS, OILS FRUITS, (VEGETABLE FATTY ACIDS/FAT/OIL)	139	38	27
OTHER PLANTS, THEIR PRODUCTS AND BY-PRODUCTS	7	2	29
OTHER SEEDS AND FRUITS THEIR PRODUCTS AND BY-PRODUCTS	3	1	33
TUBER, ROOTS, THEIR PRODUCTS AND BY-PRODUCTS	53	13	25
MILK SUBSTITUTE	52	34	65
TOTAL	**840**	**272**	**32**

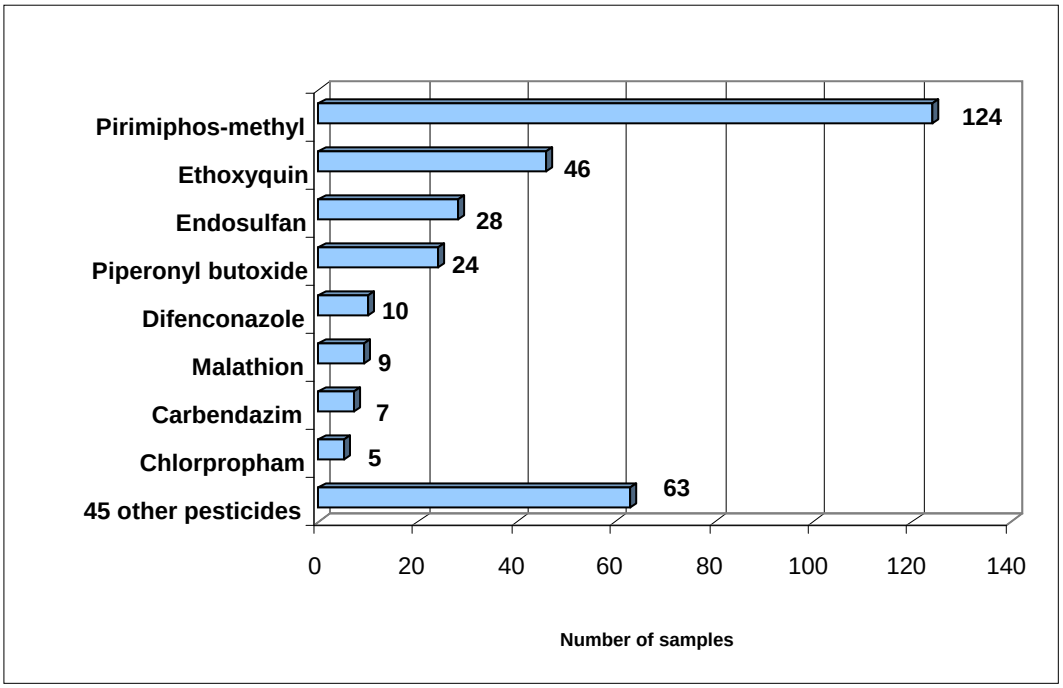
Endosulfan is one of the most widely used cotton and soy pesticides. Out of the 28 samples containing endosulfan, 24 were found in soy products, mostly soy oil. The content ranged from 0.01-0.76 mg/kg. There is no MRL for soy oil but the MRL for soy bean is 0.5 mg/kg, this would correspond to the MRL being exceeded four times in soya products. Endosulfan has been proposed as a chemical to be listed under the Stockholm Convention on Persistent Organic Pollutants.

Eight out of ten samples containing difenoconazole were from samples of beet pulp. This corresponds to the application of difenoconazole. Difenoconazole is used to control foliar fungi which have spread all over the Netherlands and have caused sugar beet yield reductions of up to 40%.

Ethoxyquin has been found in 46 samples. Ethoxyquin is an antioxidant used as a preservative and a pesticide. As a pesticide it is used as to prevent common scald (browning) in apples and pears by post-harvest treatment. As a food preservative ethoxyquin is used as an antioxidant in feeding stuff to prevent the oxidative decomposition of N3 fatty acid during long-term storage. Ethoxyquin has also been reported to have been added to the diets of dairy cattle to reduce the oxidized flavour of milk. This may explain why ethoxyquin has been found in some oils in very high amounts (211 mg/kg in a salmon oil, and 141 mg/kg in a linseed oil). About one-third of

the milk substitute samples contain ethoxyquin in a concentration from 0.11 – 3.8 mg/kg.

Figure 3.4. Frequency of the most frequently found pesticides in feed samples from the Netherlands.



Feed samples analysed by the U.S. Food and Drug Administration

The U.S. Food and Drug Administration, FDA, samples and analyses domestic and imported animal feeds for pesticide residues. Monitoring focuses on feeds for livestock and poultry - animals that ultimately become or produce food for human consumption. The data presented here are from 2006 and 2007.

The Environmental Protection Agency, EPA, determines the safety and effectiveness of the chemicals and establishes tolerance levels and regulatory guidance for residues on feed crops, as well as for raw and processed foods. These tolerance levels (the amount of pesticide allowed to be present in a food product) are normally set 100 times below the level that might cause harm to people or the environment. In the following the exceedings of regulatory guidance found by the FDA have been cross-checked with MRLs in the EU pesticide database.

In 2007, 292 feed samples (196 domestic and 96 imported) were analysed for pesticides by the FDA (Table 3-10). Of the 196 domestic samples, 145 samples (74%) contained no detectable pesticide residues, 44 samples (22%) contained one or more detectable

residues that did not exceed regulatory guidance, and seven (3.6%) contained a residue which exceeded regulatory guidance. Of the 96 imported samples, 78 (81%) contained no detectable pesticide residues, 18 (19%) contained one or more detectable residues that did not exceed regulatory guidance, and no samples contained a residue which exceeded regulatory guidance.

The seven domestic samples of animal feed with residues that exceeded regulatory guidance were three grain and four plant by-products. Two corn samples from Ohio contained 0.110 and 0.143 mg/kg of chlorpyrifos, respectively. These levels exceed the 0.05 mg/kg tolerance for chlorpyrifos on field corn (the EU-MRL for chlorpyrifos in corn is also 0.05 mg/kg). One corn sample from Missouri contained 0.030 mg/kg of chlorpyrifos-methyl. No tolerances have been established by the EPA for chlorpyrifos-methyl on corn. (This sample would not have exceeded the EU MRL for chlorpyrifos-methyl in corn, which is 3 mg/kg).

Table 3-10. Summary of the 196 domestic and 96 import samples of animal feed that were analysed for pesticides by the FDA in 2007.

Type of feed	Number of samples analysed	Samples with no pesticide residues	%	Samples exceeding regulatory guidance	%
Whole/Ground Grains	115	99	86	3	2.6
Plant By-products	80	57	71	4	5
Mixed Feed Rations	59	34	58	0	0
Supplements/Misc.	19	17	90	0	0
Hay & Hay Products	13	10	77	0	0
Animal By-products	6	6	100	0	0
TOTALS	**292**	**223**	**76**	**7**	**2.4**

Two samples, a soy hull pellet and a canola meal, contained 0.037 mg/kg and 0.066 mg/kg of tris (chloropropyl) phosphate, respectively. No tolerances, action levels, or guidance have been established by the EPA or the FDA (or by the EU) for this fire-retardant in animal feed, so any quantifiable level is considered to have exceeded regulatory guidance. One sample of cotton burrs from Texas contained 14.8 mg/kg of malathion. This level exceeds the 2 mg/kg tolerance for malathion on delinted cotton seed. The EU MRL for malathion in cotton seed is 0.02 mg/kg. One sample of peanut hulls from Texas contained 0.058 mg/kg of DEF (tribuphos). No tolerances have been established by the EPA for DEF on peanut hulls (or by the EU).

In the 51 domestic and 18 import samples of animal feed in which one or more pesticides were detected, there were 90 quantifiable residues. Malathion and ethoxyquin were the most frequently found and accounted for 55% of all residues detected. Table

3-11 shows the number of quantifiable levels for each pesticide and the concentration range.

Table 3-11. Summary of the pesticides in 51 domestic and 18 import samples of animal feed, that contained one or more detectable residues in 2007.

Pesticide	Quantifiable Levels	Range (mg/kg)	Median (mg/kg)
Malathion	32	0.011 - 14.8	0.111
Ethoxyquin	20	0.068 - 29.8	0.571
Chlorpyrifos-methyl	6	0.011 - 0.175	0.028
DDE + TDE + DDT	6	0.002 - 0.046	0.014
DEF	6	0.056 - 1.82	0.253
Chlorpyrifos	3	0.018 - 0.143	0.11
Chlorpropham	2	0.070 - 0.073	
Fenpropathrin	2	0.210 - 0.600	
Myclobutanil	2	0.047 - 1.20	
Quinoxyfen	2	0.077 - 0.330	
Tris (chloropropyl) phosphate	2	0.037 - 0.066	
Azoxystrobin	1	0.08	
All others	6	0.025 - 2.10	0.134

In 2006, 335 feed samples (264 domestic and 71 imports) were analysed for pesticides by the FDA. Of the 264 domestic samples, 196 (74%) contained no detectable pesticide residues, 66 (25%) contained residues at levels not exceeding regulatory guidance, and two (0.8%) contained residues which exceeded regulatory guidance. Of the 71 import samples none contained a residue which exceeded regulatory guidance. The two residues that exceeded regulatory guidance were a vitamin premix sample from Canada that contained 82.070 mg/kg of ethoxyquin, and a sample of tallow collected by the Chicago District Office which contained 0.069 mg/kg of ***o***-phenylphenol.

In the 68 domestic and three import samples of animal feed in which one or more pesticides were detected, there were 99 pesticide residues. Malathion and ethoxyquin were the most frequently found and accounted for 60.6% of all residues detected.

4. MRLs and toxicological data

In the EU, a new legislative framework (Regulation (EC) No 396/2005 of the European Parliament and of the Council) on pesticide residues is applicable as from 1 September 2008. This Regulation completes the harmonisation and simplification of pesticide MRLs, whilst ensuring better consumer protection throughout the EU.

All national MRLs no longer apply. The Regulation includes all "old" EU MRLs as well as many new EU MRLs which have been agreed on the basis of all of the MS's national MRLs. If there is a combination of a commodity and pesticide for which there is no MRL specified in the Regulation then a default MRL of 0.01 mg/kg applies. The MRLs in force from the 1 September 2008 are listed in regulation 396/2005[32].

So far the focus of the work in the EU on safety evaluations of pesticide residues has been on residues in food. However the Regulation (EC) NO 396/2005 of 23 February 2005 on maximum levels also relates to MRLs in feed. So far however the group of "Products intended for animal feed" has not been defined further (Directive 202/32/EC of 7 May 2002). Feeding stuff is defined as crops solely intended for feeding stuff, grass, straw, green forage for ensilage, feeding stuff peas etc.

Residues should not be present at levels presenting an unacceptable risk to humans and, where relevant, to animals (Regulation (EC) NO 396/2005). Maximum contents for some persistent pesticides have been laid down in Council Directive 1999/29/EC of 22 April 1999 on the undesirable substances and products in animal nutrition[33]. These pesticides include aldrin, dieldrin, camphechlor, DDT, endosulfan, endrin, heptachlor, hexachlorbenzene and hexachorocyclo-hexane (HCH). For these pesticides a maximum content in mg/kg relative to a feeding stuff with a moisture content of 12% has been defined.

No MRLs have so far been set for feeding stuff.

Toxicological data, such as ADI and ARfD, could also be taken into account when considering which pesticides to include in monitoring programmes. It could be argued that pesticides for which low ADI and/or ARfD have been set are more relevant to monitor for than pesticides with higher values. A combination of high MRLs and low ADI and/or ARfD could increase the importance of monitoring for residues of this particular pesticide[34].

5. Feasibility of including pesticides in multiresidue methods

Multiresidue methods are cost effective and are therefore preferable to single residue methods. The majority of the pesticides authorised for use on wheat in more than 9 of 16 northern and central European MS (listed in Table 2-4) can be included in a multiresidue method. The exceptions are e.g. glyphosate and chlormequat.

Both LC and GC compounds are represented in Table 2-4. The sulfonylurea type is generally possible to include in LC methods. However, these types of pesticides can be difficult to detect, because the sulfonylurea compounds are very potent and only spread in very low amounts per hectare, resulting in low residue levels.

The triazole and pyrethroid types are possible to include in GC methods, whereas it varies for the strobilurin type whether GC or LC methods are most applicable.

It is difficult to give general recommendations on which pesticides are of greater or less relevance when analysing feeding stuff, since feed can be composed of a wide range of products and by-products.

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