MRL dairy cow	*0.95*		*(< 0.005)*								
	10		< 0.05								
STMR beef cattle	*0.78*				*(< 0.004)*		*(< 0.004)*		*(0.019)*		*(< 0.004)*
	10				< 0.05		< 0.05		0.26		< 0.05
STMR dairy cow	*0.75*		*(< 0.004)*								
	10		< 0.05								

The dietary burden for laying hens was 0 mg/kg, therefore the table of calculation of MRLs and STMRs for poultry meat and eggs is not necessary.

The Meeting estimated maximum residue levels of 0.05 (*) mg/kg for mammalian meat (fat), mammalian edible offal, and milks to replace the present recommendations of 0.05 (*) mg/kg for cattle meat, 0.01 (*) mg/kg and 0.1 mg/kg for edible offal of cattle. The Meeting also estimated the following STMR values: muscle 0 mg/kg, fat 0 mg/kg, edible offal 0.05 mg/kg, and whole milk 0 mg/kg.

The Meeting estimated maximum residue levels of 0.05 (*) mg/kg for eggs, poultry meat (fat), and poultry edible offal, based on the limit of quantification for poultry commodities to confirm the present recommendation of 0.05 (*) mg/kg. Also estimated were STMRs of 0 mg/kg for eggs, meat, and edible offal of poultry.

DIETARY RISK ASSESSMENT

Long-term intake

The International Estimated Daily Intakes (IEDIs) of clofentezine, based on the STMRs estimated for sixteen commodities, were 0–3% of the maximum ADI of 0.02 mg/kg bw for the thirteen GEMS/Food regional diets. The Meeting concluded that the long-term intake of residues of clofentezine resulting from its uses that have been considered by JMPR is unlikely to present a public health concern.

Short-term intake

The 2005 JMPR decided that an ARfD was unnecessary. The Meeting therefore concluded that the short-term intake of clofentezine residues is unlikely to present a public health concern.

5.7 CYFLUTHRIN (157)/ BETA-CYFLUTHRIN (228)

RESIDUE AND ANALYTICAL ASPECTS

Cyfluthrin was identified as a priority compound under the Periodic Re-evaluation Programme at the 37th Session of the CCPR. The Meeting received information on cyfluthrin metabolism and environmental fate, methods of residue analysis, freezer storage stability, national registered use patterns, supervised residue trials, farm animal feeding studies, fate of residues in processing and national MRLs. The Meeting also received information on beta-cyfluthrin methods of residue analysis, freezer storage stability, national registered use patterns and supervised residue trials. The metabolism and environmental fate, transfer from feeds to farm animals and fate of residues in processing provided for cyfluthrin are used to support both pesticides.

Cyfluthrin was evaluated by the 48th JECFA for residues in animal commodities arising from direct animal treatment. In the case of animal commodities, the maximum residue limit recommendations of the 48th JECFA for cattle are fat 0.2 mg/kg, muscle, liver and kidney 0.02 mg/kg and milk 0.04 mg/kg. The residue definition (marker residue) chosen by JECFA was cyfluthrin.

The 2006 JMPR established common ADIs and ARfDs for beta-cyfluthrin and cyfluthrin of 0-0.04 mg/kg bw per day and 0.04 mg/kg bw respectively.

Cyfluthrin is a mixture of 8 stereoisomeric esters derived from esterification of the dichloro analogue of chrysanthemic acid, (2,2-dimethyl-3-(2,2-dichlorovinyl)cyclopropane carboxylic acid, DCVA) with α -cyano-3-phenoxy-4-fluorobenzyl alcohol. Beta-cyfluthrin is an enriched isomeric form of the 2 biologically active diastereoisomeric pairs of isomers.

Conclusions reached in discussing cyfluthrin equally apply to beta-cyfluthrin. In the presence of water and other protic solvents, the isomer composition of beta-cyfluthrin changes through epimerisation such that with sufficient time the isomer ratio becomes the same as cyfluthrin.

The following abbreviations are used for the metabolites discussed below:

DCVA	2,2-dimethyl-3-(2,2-dichlorovinyl)cyclopropane carboxylic acid
FPBald	4-fluoro-3-phenoxybenzaldehyde
FPBacid	4-fluoro-3-phenoxybenzoic acid
FPBalc	3-phenoxy-4-fluorobenzyl alcohol
OH-FPBacid	3-(4'-hydroxyphenoxy)-4-fluorobenzoic acid
Me-FPBacid	methyl 4-fluoro-3-phenoxybenzoate
FPBamide	4-fluoro-3-phenoxybenzamide
FPB	1-fluoro-2-phenoxybenzene
COOH-cyfluthrin	α-[[[3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropyl]carbonyl]oxy]-4-fluoro-3-phenoxybenzeneacetic acid

Animal metabolism

Two radiolabelled cyfluthrin preparations separately [^{14}C] labelled at the phenyl-UL-^{14}C- and fluorophenyl-UL positions, were used in the metabolism and environmental studies. The metabolism of laboratory animals was qualitatively the same as for farm animals. The proposed major route of cyfluthrin metabolism in livestock is via hydrolysis of the ester linkage. Hydrolysis gives initially DCVA and the unstable cyanohydrin which rapidly breaks down to the aldehyde (FPBald) and is oxidized to the corresponding acid/or hydroxylated acids (FPBacid, OH-FPBacid). A very minor route was observed in which a small amount of FPBald was converted to its corresponding alcohol, FPBalc.

Lactating cows were orally dosed with [phenyl-UL-^{14}C]-cyfluthrin at 0.5 mg/kg bw for 5 consecutive days. Cyfluthrin was the major identifiable product in milk (98% TRR, 0.039–0.079 mg/kg). The radiocarbon content of tissues, reported in cyfluthrin equivalents, was highest in liver (0.62 mg/kg), kidney (0.19 mg/kg), and fat (0.12–0.23 mg/kg) with low levels (< 0.05 mg/kg) present in other tissues. Cyfluthrin was the main component of the [^{14}C] in liver and kidney (56–86%) and in muscle and fat (93–100%). Hydrolysis products, formed from hydrolysis of the ester and oxidation, were only detected in liver (14% FPBald), kidney (43% FPBalc) and heart (29%, FPBalc).

Laying hens were orally dosed with [phenyl-UL-^{14}C]-cyfluthrin for 3 consecutive days at 5 mg/kg bw/hen/day. Radioactive residues in eggs collected in the 24 hour period prior to slaughter were 0.05 mg/kg cyfluthrin equivalents. Radioactive residues in tissues of birds slaughtered at 2 h after the last dose were highest in kidney (4.7 mg/kg cyfluthrin equivalents) and liver (3.0 mg/kg) with low levels observed in other tissues. Residues of [^{14}C] in fat were 0.1–0.2 mg/kg while those in muscle were 0.2–0.3 mg/kg, both expressed in cyfluthrin equivalents. The major radiolabelled fraction identified in eggs (56%), fat (75%) and muscle (21–39%) was cyfluthrin. Significant metabolites were FPBacid (12% liver, 11% kidney, 15–21% muscle) and OH-FPBacid (10% liver, 12% kidney, 11-20% muscle).

Plant metabolism

The Meeting received information on the fate of [phenyl-UL-^{14}C]cyfluthrin after foliar application to on apple, cotton, potato, soya bean and wheat and of [cyclopropyl-1-^{14}C]cyfluthrin on wheat. Studies were also available on the fate of [fluorophenyl-UL-^{14}C]cyfluthrin on tomatoes and stored wheat grain.

The metabolism of [^{14}C]cyfluthrin was studied in apples. The majority of the [^{14}C] was associated with the fruit surface (rinses and peel) with 4% or less associated with pulp. Cyfluthrin was the major component of the radioactivity detected at 0 to 28 days after application accounting for 91–84% of the [^{14}C] in rinse solutions and peel. Several minor components, principally FPBald and FPBacid, were present at ≤ 2% of the [^{14}C].

Unchanged cyfluthrin accounted for > 90% of the TRR present tomato fruit and leaves from 1 to 35 days after application to both fruit and leaves.

Potato plants were treated in a greenhouse study with [phenyl-UL-^{14}C]cyfluthrin as a foliar treatment. There was limited translocation of [^{14}C] to potato tubers. Residues in leaves sampled at 0–98 days after application mostly comprised unchanged cyfluthrin (70–95%) together with a number of free and conjugated metabolites (FPBald, FPBacid, OH-FPBacid, FPB) each present at < 5%TRR.

Cyfluthrin was also the major component of [^{14}C] residues following application of [phenyl-UL-^{14}C]cyfluthrin to soya bean plants raised in a greenhouse (43–92% TRR at 4–88 days after application). Individual metabolites identified in whole plants, leaves and stalks were present in both free and conjugated forms and were all individually < 10% TRR (FPBald, OH-FPBacid, FPBacid, FPBalc, Me-FPBacid, FPBamide, FPB). There was limited translocation of [^{14}C] to pods. Incubation of [phenyl-UL-^{14}C]cyfluthrin with soya bean tissue cultures produced a similar range of metabolites.

Cotton plants were treated with [phenyl-UL-^{14}C]cyfluthrin as a foliar treatment and exposed to natural sunlight or grown in a greenhouse. Cyfluthrin was the major component of the [^{14}C] accounting for 61–99% of the TRR at 0–63 days after application. All metabolites identified were present at levels ≤10% TRR in free and conjugated forms (FPBald, FPBalc, FPBacid, Me-FPBacid, OH-FPBacid). Little translocation was observed when individual leaves or bolls were treated. Degradation of cyfluthrin was greater for plants exposed to field conditions than those grown in the glasshouse.

The metabolism of [phenyl-UL-^{14}C]cyfluthrin was also studied in wheat. In forage, straw and heads at up to 21 days after application, 51–69% of [^{14}C] residues were identified as cyfluthrin. Minor metabolites were present at ≤ 5% TRR and occurred in both free and conjugated forms (COOH-cyfluthrin, FPBacid, OH-FPBacid). In a study where [cyclopropyl-1-^{14}C]cyfluthrin and [phenyl-UL-^{14}C]cyfluthrin were applied to wheat plants as seven applications with harvest one day after the last application, cyfluthrin was the major component of [^{14}C] in both heads and straw (77–86%). Metabolites were individually < 10% of TRR as would be expected with application of the last spray so close to harvest. Metabolites identified were DCVA, COOH-cyfluthrin, FPBald, FPBacid, FPBalc and OH-FPBacid.

In a study of the degradation of cyfluthrin on stored wheat grain treated with [fluorophenyl-UL-^{14}C]cyfluthrin at 0.3–0.8 mg/kg, the majority of the radioactivity was located on the grain surface and released into rinse solutions. Unchanged cyfluthrin was the major component identified. After 9 months of storage, 79% of the TRR was cyfluthrin with a further 1.9% identified as FPBald and 0.8% as FPBalc.

Metabolism studies in apples, tomato, cotton, potatoes, soya beans and wheat demonstrated that cyfluthrin was slowly degraded and that the degradation pattern was similar in all crops. The major identified products of cyfluthrin metabolism in plants are analogous to those in mammals. The proposed degradation pathway consists of epimerisation, hydrolysis, ester cleavage, reduction, oxidation and hydroxylation. Cyfluthrin is not systemic, with only limited translocation in plants.

Environmental fate in soil

The half-life for degradation of cyfluthrin in soil is estimated to be < 6 months. Degradation occurred via ester hydrolysis followed by oxidation and mineralisation to $[^{14}C]O_2$.

Photodegradation on soil surfaces is fast with half-lives for degradation of cyfluthrin that are < 20 days. During irradiation with artificial or natural sunlight cyfluthrin in soils underwent ester hydrolysis with FPBald, FPBacid and DCVA identified as degradates.

Hydrolysis in water is pH dependent. Cyfluthrin is considered stable at pH 4 and 7 but is rapidly hydrolysed at pH 9 with a half-life of < 2 days. Two degradation products were identified, FPBald and traces of DCVA, presumably formed from cyfluthrin on hydrolysis of the ester. Abiotic hydrolysis is unlikely to contribute significantly to the degradation of cyfluthrin residues in aquatic systems unless the pH is high.

In confined and field rotational crop studies, no significant residues of cyfluthrin (< 0.01 mg/kg) were found in any crop material. It is concluded that succeeding or rotational crops are unlikely to contain significant residues of cyfluthrin.

Analytical methods

Several different analytical methods have been reported for the analysis of cyfluthrin (and isomers) in plant material and animal commodities. The basic approach involves extraction by homogenisation with an organic solvent mixture incorporating varying proportions of polar and non-polar solvents depending upon the nature of the matrix being extracted and its water content. In general, a primary liquid – liquid partition follows extraction to transfer cyfluthrin residues to less polar solvents prior to column clean-up. Residues are finally determined by gas chromatography with electron capture or mass spectra detectors. In a small number of the methods the four pairs of diastereoisomeric enantiomers that make up cyfluthrin were resolved.

The methods for cyfluthrin and beta-cyfluthrin have been extensively validated with numerous recoveries on a wide range of substrates with LOQs typically in the range 0.01 to 0.05 mg/kg.

Stability of pesticide residues in stored analytical samples

Freezer storage stability was tested for a range of representative substrates. Residues of cyfluthrin were generally stable in crops and their processed products.

Cyfluthrin was stable in homogenized samples fortified at 1 mg/kg and stored frozen for at least 1118 days for apple, 1145 days for cantaloupe, 1130 days for corn, 1145 days for corn oil, 1125 days for corn starch, 1145 days for cucumber, 739 days for oranges, 1145 days for orange juice, 739 days for orange pulp, 1145 days for peanut shells, 1126 days for potatoes, 1130 days for potato chips, 1126 days for potato granules, 95 days for potato peel (wet), 1146 days for potato peel (dry), 102 days for rice, 207 days for rice hulls, 1155 for sugar cane stalks, 1125 days for molasses, 1151 days for tomatoes, 1130 days for wheat and for wheat bran, 1118 days for wheat flour and 1126 days for wheat dust. Incurred cyfluthrin residues were stable in bovine muscle, fat, milk and kidney tissues for at least 6 months and liver for at least 1 month. Fortified liver samples were stable on freezer storage for at least 1 year.

Residue definition

The residue following use of cyfluthrin on crops is predominantly cyfluthrin. Methods are available that can measure cyfluthrin however they do not generally resolve the individual diastereoisomers.

The ratio of cyfluthrin to major metabolites differed in the lactating cow metabolism and feeding studies. In the feeding study, cyfluthrin is the major component of the residue in edible animal commodities, tissues, milk and eggs. Major metabolites derived from hydrolysis of the ester are

DCVA and FPBald, FPBacid and FPBalc. None of these metabolites are unique to cyfluthrin. DCVA is a metabolite common to permethrin, cypermethrin and cyfluthrin while metabolites derived from FPBald are common to cyfluthrin and flumethrin. Separate methods are required for measuring the metabolites. The metabolites were not identified in the evaluation of the toxicological data for cyfluthrin and cypermethrin by the 2006 JMPR as being of toxicological concern.

No metabolism studies were available that specifically used beta-cyfluthrin however the data for cyfluthrin can be used to support beta-cyfluthrin. The residue following its use on crops is predominantly cyfluthrin. Methods are available that can measure both cyfluthrin and beta-cyfluthrin however they do not generally resolve the individual diastereoisomers. Epimerisation of beta-cyfluthrin leads to a change in isomer composition.

Based on the actual residue measured, the Meeting recommended that the residue definition for plant and animal commodities for compliance with MRLs and for estimation of dietary intake should be cyfluthrin. The log K_{ow} of cyfluthrin (pH 6) and the animal metabolism and feeding studies suggest that cyfluthrin should be described as fat-soluble. In the lactating cow metabolism study cyfluthrin residues were approximately 10 times greater in fat than muscle.

Definition of the residue (for compliance with MRL and for estimation of dietary intake) for plant and animal commodities: cyfluthrin (sum of isomers).

The residue is fat-soluble.

Results of supervised residue trials on crops

Supervised trials were available for the use of cyfluthrin on numerous crops: apples, pears, Brassica vegetables (broccoli, Brussels sprouts, cabbage, cauliflower and Chinese cabbage), cotton, oranges, grapefruit, lemons, peppers, potatoes, rape, soya beans, sunflower, sweet corn, mangoes and tomatoes. Specific supervised trials based on unvalidated analytical data (from Craven Laboratories) could not be considered further for sweet corn and soy beans.

Supervised trials were also available for the use of beta-cyfluthrin on several crops: mango, cabbage, cotton, soya beans and rape.

Trial data or relevant GAP was not submitted for maize for which there is a current recommendation for a maximum residue level. The Meeting agreed to withdraw its previous maximum residue level recommendation of 0.05 mg/kg for maize.

Citrus (cyfluthrin)

Cyfluthrin is registered in the USA for use on citrus fruits at 28–112 g ai/ha, PHI 0 days with a maximum seasonal application of 112 g ai/ha and no more than 112 g ai/ha to be applied in a seven day period. Trials conducted in the USA that approximated GAP were often conducted such that more than one plot was treated per trial location. Often treatments involved high and low spray volumes and in some cases different formulations (EC and WP). The Meeting decided that for the purposes of estimation of maximum residue levels that only one result per trial location be used. Seven trials from the USA on grapefruit were selected as complying with US GAP. Residues in whole fruit (n=7) were 0.02, 0.02, 0.03, 0.04, 0.04, 0.07 and 0.11 mg/kg. Residues in oranges from US trials conducted according to GAP (n=7) were 0.03, 0.05, 0.05, 0.05, 0.06, 0.06 and 0.2 mg/kg. Residues in lemons from US trials conducted according to GAP (n=5) were 0.08, 0.08, 0.10, 0.10 and 0.11 mg/kg.

The Meeting decided to combine the trials in the various citrus fruit for the purposes of estimating a maximum residue level and STMR. Residues in rank order are: 0.02, 0.02, 0.03, 0.03, 0.04, 0.04, 0.05, 0.05, 0.05, <u>0.06</u>, 0.06, 0.07, 0.08, 0.08, 0.10, 0.10, 0.11, 0.11 and 0.2 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in citrus whole fruit of 0.3, 0.06 and 0.2 mg/kg respectively.

Apples and pears (cyfluthrin)

Data were available from supervised trials on apples in the USA (GAP: 25–49 g ai/ha, PHI 7 days with a maximum seasonal application of 49 g ai/ha and no more than 49 g ai/ha to be applied in a fourteen day period). Residues of cyfluthrin from twelve trials in USA at 49 g ai/ha with a PHI of 7 days were 0.01, 0.01, 0.02, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03, 0.04 and 0.06 mg/kg.

Data were available from supervised trials on pears in the USA (GAP: 25–49 g ai/ha, PHI 7 days with a maximum seasonal application of 49 g ai/ha and no more than 49 g ai/ha to be applied in a fourteen day period). Residues of cyfluthrin from six trials in USA at 49 g ai/ha with a PHI of 7 days were 0.02, 0.02, 0.02, 0.02, 0.04 and 0.05 mg/kg.

The Meeting noted that the use patterns for apple and pears in the USA were the same and that the residues populations for each crop could be used to support the other. Therefore the Meeting decided to combine the data for apples and pears to increase the database for the purposes of estimating a maximum residue level, STMR and HR but to make separate recommendations as a general pome fruit use pattern does not exist in the USA.

Residues in rank order (n=18), median underlined, were: 0.01, 0.01, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02, 0.03, 0.03, 0.03, 0.04, 0.04, 0.05 and 0.06 mg/kg.

The Meeting estimated maximum residue levels, STMR values and HR values for cyfluthrin in apples and pears of 0.1, 0.02 and 0.06 mg/kg respectively. The Meeting agreed to withdraw its previous recommendation of 0.5 mg/kg for apples.

Mangoes - cyfluthrin

Results from three supervised trials on mangoes conducted in the Philippines were made available to the Meeting. One trial was conducted using cyfluthrin and two with beta-cyfluthrin.

One cyfluthrin trial matched GAP for the Philippines (2.5 g ai/hL, PHI 14 days) with residues of 0.02 mg/kg in whole fruit. The Meeting considered a single trial insufficient to estimate a maximum residue level for cyfluthrin in mangoes.

Mangoes (beta-cyfluthrin)

Results from two supervised trials on mangoes conducted in the Philippines were made available to the Meeting. One beta-cyfluthrin residue trial matched GAP of the Philippines (10 g ai/hL, PHI 28 days) with residues in fruit of < 0.01 mg/kg. The Meeting considered one trial insufficient to estimate a maximum residue level.

Brassica vegetables (cyfluthrin)

Cyfluthrin is registered in the USA for use on Brassica vegetables at 15–56 g ai/ha, PHI of 0 days and a maximum application per season of 224 g ai/ha and a maximum of 56 g ai/ha in a 7 day period.

Trials were available from USA of Brussels sprouts approximating GAP with residues of 0.39 and 0.44 mg/kg. The Meeting considered two trials are not sufficient to recommend a maximum residue level.

Thirteen trials approximating GAP were available for broccoli: 0.04, 0.05, 0.19, 0.19, 0.19, 0.19, 0.20, 0.26, 0.28, 0.29, 0.30, 0.46 and 1.5 mg/kg. The Meeting estimated a maximum residue level of 2 mg/kg, STMP of 0.20 mg/kg and an HR of 1.5 mg/kg for residues of cyfluthrin in broccoli.

Six trials on cauliflower that matched GAP of the USA were: < 0.01, 0.11, 0.17, 0.31, 0.32 and 0.91 mg/kg. The Meeting estimated a maximum residue level of 2 mg/kg, STMR of 0.24 mg/kg and HR of 0.91 mg/kg for cauliflower.

In eighteen trials on cabbage from the USA that matched GAP residues were: 0.01, 0.03, 0.03, 0.06, 0.07, 0.10, 0.10, 0.18, 0.24, 0.25, 0.33, 0.42, 0.58, 0.62, 1.0, 1.2, 1.3 and 2.1 mg/kg for cabbage. The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in cabbages of 4, 0.25 and 2.1 mg/kg respectively.

Cabbage (beta-cyfluthrin)

Results from four supervised trials on cabbage conducted in Germany (no GAP) were made available to the Meeting. The Meeting decided to evaluate the German trials against the GAP of Sweden (10 g ai/ha, PHI 7 days). Four trials matched the GAP of Sweden with beta-cyfluthrin residues of < 0.01, < 0.01, 0.06 and 0.08 mg/kg.

Tomatoes (cyfluthrin)

Trials on tomatoes were reported from the USA (GAP: 28–49 g ai/ha, PHI of 0 days and a maximum application per season of 295 g ai/ha and a maximum of 49 g ai/ha in a 7 day period). All trials were for field grown tomatoes with no data for tomatoes grown under protective cover.

Cyfluthrin residues in eleven trials from the USA matching GAP in rank order were (median underlined): < 0.01, 0.01, 0.02, 0.06, 0.07, 0.07, 0.07, 0.08, 0.08, 0.09 and 0.10 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in tomatoes of 0.2, 0.07 and 0.10 mg/kg respectively. The recommendation replaces the previous recommendation of 0.5 mg/kg for tomatoes.

Peppers (cyfluthrin)

Trials on peppers were reported from the USA (GAP: 28–49 g ai/ha, PHI of 7 days and a maximum application per season of 295 g ai/ha and a maximum of 49 g ai/ha in a 7 day period). All trials were for field grown peppers (including chilli) with no data for peppers grown under protective cover.

The Meeting agreed to combine the three trials on chilli peppers (0.06, 0.08, 0.08 mg/kg) with the six trials on sweet peppers (0.01, 0.01, 0.05, 0.06, 0.12 and 0.12 mg/kg) matching GAP in the USA. Residues matching GAP in rank order were (median underlined): 0.01, 0.01, 0.05, 0.06, 0.06, 0.08, 0.08, 0.12 and 0.12 mg/kg.

The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in peppers of 0.2, 0.06 and 0.12 mg/kg respectively. The recommendation for peppers replaces the previous recommendation of 0.2 mg/kg for peppers sweet.

Egg plant (cyfluthrin)

The Meeting noted that the registered use of cyfluthrin in the USA also includes egg plant (GAP: 28–49 g ai/ha, PHI of 7 days and a maximum application per season of 295 g ai/ha and a maximum of 49 g ai/ha in a 7 day period). The meeting considered the results from the trials conducted on peppers and tomatoes that comply with GAP for egg plants could be extrapolated to egg plants for the purposes of estimating maximum residue, STMR and HR levels. Residues on tomatoes that matched GAP for egg plants were < 0.01, 0.01, 0.02, 0.02, 0.03, 0.03, 0.04, 0.04, 0.04, 0.05, 0.05, 0.05, 0.05, 0.05, 0.06, 0.08 and 0.09 mg/kg. Residues on peppers that matched GAP for egg plants were 0.01, 0.01, 0.05, 0.06, 0.06, 0.08, 0.08, 0.12 and 0.12 mg/kg. The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in egg plant of 0.2, 0.05 and 0.12 mg/kg respectively.

Sweet corn (cyfluthrin)

Trials on sweet corn were reported from the USA (GAP: 15–49 g ai/ha, PHI of 0 days and a maximum application per season of 493 g ai/ha and a maximum of 49 g ai/ha in a 2 day period).

Cyfluthrin residues in three trials from the USA matching GAP in rank order were (median underlined): < 0.01 (2) and 0.01 mg/kg.

The Meeting considered three trials insufficient to estimate a maximum residue level for cyfluthrin in sweet corn.

Potatoes (cyfluthrin)

Trials on potatoes were reported from Canada (no GAP) and the USA (GAP: 15–49 g ai/ha, PHI of 0 days and a maximum application per season of 295 g ai/ha and a maximum of 49 g ai/ha in a 7 day period).

Cyfluthrin residues in seventeen trials from the USA matching GAP in rank order were (median underlined): < 0.01 (17) mg/kg. Residues were not detected in residue trials and metabolism results on plants including potatoes confirm that cyfluthrin is not translocated by plants. The Meeting considered detectable residues in potato tubers to be unlikely.

The Meeting estimated a maximum residue level, an STMR value and an HR value for cyfluthrin in potatoes of 0.01*, 0 and 0 mg/kg respectively.

Soya beans (cyfluthrin)

Trials on soya beans were reported from the USA (GAP: 15–49 g ai/ha, PHI of 45 days and a maximum application per season of 196 g ai/ha and a maximum of 49 g ai/ha in a 7 day period).

Cyfluthrin residues in five trials from the USA matching GAP in rank order were (median underlined): < 0.01 (5) mg/kg. In addition, residues ranging from < 0.01 to 0.02 mg/kg were reported in unvalidated trials.

The Meeting considered five trials insufficient to estimate a maximum residue level for cyfluthrin in soya beans (dry).

Soya beans (beta-cyfluthrin)

Four trials on soya beans employing beta-cyfluthrin were reported from Brazil (12.5 g ai/ha, PHI 21 days) that complied with GAP for Brazil. Residues were < 0.01 and < 0.05 (3) mg/kg. The Meeting considered four trials on soya beans insufficient to estimate a maximum residue level for residues arising from the use of beta-cyfluthrin in soya beans.

Cotton seed (cyfluthrin)

Trials on cotton were reported from the USA (GAP: 15–49 g ai/ha, PHI of 0 days and a maximum application per season of 560 g ai/ha and a maximum of 56 g ai/ha in a 3 day period).

Cyfluthrin residues in seven trials from the USA matching GAP in rank order were (median underlined): < 0.01, 0.02, 0.03, < 0.1, < 0.1, 0.1 and 0.52 mg/kg.

The Meeting estimated a maximum residue level and an STMR value for cyfluthrin in cotton seed of 0.7 and 0.1 mg/kg respectively. The recommendation for cotton seed replaces the previous recommendation of 0.05 mg/kg.

Cotton seed (beta-cyfluthrin)

Beta-cyfluthrin trials on cotton were reported from the USA (GAP: 7–28 g ai/ha, PHI of 0 days and a maximum application per season of 280 g ai/ha and a maximum of 28 g ai/ha in a 3 day period). Beta-cyfluthrin residues in three trials from the USA matching GAP in rank order were: < 0.1, < 0.1 and 0.38 mg/kg.

Rape seed (cyfluthrin)

Cyfluthrin trials on rape were reported from Germany (no GAP). The Meeting decided to assess the German trials against the GAP of Belgium (15 g ai/ha, application according to growth stage, maximum 2 applications per crop, one spray from seed to 3 leaf BBCH 10–13, one at bud development BBCH 50–59 and one at pod development BBCH 70-75). Seven trials matched GAP of Belgium with residues of < 0.05 (6) and 0.05 mg/kg.

The Meeting estimated a maximum residue level and an STMR value for cyfluthrin in rape seed of 0.07, 0.05 and < 0.05 mg/kg respectively. The recommendation for rape seed replaces the previous recommendation of 0.05 mg/kg.

Rape seed (beta-cyfluthrin)

Trials conducted on rape using beta-cyfluthrin trials were reported from the Germany (GAP: 5.2–7.7 g ai/ha, 0.2-0.3 g ai/hL, PHI of 56 days). Beta-cyfluthrin residues in nine trials from the Germany matching GAP in rank order were (median underlined): < 0.01, < 0.01, 0.01, < 0.02 (4), < 0.05, and < 0.05 mg/kg.

Sunflower seed (cyfluthrin)

Trials on sunflower were reported from Canada (no GAP) and the USA (GAP: 15–49 g ai/ha, PHI of 30 days and a maximum application per season of 147 g ai/ha and a maximum of 49 g ai/ha in a 7 day period).

Cyfluthrin residues in five trials from Canada and the USA matching GAP of the USA in rank order were (median underlined): < 0.01 (3) and 0.01 (2) mg/kg.

The Meeting considered five trials insufficient to estimate a maximum residue level for cyfluthrin in sunflower seed.

Animal feedstuffs

Sweet corn forage (cyfluthrin)

Field trials on sweet corn were made available to the Meeting from the USA (GAP: 15–49 g ai/ha, PHI of 0 days and a maximum application per season of 493 g ai/ha and a maximum of 49 g ai/ha in a 2 day period).

Residues on sweet corn forage were 3.7, 3.7 and 7.7 mg/kg (fresh weight basis).

Residues on sweet corn cannery waste were 0.20, 0.43 and 0.90 mg/kg (fresh weight basis).

The Meeting considered three trials insufficient to estimate median and high residues for sweet corn livestock feeds.

Cotton gin-trash (cyfluthrin)

Cyfluthrin field trials on cotton were made available to the Meeting from the USA (GAP: 15–49 g ai/ha, PHI of 0 days and a maximum application per season of 560 g ai/ha and a maximum of 56 g ai/ha in a 3 day period; Do not graze treated fields).

Cyfluthrin residues on cotton gin-trash were 2.4, 2.8 and 9.2 mg/kg (fresh weight basis). The Meeting considered three trials insufficient to estimate median residues for cotton gin-trash as a livestock feed.

Cotton gin-trash (beta-cyfluthrin)

Beta-cyfluthrin field trials on cotton were made available to the Meeting from the USA (GAP: 7–28 g ai/ha, PHI of 0 days and a maximum application per season of 280 g ai/ha and a maximum of 28 g ai/ha in a 3 day period; Do not graze treated fields).

Beta-cyfluthrin residues on cotton gin-trash were 2.3, 2.6, 2.9 mg/kg (fresh weight basis). The Meeting considered three trials insufficient to estimate median residues for cotton gin-trash as a livestock feed.

Rape forage and straw (cyfluthrin)

Field trials on rape seed were made available to the Meeting from the Germany (GAP: 15 g ai/ha, application according to growth stage, maximum 2 applications per crop, one spray from seed to 3 leaf BBCH 10–13, one at bud development BBCH 50-59 and one at pod development BBCH 70–75).

Residues on rape straw were < 0.02, < 0.02, < 0.02, < 0.02, < 0.02 and 0.06 mg/kg. The Meeting estimated an STMR and a high residue value for cyfluthrin in rape straw of < 0.02 and 0.06 mg/kg, respectively, both on an as received basis.

As the registered use pattern for rape in Germany does not restrict grazing, the Meeting assumed that according to GAP in Germany rape could be grazed at the earliest time after application. Residues on rape forage were 0.13, 0.15, 0.18, 0.20, 0.21, 0.27, 0.32 and 0.34 mg/kg (fresh weight basis). The Meeting estimated an STMR and a high residue value for cyfluthrin in forage of 0.205 and 0.34 mg/kg, respectively, both on a fresh weight basis.

Rape fodder (beta-cyfluthrin)

For beta-cyfluthrin trials on rape were reported from Germany (GAP: 5.2–7.7 g ai/ha, 0.2–0.3 g ai/hL, PHI of 56 days). Beta-cyfluthrin residues from rape straw in seven trials from Germany matching GAP in rank order were (median underlined): < 0.05, < 0.05, < 0.05, 0.02, 0.06, 0.07, 0.08 mg/kg (fresh weight basis). As the directions for use in Germany do not provide specific guidance for livestock feeding it is assumed forage rape can be grazed without restriction anytime after application. Residues in rape forage at 0 days after application were: < 0.05, 0.08, 0.16, 0.17, 0.19, 0.24, 0.26, 0.27 and 0.33 mg/kg. The Meeting estimated an STMR and a high residue value for cyfluthrin in rape forage of 0.19 and 0.33 mg/kg, respectively, both on a fresh weight basis.

Soya bean forage and vines (cyfluthrin)

Field trials on soya beans were made available to the Meeting from the USA (GAP: 15–49 g ai/ha, PHI of 45 days and a maximum application per season of 196 g ai/ha and a maximum of 49 g ai/ha in a 7 day period; dry vines and green forage may be fed 45 and 15 days, respectively after last application).

Residues on soya bean forage were 0.10, 0.26, 0.33, 0.34, 0.38, 0.45, 0.96 and 3.3 mg/kg (fresh weight basis). The Meeting estimated an STMR and a high residue value for cyfluthrin in soya bean forage of 0.36 and 3.3 mg/kg, respectively, both on a fresh weight basis.

Residues on soya bean dry vines were 0.01, 0.09, 0.21, 0.31 and 2.66 mg/kg (fresh weight basis). The Meeting considered five trials insufficient to estimate median and high residues for soya vines that may be used as livestock feed.

Sunflower fodder (cyfluthrin)

Trials on sunflowers were reported from Canada (no GAP) and the USA (GAP: 15–49 g ai/ha, PHI of 30 days and a maximum application per season of 147 g ai/ha and a maximum of 49 g ai/ha in a 7 day period; pre-grazing or foraging interval, 30 days).

Cyfluthrin residues in sunflower fodder in five trials from Canada and the USA matching GAP of the USA were 0.04, 0.13, 0.30, 0.33 and 0.63 mg/kg (fresh weight basis). The Meeting estimated an STMR and a high residue value for cyfluthrin in sunflower fodder of 0.30 and 0.63 mg/kg, respectively, both on a fresh weight basis.

Fate of residues during processing

The fate of cyfluthrin residues has been examined in potato, cabbage, tomato, citrus fruit, apples and oil seed crops processing studies. Processing of tomatoes into pulp and paste showed a slight increase of cyfluthrin residues in the processed commodities compared to the RAC. Whilst there was a decrease in residues found in the corresponding juice, ketchup and purée. Citrus and apples also both showed a decrease in residues found in the juice, but a slight increase in pomace and/or oil and molasses. There was a concentration into the oil of cottonseed and sunflower. Processing studies on potatoes, cabbages, soya bean and rape seed did not show any indication regarding the fate of beta-cyfluthrin/cyfluthrin residues during processing as residues in the RAC or processed products were all below the LOQ. Estimated processing factors, HRs and STMRs are summarized below.

Summary of processing factors for cyfluthrin residues.

Raw agricultural commodity (RAC)	Processed commodity	Calculated processing factors	PF (Mean, median or best estimate)	RAC-STMR	RAC-STMR×PF
Orange	Pulp dry	5.3	5.3	0.06	0.318
Apple	Pomace, dry	0.11, 16	16	0.02	0.32
Cotton	Hulls	1.9	1.9	0.1	0.19
Cotton	Meal	0.08	0.08		0.008
Cotton	Oil, crude	1.9	1.9		0.19
Cotton	Oil, refined	1.2	1.2		0.12

The Meeting decided to make maximum residue level recommendations for citrus pulp (dry) and cotton seed hulls. Based on an estimated high residue value of 1.06 mg/kg (5.3 × 0.2 mg/kg) for citrus pulp (dry), the meeting recommended a maximum residue level of 2 mg/kg for citrus pulp (dry). The Meeting also recommended a maximum residue level of 1 mg/kg for cotton seed oil, crude based on an estimated high residue of 0.988 mg/kg (1.9 × 0.22 mg/kg).

The Meeting also decided to use the default generic processing factor of 7 to estimate a maximum residue level for chilli pepper (dry) of 1 mg/kg based on an HR-P of 0.84 mg/kg (7 × 0.12) and STMR-P of 0.42 mg/kg (7 × 0.06).

Residues in animal commodities

Farm animal dietary burden

The Meeting estimated the dietary burden of cyfluthrin in farm animals on the basis of the diets listed in Annex 6 of the 2006 JMPR Report (OECD Feedstuffs Derived from Field Crops). Calculation from highest residue, STMR (some bulk commodities) and STMR-P values provides the levels in feed suitable for estimating MRLs, while calculation from STMR and STMR-P values for feed is suitable for estimating STMR values for animal commodities. The percentage dry matter is taken as 100% when the highest residue levels and STMRs are already expressed as dry weight.

Estimated maximum and mean dietary burdens of farm animals

Dietary burden calculations for beef cattle, dairy cattle, broilers and laying poultry are provided in Annex 6. The calculations were made according to the animal diets from US-Canada, EU and Australia in the OECD Table (Annex 6 of the 2006 JMPR Report).

	Animal dietary burden, cyfluthrin, ppm of dry matter diet					
	US-Canada		EU		Australia	
	max	mean	max	mean	max	mean
Beef cattle	1.87	0.31	3.00	0.49	5.89 [1]	0.68 [3]
Dairy cattle	1.84	0.26	3.00 [2]	0.49 [4]	2.47	0.36
Poultry - broiler	0.009	0.009	0.0152	0.015	0.003	0.003
Poultry - layer	0.009	0.009	1.3 [5]	0.16 [6]	0.003	0.003

[1] Highest maximum beef or dairy cattle dietary burden suitable for MRL estimates for mammalian meat

[2].Highest maximum dairy cattle dietary burden suitable for MRL estimates for mammalian milk

[3]Highest mean beef or dairy cattle dietary burden suitable for STMR estimates for mammalian meat.

[4] Highest mean dairy cattle dietary burden suitable for STMR estimates for milk.

[5]Highest maximum poultry dietary burden suitable for MRL estimates for poultry meat and eggs.

[6]Highest mean poultry dietary burden suitable for STMR estimates for poultry meat and eggs.

The cyfluthrin dietary burdens for animal commodity MRL and STMR estimation (residue levels in animal feeds expressed on dry weight) are: beef cattle 5.89 and 0.68 ppm, dairy cattle 3.06 and 0.50 ppm and poultry 1.3 and 0.16 ppm.

Farm animal feeding studies

The Meeting received information on the residue levels arising in animal tissues and milk when dairy cows were dosed with cyfluthrin for 28 days at the equivalent of 4.5, 13 and 40 ppm in the diet. Average residues in milk of the 40 ppm dose group were 0.22 mg/kg at day 14 and 0.14 mg/kg at day 28. Cyfluthrin residues in the fat were higher than in other tissues. Transfer factors (average residue level in tissue ÷ residue level in feed) for each tissue and milk for the three dosing levels (3 animals per dose group) were: fat, 0.056, 0.054, 0.066; muscle, < 0.002, < 0.001, 0.00075; kidney, 0.0042; liver, 0.0032; milk 28 days, 0.0037, 0.0036, 0.0036.

In an additional dosing study conducted at levels equivalent to 11, 36 and 112 ppm in the diet average residues in milk at day 28 were 0.45 mg/kg for the 112 ppm dose group. As for the previous study, residues were highest in fat with only low levels of cyfluthrin detected in other tissues. Transfer factors for each tissue and milk for the three dosing levels (3 animals per dose group) were: fat, 0.11, 0.074, 0.061; muscle, < 0.0009, 0.001, 0.00063; kidney, < 0.0009, < 0.0008, 0.00045; liver, < 0.0036, < 0.00028, 0.00018; milk 28 days, 0.0055, 0.0033, 0.0041.

The Meeting also received information on the residue levels arising in tissues and eggs when laying hens were dosed with cyfluthrin for 28 days at the equivalent of 6 and 20 ppm in the diet. Residues in eggs were below the LOQ for both feed levels. At the 2 ppm feeding level the residues in tissues were below the LOQ of the analytical methods. For the 20 ppm feed level, residues in fat were substantially higher than residues in other tissues 0.05 mg/kg compared to < 0.01-0.01 mg/kg. Transfer factors based on residues for fat were 0.0025 for the 20 ppm feed levels. Transfer factors (mean residue) for muscle and liver were < 0.0005 and < 0.0005 respectively for the 20 ppm feeding level while that for skin was 0.0005.

Farm animal direct treatment

No studies were received on the residues of cyfluthrin arising from direct animal treatment. The Meeting noted that JECFA has evaluated cyfluthrin residues arising from direct animal treatment at its 48th Meeting in 1997 and recommended maximum residue limits for cattle of 20 µg/kg for muscle, liver and kidney, 40 µg/kg for milk and 200 µg/kg for fat. The marker residue that applied to the residue limits was cyfluthrin.

Animal commodity maximum residue levels

The maximum dietary burden for beef and dairy cattle is 5.89 and 3.06 ppm respectively, so the levels of residues in tissues can be obtained by interpolation between the high residues obtained in tissues and at the 4.5 and 13 ppm feeding levels for milk, muscle and fat and from the 40 ppm feed level for kidney and liver as these are the only kidney and liver samples subjected to strong extraction required to release the majority of cyfluthrin residues. Maximum residues expected in tissues are: fat 0.37 mg/kg, muscle < 0.01 mg/kg, liver 0.021 mg/kg, kidney 0.027 mg/kg and the mean residue for milk 0.0136 mg/kg. No data was available on the partitioning of residues in milk between aqueous and fat phases of milk.

The Meeting estimated maximum residue levels for meat (from mammals other than marine mammals) 1 mg/kg (fat); kidney of cattle, goats, pigs and sheep 0.05 mg/kg; liver of cattle, goats, pigs and sheep 0.05 mg/kg and milks 0.04 mg/kg. The recommendation of 0.04 mg/kg milk replaces the previous recommendation of ML 0812 Cattle milk 0.01 F mg/kg, which also incorporated direct animal treatment. The Meeting noted the recommendation for cattle milk arising from exposure to cyfluthrin through the cattle diet is the same as proposed by JECFA for direct animal treatment.

The STMR dietary burdens for beef and dairy cattle are 0.68 and 0.50 ppm respectively. Transfer factors from the average residues from the 4.5 ppm feeding level were used to estimate STMR values as for cyfluthrin. The estimated STMRs are: meat (from mammals other than marine mammals) < 0.01 mg/kg, fat (from mammals other than marine mammals) 0.0378 mg/kg, kidney of cattle, goats, pigs and sheep < 0.01 mg/kg, liver of cattle, goats, pigs and sheep < 0.01 mg/kg and milks 0.0027 mg/kg.

The highest individual tissue residue from the relevant feeding group was used in conjunction with the highest residue dietary burden to calculate the likely highest animal commodity residue level. As only a single animal is available per feeding group, the tissue residues from the animals in the relevant feeding groups were used in conjunction with the STMR dietary burden to estimate the animal commodity STMR values. For milk, the mean milk residue at the plateau level from the relevant feeding group was used to estimate both the maximum residue level and the STMR.

Dietary burden (mg/kg)[1] Feeding level [ppm][2]		Cyfluthrin residues, mg/kg[3]								
		Milk	Fat		Muscle		Liver		Kidney	
		Mean	High	mean	High	mean	high	mean	High	mean
MRL beef	(5.89) [4.5] high		*(0.37)* 0.30		*(< 0.01)* < 0.01		*(0.021)* 0.14[4]		*(0.027)* 0.18[4]	
MRL dairy	(3.06) [4.5] av	*(0.0136)* 0.02								
STMR beef	(0.68) [4.5] av		*(0.0378)* 0.25		*(< 0.01)* < 0.01		*(< 0.01)* < 0.01		*(< 0.01)* < 0.01	
STMR dairy	(0.50) [4.5] av	*(0.0022)* 0.02								

[1] Values in parentheses are the estimated dietary burdens

[2] Values in square brackets are the actual feeding levels in the transfer study

[3] Residue values in parentheses in italics are interpolated from the dietary burden, feeding levels in the transfer study and the residues found in the transfer study. High is the highest individual animal tissue residue in the relevant feeding group. Mean is mean animal tissue (or milk) residue in the relevant feeding group.

[4]Residue values for kidney and liver were obtained from the dosing level equivalent to 40 ppm in the feed as only these samples were subject to reanalysis using a stronger extraction process

The maximum dietary burden for poultry is 1.3 ppm. No residues above the LOQ of the analytical method used were observed in the feeding study for laying hens at the lowest dose level equivalent to 2 ppm in the diet. Maximum residues expected are: muscle, fat, liver, kidney and eggs are all < 0.01 mg/kg.

The Meeting estimated maximum residue levels for poultry meat 0.01(*) mg/kg (fat); poultry offal 0.01(*) and eggs 0.01 (*) mg/kg.

As no residues are observed at the maximum feeding level for poultry, the STMRs for poultry meat, edible offal and eggs are the same as the maximum residue levels.

DIETARY RISK ASSESSMENT

Long-term intake

The evaluation of cyfluthrin has resulted in recommendations for MRLs and STMRs for raw and processed commodities. Consumption data were available for 22 food commodities and were used in the dietary intake calculation. The results are shown in Annex 3.

The International Estimated Daily Intakes for the 13 GEMS/Food regional diets, based on estimated STMRs were in the range 0–2% of the maximum ADI of 0.04 mg/kg bw (Annex 3). The Meeting concluded that the long-term intake of residues of cyfluthrin from uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The international estimated short-term intake (IESTI) for cyfluthrin was calculated for the food commodities (and their processing fractions) for which maximum residue levels and HRs were estimated and for which consumption data were available. The results are shown in Annex 4.

For the general population the IESTI varied from 0–120% of the ARfD (0.04 mg/kg bw) while for children the IESTI varied from 0–240% of the ARfD. The IESTI (as a% of the ARfD) for broccoli for children was 120% and 70% for the general population, 240% for head cabbage for children and 100% for the general population.

The Meeting concluded that the short-term intake of residues of cyfluthrin resulting from uses that have been considered by the JMPR, except the uses on broccoli and head cabbage, is unlikely to present a public health concern.

The Meeting noted that no residue data relating to alternative GAP were submitted for broccoli and head cabbage. The information provided to the JMPR precludes an estimate that the dietary intake would be below the ARfD for consumption for broccoli and head cabbage by children.

5.8 LAMBDA-CYHALOTHRIN (146)

TOXICOLOGY

Lambda-cyhalothrin, the ISO approved common name for (*R*)-cyano(3-phenoxyphenyl)methyl (1*S*,3*S*)-rel-3-[(1*Z*)-2-chloro-3,3,3-trifluoro-1-propenyl]-2,2-dimethylcyclopropanecarboxylate is a synthetic cyano-containing type II pyrethroid insecticide (CAS No. 91465-08-6).

Cyhalothrin (CAS No. 68085-85-8) was evaluated by JMPR in 1984, when an ADI of 0–0.02 mg/kg bw was established based on a NOAEL of 20 ppm, equal to 2 mg/kg bw per day, identified on the basis of clinical signs in a 2-year study in mice; a NOAEL of 30 ppm, equal to