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GUIDANCE DOCUMENT ON RESIDUES IN LIVESTOCK

Series on Pesticides
No. 73

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OECD Environment, Health and Safety Publications

Series on Pesticides

No. 73

GUIDANCE DOCUMENT ON RESIDUES IN LIVESTOCK

IOMC

INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

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FOREWORD

This Guidance Document has been developed by the Residue Chemistry Expert Group of the OECD Working Group on Pesticides.

Residues in livestock studies are conducted to quantify levels of residues in meat, milk, eggs and edible meat by-products following the use of a pesticide product. Situations to which such studies may apply include application of a pesticide to raw agricultural commodities (RACs) and feeding by livestock, pesticides that may be directly applied to livestock, and pesticides that are used in livestock premises. The *OECD Guideline for the Testing of Chemicals on Residues in Livestock* (TG 505, published in January 2007) provides the basis for establishing maximum residue limits (MRLs) and for conducting dietary intake assessments for consumer safety in OECD countries. This *Guidance Document on Residues in Livestock* expands upon the guidance on residues in livestock and updates the OECD Table of Feedstuffs Derived from Field Crops found in the *Guidance Document on Overview of Residue Chemistry Studies* (Series on Testing and Assessment no. 64 and Series on Pesticides No. 32). Specifically, it describes current differences in OECD countries in livestock feeding practices and diet composition and factors influencing the determination of dietary burden and dose selection, and provides guidance for interpreting results (including example calculations for dietary burdens and MRL setting) from OECD TG 505 studies.

After a final round of comments in October and November 2012 among the Working Group on Pesticides (WGP), this document was approved by the WGP by written procedure.

This document is being published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology, which has agreed that it be declassified and made available to the public.

TABLE OF CONTENTS

Introduction

1. This document provides some detailed guidance on livestock residue studies conducted according to OECD Test Guideline (TG) 505 on Residues in Livestock (1). Studies of residues in livestock are used to determine the quantity of pesticide residues in products of animal origin which will result from residues in feedstuffs (including fodder crops) or from direct application to livestock and/or premise treatment. The data obtained provide quantitative information on the transfer of residues to meat, fat, milk, eggs and edible offal. It is then possible to establish maximum residue levels for food commodities of animal origin, and to ensure that these residues do not pose unacceptable risks for consumers.

2. Feeding studies are conducted using ruminants (cattle) and poultry (chicken). Some countries may also request fish feeding studies. Where the results of a rat metabolism study indicate routes of degradation with intermediates or end-products that differ from those of the ruminant metabolism study, and these end-products are considered to be of toxicological concern, a swine feeding study may need to be conducted, unless the expected intake by swine is not significant. Background information on livestock diets and feed tables are given in Annex I, examples on how to calculate dose levels used in the study are given in Annex II, and several examples for data interpretation of study results are given in Annex III.

Livestock Feeding

International differences in feeding practices & diet composition

3. Livestock can be fed with a large variety of agricultural commodities and by-products. These feedstuffs must be combined in the proper proportions to allow adequate growth and maintenance of animals. In the early life stages, the diet is adjusted to promote a healthy, steady growth of the animal. As the animal grows, its nutrient requirements change. For example, diets are adjusted when the animal approaches the finished stage for beef cattle or the maintenance stage for milk producing cows, and the food commodities of animal origin are ready to enter the consumer market.

4. The selection of the appropriate dose levels to use in livestock feeding studies is based on detailed considerations with respect to the type of feedstuffs available for livestock, quantities being fed, and which feedstuff components might be used as alternatives and are interchangeable. The animals in the study are usually in the egg or milk producing stage or are close to slaughter (e.g., last 100 days for beef cattle).

5. Livestock rearing is linked to regional practices and seasonal availability of feedstuffs. Important drivers for the selection of feedstuffs are price, local availability, and, especially for more traditional farming, whether feedstuffs can be produced on the farm where the animals are raised.

6. Some facilities either do not produce feed at all or produce only selected feedstuffs that are supplemented by commercially available compound feed.

7. For the purpose of this guidance document, non-intensive livestock production systems are defined as pasture and crop-based grazing. Intensive livestock production systems include lot feeding arrangements.

8. In some countries, extensive production systems for beef, dairy cattle, sheep, and goats based particularly on grazing natural or improved pastures and fodder crops are modified to more intensive production aspects during the finishing phase. Grazing livestock may be supplemented with grains, conserved fodders (hay or silage), by-products or compounded feeds to enhance growth rates, body composition or milk production.

Determination of Dietary Burden

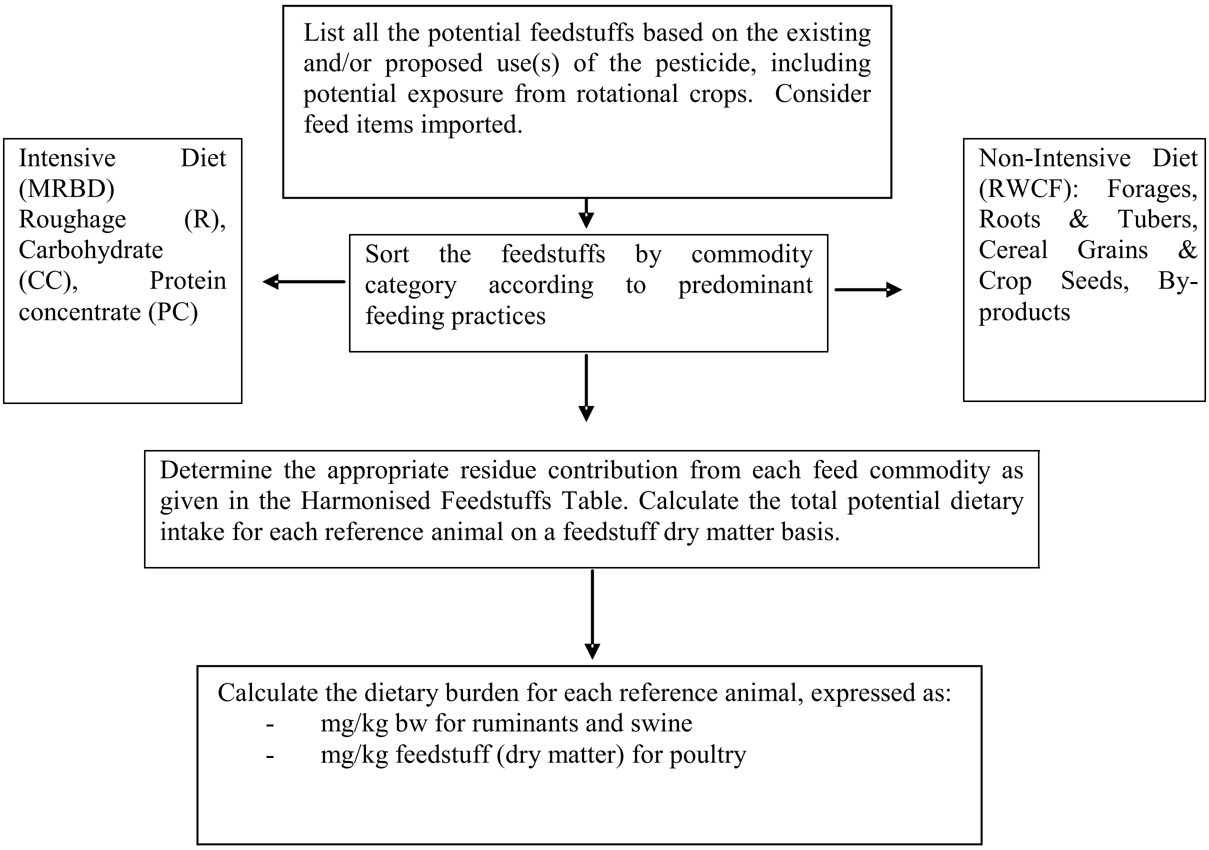
9. The harmonised format for the OECD Table of Feedstuffs Derived from Field Crops (Annex I) has individual feed commodities classified into specific feedstuff categories. The format provides separate columns for each country or region and includes data on cattle, swine, poultry, and sheep. The information provided with respect to the % of diet for each feedstuff is based on national agricultural practices, typical body weight of the finished animal, and daily feed consumption parameters. The calculation is done on the basis of uses for which a national (regional) maximum residue limit (MRL) or use will be applied plus consideration of import MRLs (tolerances) or imported treated feedstuffs for that nation (region).

10. Globally dietary burdens may vary significantly. To account for this variability at the international level, feed items can be grouped according to their nutritional relevance. Using this type of approach, comparable dietary burden calculations may be conducted. For example, in North American cattle, the protein component of animal feeds are mainly based on soybean, corn and cereals; in the European Union feeds are based on canola, corn and cereals; while in Australia feeds are based on sorghum, wheat and oilseed meals.

11. Based on the predominant livestock feeding practices in a given region, different approaches have been developed for the calculation of the anticipated dietary burden in livestock. In regions where non-intensive (e.g. grazing) livestock production systems predominate, anticipated dietary burdens are calculated based on a "reasonable worst case diet/feed" approach (RWCF). In regions where intensive feeding practices predominate, the anticipated dietary burden is calculated based on a "maximum reasonably balanced diet (MRBD)" approach. The approach uses fixed percentages of roughage, carbohydrate concentrate, and protein concentrate of various livestock types (See Table 8 of Annex II). The MRBD approach is used for the North America region (US/CAN). Intensive rearing practices do exist in other regions as well; however a substantial percentage of livestock is reared with less intensive to non-intensive diets. Therefore for European OECD member countries, Japan, and Australia the dietary burden is calculated according to the 'reasonably worst case diet/feed' (RWCF) approach. In case of doubt which diet applies in your country contact an expert in your competent authority.

12. The following steps are taken in the calculation of the dietary burden (see Figure 1).

Figure 1. Calculation of Dietary Burdens from Different Regions.



13. For the determination of the dietary burden in each region, the feedstuff or feedstuffs leading to the highest dietary burden for each category (on a dry weight basis) are allocated a percentage of each reference animal's diet in accordance with the complete dietary composition until 100% of the diet is achieved. Please note that the MRBD approach uses fixed percentages for each of its categories (roughage, carbohydrate concentrate, protein concentrate) and that several crops can be used per crop category, whereas in the RWCF approach only one crop is selected per crop category (forages/fodders, roots and tubers, cereal grains/crops seeds, by-products), but in both cases not necessarily the crop(s) with the highest residue is/are selected but those leading to the highest dietary burden per crop category. For the RWCF approach, in deriving the highest dietary burden per crop category, it is necessary to consider the residue contribution on a percentage-of-diet basis. For example within one category crop A may contribute 0.1 mg/kg based on 20% of diet, whereas crop B may contribute 0.05 mg/kg based on 5% of diet. If the overall diet exceeds 100% and needs to be reduced to 100%, then crop B may be the more appropriate entry rather than crop A for that category. Note also that for the RWCF approach, maximizing the diet in each category must be balanced against maximizing the diet in the remaining categories such that the overall diet is maximized. The calculation is performed for all available diets (see Annex I). Calculation examples are given in Annex II.

Dose Selection

14. Dose selection for feeding studies using both approaches to determine dietary burdens (intensive and non-intensive) will ensure that a single study may be performed to account for all potential dietary burdens in support of a global registration request in all OECD countries.

15. Dose levels used in the feeding study should cover the lowest and highest dietary burdens identified across all relevant regions.

16. The dose level can be expressed in mg/kg feedstuff, which is the most pragmatic approach for poultry studies. For large livestock animals (ruminants, pigs) it is more accurate to express the dose level in mg/kg bodyweight assuming that relevant bodyweight changes during the study are unlikely. Note that livestock bodyweights differ among regions.

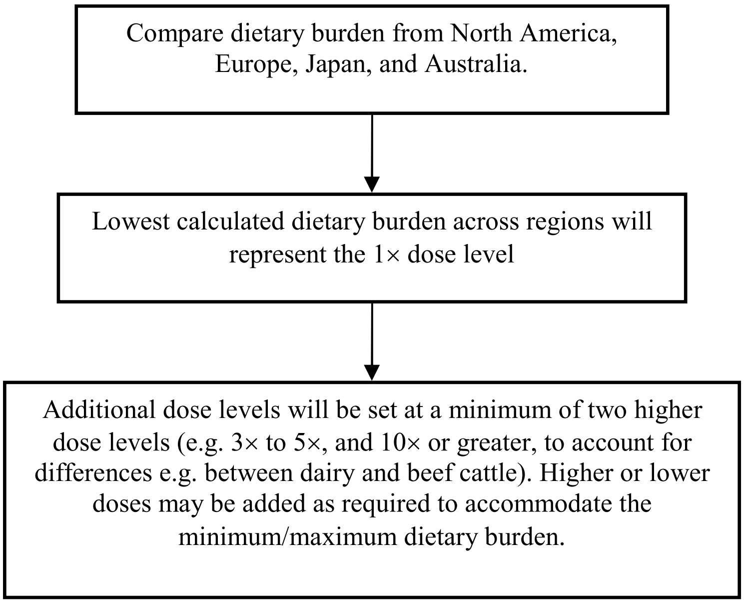
17. Additional dose levels may be added by the applicant as appropriate, for example, to refine dietary risk assessments, but the value gained from including additional dose groups should be balanced with animal welfare aspects (see Figure 2). As the basic assumption is that all feedstuffs that make up the total livestock diet and that may be treated according to the pesticide use pattern will be pesticide treated, the dietary burden reflects the most severe case that may occur in practice. Feeding studies conducted according to OECD TG 505 (1) can be used by regulators to set MRLs in a consistent manner in their countries or regions and to use appropriate data for the calculation of consumers' exposure.

18. If the original study does not contain a depuration phase, it might be necessary in some cases to generate additional data to provide information on the potential decline of the residue levels within that depuration period (see paragraph 27). For animal welfare reasons, it should be thoroughly investigated whether a repeat of the full study is warranted. Where possible the missing information should be provided in a bridging study by using a testing scheme requiring a smaller number of test animals compared to the full study.

19. To allow the combination of the results from the original study and the new additional information (from the depuration study), similar housing and other test conditions compared to the original study should be chosen, provided relevant elements of good livestock husbandry practice are met. The applicant is advised to discuss the design of the new study with regulatory authorities.

20. Most livestock feeding studies are conducted with laying hen or dairy cattle, and only poultry and cattle data should be used to calculate the 1× dose for these studies. Data for swine and sheep should not be used for this purpose. However, in many cases the results of these studies can be used to estimate the residues in food commodities from other domestic animals if the relevant dietary burdens are taken into account, and it is for this reason that feed data for swine and sheep are included in the feed table (Annex 1).

Figure 2. Dose Selection Based on International Dietary Contribution.



Note: For cattle the calculation for beef and dairy is performed separately and then the higher level for the 1× dose is used. The same approach is used for poultry, where the dietary exposure is calculated for broiler, layer, and turkey. The highest dietary burden for each animal type is used as 1× dose in the feeding study. Generally, the selected 1× dose for cattle is assumed to apply to swine and sheep. The diets calculated from Annex I (swine breeding and finishing; sheep ram/ewe and lamb) are used only for MRL derivation for the relevant livestock products.

Extrapolation in Livestock

21. Most livestock feeding studies are conducted with laying hen or dairy cattle. However, in many cases the results of these studies can be used to estimate the residues in food commodities from other domestic animals if the relevant dietary burdens are taken into account. The following extrapolations are proposed:

- Laying hen feeding study data to poultry
- Cattle feeding study data to all ruminants (*e.g.* goats and sheep), and other animals such as horses, pigs and rabbits.

Transfer factors obtained in feeding studies should be used as appropriate (See paragraph 27).

22. Estimates of the anticipated residues in food commodities of animal origin, based on the calculation of dietary burdens, can be used for the purposes of MRL setting and for input into the dietary risk assessment. Different calculations of the anticipated residue may be required for each purpose if the definition of the residue in livestock differs between that required for MRL setting and that required for risk assessment.

23. In this case, the Guidance Document (GD) on the Definition of Residue (Series on Testing and Assessment no. 63 and Series on Pesticides No. 31) (2) provides detailed guidance to identify the appropriate chemical moieties. Such guidance is available to pesticide applicants so that they may propose appropriate definitions of the residue and provide data for regulatory purposes. If the residue definition in food of animal origin includes the parent compound and one or several metabolites and if the feeding study was conducted with the parent compound only, the transfer factor for risk assessment corresponds to the ratio between the combined residues of the parent compound and its relevant metabolites measured in edible commodities of animal origin during the feeding study (calculated as parent equivalents) and the dose level of parent compound administered to the animals.

Exposure from Direct Application of a Pesticide to Livestock[1]

24. When a pesticide is proposed for direct use on food animals, data are needed to determine the extent of residues in livestock commodities arising from the use. Direct uses include pesticide application by back-line treatments, sprays, dips, pour-ons, dusts, dust-bags, back-rubbers, ear-tags or by jetting.

25. The experimental treatment should reflect as closely as possible the conditions under which the pesticide will be used commercially, including formulation types and mode of treatment. All factors that might contribute to the variability of residue levels in animal commodities, such as animal husbandry conditions, gender and maturity according to good agricultural practice (GAP) should be considered and taken into account in the planning and conduct of trials. Extrapolation based on direct animal treatment is generally not justified. Separate studies should be carried out for each species of livestock to be treated. The dose range for the animals in the residue study should include the lowest and highest dose rates as determined by the bodyweight range of the proposed product label.

26. In many cases it is not practical to remove animals from their housing while premise treatment takes place; an exception would be milking sheds. In the case of treatment to animal premises, the applicant may propose a scientific rationale to waive specific studies, based on data derived from direct animal treatments and animal husbandry practices.

27. When the use of pesticides in agricultural buildings is such that label restrictions cannot preclude the possibility of residues in meat, milk or eggs, residue studies should be carried out reflecting the maximum conditions of exposure. The study should be conducted using the species and animal housing situation which gives the greatest potential for animal exposure and the studies should reflect all possible residue transfer routes.

Interpretation of Study Results

28. Confirm that the study complies with requirements and reporting elements outlined in OECD TG 505 (1). Several general points to consider when interpreting data from livestock feeding studies are described below. Note that in the case of fat-soluble compounds data interpretation might be handled differently by different jurisdictions.

- Confirm that the actual dose administered is equivalent to the nominal dose estimated for each feed level. To avoid incorrect interpretation of the results, the actual dose levels reported in the study should be used.

[1] In some OECD countries direct uses of pesticides on food animals are considered as pesticide uses, while in others they fall under biocide or veterinary drug regulations. Guidance provided in the context of those regulations should be taken into account if appropriate.

- It is assumed that control animals are not exposed to the pesticide and therefore no pesticide residues should be present in food commodities of animal origin. Although the analytical uncertainty does not allow a true 'zero', it is recommended as a pragmatic approach to use the point of origin for the untreated group (zero residues), as long as the analytical results confirm that residue levels in control animal matrices are below detection limits.

- Plot residues for each matrix versus dose level in the study. Plot all residue values (including multiple results for different animals at a given dose level) versus dose level to determine the spread of residue values (at each dose level) and to ascertain if a linear dose response is observed.

- If a linear relationship exists (through 3 or more data points), i.e., all transfer factors (TF) are approximately the same, interpolation, linear regression, or use of the average transfer factor is acceptable.

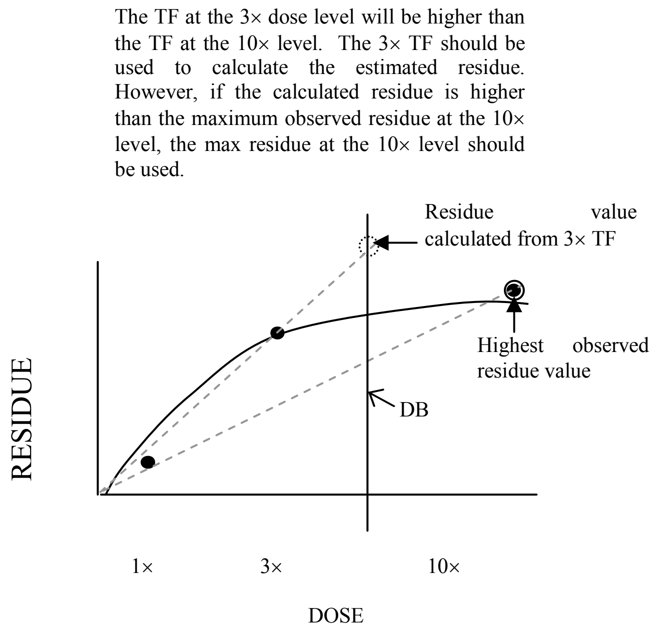
- If the calculated dietary burdens are either below the lowest dose or above the highest dose of the feeding study, the transfer factor nearest the calculated burden may be used to calculate the residue value, or linear regression may be used if a linear relationship exists. The experimental dose values should be within about 30% of the dietary burden.

- If a linear relationship does not exist, it may be possible to interpolate between two data points on either side of the exposure, or it may be possible to use the transfer factor from a single data point not more than 30 - 50% removed from the exposure. Generally the approach giving the highest residue value should be used.

- Two possible non-linear scenarios are summarized as follows:

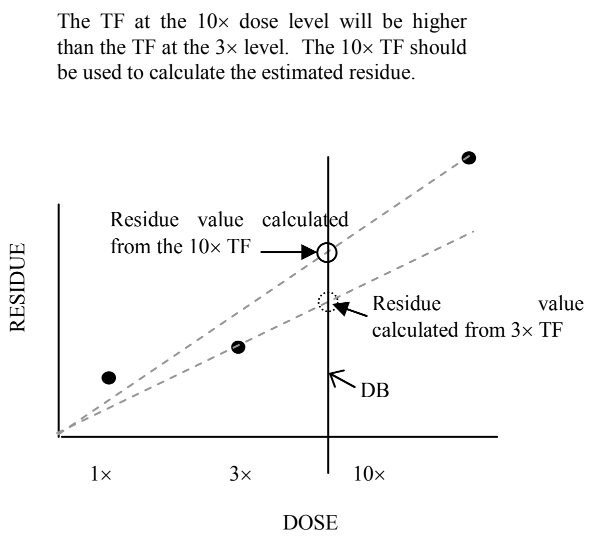
  (a) The dose-response curve saturates or approaches a plateau (figure 3). The TF from the dose level below the dietary burden will give a higher calculated residue value than the TF from the higher dose level. Thus the TF from the lower dose level should be used to calculate the estimated residue. However, if this calculated value exceeds the observed residues at the higher dose level, then the maximum residue value from the higher dose level should be used.

Figure 3. Plot of Dose Level versus Residue Concentration with Saturating Dose-Response Curve.



(b) The dose-response ratio increases with feeding level (figure 4). The TF from the dose level above the dietary burden will give a higher calculated residue value than the TF from the lower dose level. Thus the TF from the higher dose level should be used to calculate the estimated residue, assuming it is not too remote from the dietary exposure of interest.

Figure 4. Plot of Dose Level versus Residue Concentration with Increasing Dose-Response Ratio.



- For fat-soluble pesticides (see definition in OECD TG 505 (1)), note whether different fat depots have been analysed as required. It is important to determine which depot for each fat-soluble pesticide has the highest residue so that the MRL is not underestimated. Variability in results should also be considered.

- If milking animals are used in the feeding study, if the pesticide is fat-soluble, and if quantifiable residues in the milk and/or cream exceed residue levels in fat, then milk is indicated as a significant elimination pathway. Non-fat soluble pesticide residues are more likely to be found in the kidney, rather than in fat and in milk and cream, as they are usually eliminated quickly via the kidney. Fat-soluble pesticides will tend to accumulate in milk/cream. Accumulation of the residue in fat from a male animal will be greater than in a milking ruminant because milk/cream provides an alternative elimination pathway for the residue. If the residue is higher in milk and/or cream than in fat, another study using non-lactating animals may be considered to determine accurately residues in fat. Alternatively it may be possible for an adjustment factor to be applied to the residues observed in the milk producing animal study to account for likely higher residues in meat-only animals. For example, this could be done if adequate data were provided to determine a half-life for elimination from depuration data, collected as part of the milk producing animal study.

- If laying hens are used in the feeding study, if the pesticide is fat-soluble, and if quantifiable residues in the egg (yolk) exceed residue levels in fat, then egg (yolk) is indicated as a significant pathway. In such cases, residues in fat of broilers (meat-bird production) may be higher than residues in the fat of layers. Currently there is no mechanism to account for this possibility in MRL setting.

Interpretation of data for direct application of a pesticide to livestock

29. As included in OECD TG 505 (1), check the label dose ranges and develop a table of dosing per bodyweight range to find the nominal and highest doses.

- Compare the residue data submitted against the nominal and highest doses proposed for registration to ensure that the dose range is adequately covered by the data. Review the data at each time point for each tissue to determine the maximum residue levels versus time.

- Determine the highest residue over the period of time that is required to provide adequate efficacy following treatment, i.e. compare against the slaughter time as proposed on the label and consider principles of good veterinary practice where appropriate.

LITERATURE

(1) OECD (2007), *Test No. 505: Residues in Livestock*, OECD Guidelines for the Testing of Chemicals, Section 5, OECD Publishing. doi: 10.1787/9789264061903-en

(2) OECD (2009), OECD Environmental Health and Safety Publications Series on Testing and Assessment Number 63 and Series on Pesticides Number 31: Guidance Document on the Definition of Residue (as revised in 2009). Organisation for Economic Co-operation and Development (OECD), Paris, France.

ANNEX I: HARMONISED OECD TABLE OF FEEDSTUFFS DERIVED FROM FIELD CROPS AND BACKGROUND INFORMATION

USA/CAN

1. To meet consumer demands in terms of price and quality, specific beef and dairy breeds have been developed to produce more meat and more milk. In order to meet their financial targets, breeders or farmers rely on diets that are very specific with respect to the nutritional components, e.g., % of proteins or carbohydrates. However, the source and nature of the raw agricultural commodity (RAC) may change. Similarly, in the poultry and swine industry, special animals are bred for specific food items. For example, some poultry producers design a chicken for “chicken nuggets” which can involve a three year contract with a special fixed diet to produce this special fowl.

2. Data from commercial rearing are available that provide % for roughage, protein and carbohydrate content for nutritionally balanced diets for cattle, poultry and swine. This approach is referred to as the maximum reasonably balanced diet (MRBD). The objective of the MRBD is to propose a daily ration that allows animals to have steady weight gain, high milk volumes, and consistently high egg production (See Table 8, Annex II).

European Union

3. The European Union feedstuff tabulation lists maximum feed intake for livestock, which is relevant for cattle close to slaughter or high yielding dairy cows at their peak of milk production. This is only achievable on professionally managed farms. Based on data from EU-15 (the member countries in the European Union prior to the accession of further countries in 2004), on average 80% of all cattle are housed on farms having herd sizes of 50 or more. The range of such herds for EU-15 is from a high of 95% to a low of 45%, depending on the specific nation/university dealing with production of livestock commodities. It should be noted, that no such information was available from the accession states, mainly the Eastern European countries.

Australia

4. Exported meat (sheep, beef) is a major commercial commodity in Australia. Body weight ranges of finished animals are very broad, depending on the target market. In Australia, beef cattle and sheep are raised on pastures. About one third of beef produced in Australia are "finished" on a grain-based ration prior to live export or slaughter for export or domestic use. Some lot feeding is also undertaken with lambs intended for slaughter and young sheep produced for live export. Barley and sorghum are the most common feed grains used. Cattle are lot fed for periods varying from about 30 days to about 300 days depending on the level of marbling and weight required by the customer. However, to obtain a "grain fed" classification, cattle must be on that feed for at least 70 days for steers and 60 days for heifers.

5. There are around 2.02 million dairy cows in Australia and they each produce 4,900 liters of milk per year. Dairy production in Victoria benefits from year-round pasture grazing. Victoria produces greater than 60% of Australia's milk. Only 30% of total milk is diverted to market. The majority is used in the manufacture of dairy products (cheese, butter, milk powder). The other regions (New South Wales, Queensland, and Western Australia; 25% of total milk) have less rainfall and are more subject to drought. In these areas grain supplements are fed in addition to pasture grazing. A semi-mixed ration of forages, by-products, protein meals, and grains is fed. Such feedlot based dairying is expanding at a slow rate.

New Zealand

6. In New Zealand, livestock feeding systems (cattle, sheep and dairy cows) are based on all-year grazing on pasture (ryegrass/clover), with hay and silage used as supplementary feed in drought periods and to complement low winter pasture growth rates. Fodder Brassicas (roots and tops) are used to finish stock in the summer and as an alternative complimentary feed in winter. The majority of this supplementary feed is grown 'on-farm', although there is some local or regional re-distribution.

Japan

7. In Japan, grains account for about 42% of the total amount (36 million tonnes), while forage and by-product feeds each account for around 32% and 26% respectively. Imported feeds, mostly grain, account for about 45% of total rations. Corn grain is used the most with all livestock species. Other grains used in lesser amounts are barley (beef), milo (poultry and swine), rye (beef and dairy), and wheat (beef, dairy, and swine). More forage and by-product feeds are produced domestically than are imported.

8. About half of the by-product feeds in Japan are consumed by cattle. The by-products include grain bran fractions, dried beet pulp, and oilseed meals. The ratio of by-product feeds to grain in the diet is higher in the case of dairy cattle (0.98) or beef cattle (0.64) than with poultry (0.59) or swine (0.42). Most by-product feeds used in poultry and swine production are mixed in advance with grain as formulated rations by feed companies. However, only half of the by-product feeds consumed by cattle are used in this way. The remaining half is obtained by individual farmers in the areas where they live. This suggests that the by-products produced locally are most effectively used in cattle diets. Dairy cattle have a higher ration of by-product feeds in relation to grain (0.98 vs. 0.64) than beef cattle. Thus, the by-product feedstuffs are most actively used by dairy farmers in Japan. These feedstuffs are distributed all over the country by large feed companies in the form of feed concentrates.

9. In response to recent shortage in feed supply and consequential price increase in the world and in order to improve the self-sufficiency of feeds in Japan, a number of efforts have been made, such as: promotion of feed use of domestically produced rice straw and whole crop rice silage (WCS); and encouragement to increase production of WCS and rice varieties for feed uses with higher yield than those for food uses. This new situation necessitated urgent establishment of MRLs for pesticides used for production of rice and WCS in feeds, and MRLs for foods from animals fed these feeds. To facilitate the process, Japan has developed tables of maximum proportions of agricultural commodities for cattle, swine and poultry on a basis of the answers from large feed companies and farmers to a questionnaire in Japan.

OECD Table of Feedstuffs Derived from Field Crops

FEEDSTUFFS				Reference Animals		CATTLE							
						BEEF				DAIRY			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Forages/Fodders													
Alfalfa	forage	2-00-196	R	HR	35	*	70	100	*	20	40	60	*
Alfalfa	hay	1-00-054	R	HR	89	15	*	80	10	20	40	60	25
Alfalfa	meal	1-00-023	R	HR	89	*	*	40	10	15	40	40	25
Alfalfa	silage	3-08-150	R	HR	40	*	25	100	*	20	40	40	20
Barley	forage	2-00-511	R	HR	30	*	30	50	*	*	30	50	*
Barley	hay	1-00-495	R	HR	88	15	*	100	*	20	*	50	*
Barley	straw	1-00-498	R	HR	89	10	30	100	*	10	30	20	*
Barley	silage	3-00-512	R	HR	40	*	30	100	*	*	30	50	*
Bean	vines	2-14-388	R	HR	35	*	*	60	*	*	20	70	*
Beet, mangel	fodder	2-00-632	R	HR	15	*	30	*	*	*	25	*	*
Beet, sugar	tops	2-00-649	R	HR	23	*	20	*	*	*	30	*	*
Cabbage, heads	leaves	2-01-046	R	HR	15	*	20	*	*	*	20	*	*
Clover	forage	2-01-434	R	HR	30	*	30	100	*	20	40	60	*
Clover	hay	1-01-415	R	HR	89	15	30	100	*	20	40	60	*
Clover	silage	3-01-441	R	HR	30	*	25	100	*	20	40	60	*
Corn, field	forage/silage	3-28-345	R	HR	40	15	80	80	*	45	60	80	20/50
Corn, field	stover	3-28-251	R	HR	83	15	25	40	*	15	20	40	*
Corn, pop	stover	2-02-963	R	HR	85	15	25	20	*	*	20	20	*
Corn, sweet	forage	1-08-407	R	HR	48	*	*	80	*	45	*	40	*
Corn, sweet	stover	NA	R	HR	83	*	*	40	*	15	*	20	*
Cowpea	forage	2-01-655	R	HR	30	*	35	100	*	20	35	60	*
Cowpea	hay	1-01-645	R	HR	86	*	35	100	*	20	35	60	*
Crown, vetch	forage	2-19-834	R	HR	30	*	*	100	*	10	*	100	*
Crown, vetch	hay	1-20-803	R	HR	90	*	*	100	*	*	*	100	*

FEEDSTUFFS				Reference Animals		CATTLE							
						BEEF				DAIRY			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Grass	forage (fresh)	2-02-260	R	HR	25	*	50	100	5	45	60	100	10
Grass	hay	1-02-250	R	HR	88	15	50	100	40	45	60	60	70
Grass	silage	3-02-222	R	HR	40	*	50	100	5	45	60	60	80
Kale	leaves	2-02-446	R	HR	15	*	20	*	*	*	20	40	*
Lespedeza	forage	2-07-058	R	HR	22	*	*	20	*	40	*	60	*
Lespedeza	hay	1-02-522	R	HR	88	15	*	20	*	40	*	60	*
Millet	forage	2-03-801	R	HR	30	*	*	100	*	20	30	50	*
Millet	hay	1-03-119	R	HR	85	10	*	100	*	20	*	50	*
Millet	straw	1-23-802	R	HR	90	10	10	80	*	10	*	50	*
Oat	forage	2-03-292	R	HR	30	*	20	100	*	30	20	90	5
Oat	hay	1-03-280	R	HR	90	15	20	100	*	30	20	90	5
Oat	straw	1-03-283	R	HR	90	10	20	80	*	10	20	60	5
Oat	silage	3-03-298	R	HR	35	*	*	100	*	*	*	40	5
Pea	vines	3-03-596	R	HR	25	*	20	60	*	10	20	40	*
Pea	hay	1-03-572	R	HR	88	*	25	100	*	10	30	70	*
Pea	silage	3-03-590	R	HR	40	*	25	100	*	10	30	40	*
Peanut	hay	1-03-619	R	HR	85	*	*	60	*	15	*	60	*
Rape	forage	2-03-867	R	HR	30	*	10	100	*	10	10	40	*
Rice	straw	1-03-925	R	HR	90	*	10	60	55	*	5	20	25
Rice	whole crop silage	NA	R	HR	40	*	*	*	5	*	*	*	55
Rye	forage	2-04-018	R	HR	30	*	20	100	*	20	20	20	*
Rye	straw	1-04-007	R	HR	88	10	20	20	*	10	20	20	5
Rye	silage	3-04-020	R	HR	28	*	*	*	*	*	*	*	5
Sorghum, forage	see Grasses												
Sorghum, grain	forage	2-04-465	R	HR	35	15	20	70	*	40	20	70	40
Sorghum, grain	stover	1-07-960	R	HR	88	15	15	70	*	15	15	70	5

FEEDSTUFFS				Reference Animals		CATTLE							
						BEEF				DAIRY			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Sorghum, grain	silage	3-04-323	R	HR	21	15	*	*	*	40	*	*	10
Soybean	forage	2-04-574	R	HR	56	*	*	100	*	20	*	40	*
Soybean	hay	1-04-558	R	HR	85	*	*	80	*	20	*	40	*
Soybean	silage	3-04-581	R	HR	30	*	*	80	*	20	*	40	*
Sugarcane	tops	2-04-692	R	HR	25	*	*	50	*	*	*	25	*
Trefoil	forage	2-20-786	R	HR	30	*	20	100	*	40	40	40	*
Trefoil	hay	1-05-044	R	HR	85	15	20	90	*	40	40	40	*
Triticale	forage	2-02-647	R	HR	30	*	20	100	*	20	20	70	*
Triticale	hay	NA	R	HR	88	15	20	100	*	20	20	70	*
Triticale	straw	NA	R	HR	90	10	20	50	*	10	20	70	*
Triticale	silage	3-26-208	R	HR	35	*	*	90	*	*	*	50	*
Turnip	tops (leaves)	2-05-063	R	HR	30	*	40	80	*	30	20	*	*
Vetch	forage	2-05-112	R	HR	30	*	25	90	*	20	25	35	*
Vetch	hay	1-05-122	R	HR	85	15	25	90	5	20	25	35	25
Vetch	silage	3-26-357	R	HR	30	*	*	90	*	*	*	50	60
Wheat	forage	2-08-078	R	HR	25	*	20	100	*	20	20	60	*
Wheat	hay	1-05-172	R	HR	88	15	20	100	*	20	20	20	*
Wheat	straw	1-05-175	R	HR	88	10	20	80	*	10	20	20	*
Wheat	silage	3-05-186	R	HR	30	*	*	90	*	*	*	50	*
Roots & Tubers													
Carrot	culls	2-01-146	CC	HR	12	*	15	5	*	10	15	5	*
Cassava/tapioca	roots	2-01-156	CC	HR	37	*	20	*	*	*	15	*	*
Potato	culls	4-03-787	CC	HR	20	30	30	10	*	10	30	10	*
Swede	roots	4-04-001	CC	HR	10	*	40	10	*	*	20	10	*
Turnip	roots	4-05-067	CC	HR	15	*	20	10	*	10	20	10	*
Cereal Grains/Crops Seeds													

FEEDSTUFFS				Reference Animals		**CATTLE**							
						BEEF				**DAIRY**			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Barley	grain	4-00-549	CC	STMR	88	50	70	80	70	45	40	40	40
Bean	seed	4-00-515	PC	STMR	88	*	20	50	*	*	20	15	*
Corn, field	grain	4-20-698	CC	STMR	88	80	80	80	75	45	30	20	80
Corn, pop	grain	4-02-964	CC	STMR	88	80	*	80	75	45	30	20	80
Cotton	undelinted seed	5-01-614	PC	STMR	88	*	*	30	*	10	10	20	*
Cowpea	seed	5-01-661	PC	STMR	88	*	20	20	*	*	20	20	*
Lupin	seed	5-02-707	PC	STMR	88	*	20	40	*	*	20	20	*
Millet	grain	4-03-102	CC	STMR	88	50	40	50	*	20	40	50	*
Oat	grain	4-03-309	CC	STMR	89	*	40	80	*	20	40	10	5
Pea	seed	5-03-600	PC	STMR	90	*	20	40	*	*	20	20	*
Rice	grain	4-03-939	CC	STMR	88	20	*	40	*	20	*	20	*
Rye	grain	4-04-047	CC	STMR	88	20	40	80	35	20	40	*	15
Sorghum, grain	grain	4-04-383	CC	STMR	86	40	40	80	35	45	40	50	30
Soybean	seed	5-64-610	PC	STMR	89	5	10	20	15	10	10	20	10
Triticale	grain	4-20-362	CC	STMR	89	20	40	80	*	20	40	30	*
Vetch	seed	5-26-351	PC	STMR	89	*	*	20	*	*	*	20	*
Wheat	grain	4-05-211	CC	STMR	89	20	40	80	25	20	40	20	10
By-Products													
Almond	hulls	4-00-359	R	STMR	90	*	*	10	*	10	*	10	*
Apple	pomace, wet	4-00-419	CC	STMR	40	*	20	20	*	10	10	10	*
Barley	bran fractions	NA	CC	STMR	90	*	*	*	10	*	*	*	*
Beet, sugar	dried pulp	4-29-307	R	STMR	88	15	20	*	5	15	20	*	40
Beet, sugar	ensiled pulp	4-00-662	R	STMR	15	*	25	*	*	*	40	*	*
Beet, sugar	molasses	4-30-289	CC	STMR	75	10	10	*	*	10	10	*	*
Brewer's grain	dried	5-00-516	CC	STMR	92	*	10	50	45	*	15	20	40
Canola	meal	5-08-136	PC	STMR	88	5	*	20	*	10	10	15	*

FEEDSTUFFS				Reference Animals		CATTLE							
						BEEF				DAIRY			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Citrus	dried pulp	4-01-237	R	STMR	91	10	5	30	*	10	20	30	*
Coconut	meal	5-01-572	PC	STMR	91	*	20	30	*	*	10	*	*
Corn, field	aspirated grain fraction	4-12-208	CC	STMR	85	5	*	*	*	*	*	*	*
Corn, field	milled bypdts	5-28-235	CC	STMR	85	50	30	15	5	25	30	15	*
Corn, field	hominy meal	4-03-010	CC	STMR	88	50	*	40	35	25	*	40	*
Corn, sweet	cannery waste	2-02-975	CC	STMR	30	*	*	30	*	10	*	10	*
Corn, field	gluten feed	5-28-243	CC	STMR	40	75	30	20	25	25	30	*	25
Corn, field	gluten meal	5-28-242	CC	STMR	40	75	15	20	*	25	20	*	15
Cotton	meal	5-01-617	PC	STMR	89	5	5	30	*	10	5	15	*
Cotton	hulls	1-01-599	R	STMR	90	10	*	20	*	*	*	10	*
Cotton	gin by-products	1-08-413	R	STMR	90	5	*	*	*	*	*	*	*
Distiller's grain	dried	5-00-518	CC	STMR	92	50	10	50	10	25	10	*	15
Flaxseed/linseed	meal	5-02-043	PC	STMR	88	5	10	10	*	10	15	10	*
Grape	pomace, wet	2-02-206	CC	STMR	15	*	*	20	*	*	*	20	*
Lupin seed	meal	NA	PC	STMR	85	*	20	15	*	*	20	15	*
Palm	kernel meal	5-03-486	PC	STMR	90	*	*	20	5	*	25	10	5
Peanut	meal	5-03-649	PC	STMR	85	*	20	10	*	10	10	15	*
Pineapple	process waste	4-03-722	R	STMR	25	10	*	60	*	10	*	30	*
Potato	process waste	4-03-777	CC	STMR	12	30	40	5	*	10	30	*	*
Potato	dried pulp	4-03-775	CC	STMR	88	*	10	5	*	*	10	5	*
Rape	meal	5-26-093	PC	STMR	88	*	20	15	15	*	10	15	25
Rice	hulls	1-08-075	R	STMR	90	*	*	5	*	*	*	10	*
Rice	bran/pollard	4-03-928	R	STMR	90	15	*	40	20	15	20	40	10
Sesame seed	meal	5-04-220	PC	STMR	90	*	*	*	*	*	*	*	*
Safflower	meal	5-26-095	PC	STMR	91	5	20	20	*	10	10	15	*
Sorghum grain	aspirated grain fraction	4-12-208	CC	STMR	85	5	*	20	*	*	*	*	*

FEEDSTUFFS				Reference Animals		CATTLE							
						BEEF				DAIRY			
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP
				Body weight (kg)		500	500	500	730	600	650	500	600
				Daily intake (DM in kg)		9.1	12	20	14	24	25	20	17
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)							
Soybean	aspirated grain fraction	4-12-208	CC	STMR	85	5	*	*	*	*	*	*	*
Soybean	meal	5-20-638	PC	STMR	92	5	20	10	65	10	25	15	60
Soybean	hulls	1-04-560	R	STMR	90	15	10	*	5	10	*	*	*
Soybean	okara, dried	NA	PC	STMR	92	*	*	*	40	*	*	*	20
Sugarcane	molasses	4-13-251	CC	STMR	75	10	10	30	*	10	10	25	*
Sugarcane	bagasse	1-04-686	R	STMR	32	*	*	20	*	*	*	25	*
Sunflower	meal	5-26-098	PC	STMR	92	5	20	30	*	10	10	15	*
Tomato	pomace, wet	NA	CC	STMR	20	*	*	10	*	*	*	10	*
Wheat	aspirated grain fraction	4-12-208	CC	STMR	85	5	*	*	*	*	*	*	*
Wheat gluten	meal	5-05-221	CC	STMR	40	10	15	*	*	10	20	*	*
Wheat	milled bypdts	4-06-749	CC	STMR	88	40	30	40	55	30	30	40	45

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)					
Forages/Fodders											
Alfalfa	forage	2-00-196	R	HR	35	20	40	100	20	40	90
Alfalfa	hay	1-00-054	R	HR	89	20	40	70	20	40	35
Alfalfa	meal	1-00-023	R	HR	89	15	20	*	15	20	*
Alfalfa	silage	3-08-150	R	HR	40	20	40	75	20	40	75
Barley	forage	2-00-511	R	HR	30	*	50	100	*	50	100
Barley	hay	1-00-495	R	HR	88	20	*	70	20	*	25
Barley	straw	1-00-498	R	HR	89	10	60	30	10	60	30
Barley	silage	3-00-512	R	HR	40	*	50	*	*	50	*
Bean	vines	2-14-388	R	HR	35	*	30	*	*	30	*
Beet, mangel	fodder	2-00-632	R	HR	15	*	10	*	*	10	*
Beet, sugar	tops	2-00-649	R	HR	23	*	20	*	*	20	*
Cabbage, heads	leaves	2-01-046	R	HR	15	*	10	*	*	10	*
Clover	forage	2-01-434	R	HR	30	20	85	100	20	30	100
Clover	hay	1-01-415	R	HR	89	20	80	75	20	20	35
Clover	silage	3-01-441	R	HR	30	20	85	75	20	30	75
Corn, field	forage/silage	3-28-345	R	HR	40	45	*	80	45	30	60
Corn, field	stover	3-28-251	R	HR	83	15	*	*	15	*	*
Corn, pop	stover	2-02-963	R	HR	85	*	*	*	*	*	*
Corn, sweet	forage	1-08-407	R	HR	48	45	*	25	45	*	*
Corn, sweet	stover	NA	R	HR	83	15	*	30	15	*	*
Cowpea	forage	2-01-655	R	HR	30	20	35	100	20	35	100
Cowpea	hay	1-01-645	R	HR	86	20	35	65	20	35	35
Crown, vetch	forage	2-19-834	R	HR	30	10	*	95	10	*	95
Crown, vetch	hay	1-20-803	R	HR	90	*	*	70	*	*	35

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)					
Grass	forage (fresh)	2-02-260	R	HR	25	45	95	100	45	50	100
Grass	hay	1-02-250	R	HR	88	45	90	70	45	30	25
Grass	silage	3-02-222	R	HR	40	45	90	75	45	50	50
Kale	leaves	2-02-446	R	HR	15	*	10	*	*	10	*
Lespedeza	forage	2-07-058	R	HR	22	40	*	*	40	*	*
Lespedeza	hay	1-02-522	R	HR	88	40	*	20	40	*	*
Millet	forage	2-03-801	R	HR	30	20	*	100	20	*	60
Millet	hay	1-03-119	R	HR	85	20	*	65	20	*	20
Millet	straw	1-23-802	R	HR	90	10	*	35	10	*	15
Oat	forage	2-03-292	R	HR	30	30	40	100	30	40	100
Oat	hay	1-03-280	R	HR	90	30	40	65	30	40	20
Oat	straw	1-03-283	R	HR	90	10	40	35	10	40	15
Oat	silage	3-03-298	R	HR	35	*	*	*	*	*	*
Pea	vines	3-03-596	R	HR	25	10	20	90	10	20	90
Pea	hay	1-03-572	R	HR	88	10	20	70	10	20	30
Pea	silage	3-03-590	R	HR	40	10	20	75	10	20	70
Peanut	hay	1-03-619	R	HR	85	15	*	25	15	*	*
Rape	forage	2-03-867	R	HR	30	10	40	90	10	40	90
Rice	straw	1-03-925	R	HR	90	*	10	20	*	10	15
Rice	whole crop silage	NA	R	HR	40	*	*	*	*	*	*
Rye	forage	2-04-018	R	HR	30	20	40	100	20	40	100
Rye	straw	1-04-007	R	HR	88	10	40	20	10	40	20
Rye	silage	3-04-020	R	HR	28	8	*	*	*	*	*
Sorghum, forage	see Grasses										
Sorghum, grain	forage	2-04-465	R	HR	35	40	20	100	40	20	65

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)					
Sorghum, grain	stover	1-07-960	R	HR	88	15	20	*	15	20	*
Sorghum, grain	silage	3-04-323	R	HR	21	40	8	*	40	*	*
Soybean	forage	2-04-574	R	HR	56	20	*	90	20	*	80
Soybean	hay	1-04-558	R	HR	85	20	*	70	20	*	25
Soybean	silage	3-04-581	R	HR	30	20	*	75	20	*	65
Sugarcane	tops	2-04-692	R	HR	25	*	*	*	*	*	*
Trefoil	forage	2-20-786	R	HR	30	40	40	90	40	20	90
Trefoil	hay	1-05-044	R	HR	85	40	40	70	40	20	70
Triticale	forage	2-02-647	R	HR	30	20	40	100	20	30	100
Triticale	hay	NA	R	HR	88	20	40	70	20	20	25
Triticale	straw	NA	R	HR	90	10	40	20	10	10	15
Triticale	silage	3-26-208	R	HR	35	*	*	*	*	*	*
Turnip	tops (leaves)	2-05-063	R	HR	30	30	30	75	30	30	75
Vetch	forage	2-05-112	R	HR	30	20	30	100	20	20	100
Vetch	hay	1-05-122	R	HR	85	20	30	75	20	20	30
Vetch	silage	3-26-357	R	HR	30	*	*	*	*	*	*
Wheat	forage	2-08-078	R	HR	25	20	40	100	20	30	100
Wheat	hay	1-05-172	R	HR	88	20	40	65	20	20	25
Wheat	straw	1-05-175	R	HR	88	10	40	20	10	40	15
Wheat	silage	3-05-186	R	HR	30	*	*	*	*	*	*
Roots and Tubers											
Carrot	culls	2-01-146	CC	HR	12	10	20	*	10	20	*
Cassava/tapioca	roots	2-01-156	CC	HR	37	*	20	*	*	20	*
Potato	culls	4-03-787	CC	HR	20	10	30	*	10	20	*
Swede	roots	4-04-001	CC	HR	10	*	30	80	*	30	80

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)					
Turnip	roots	4-05-067	CC	HR	15	10	30	80	10	30	80
Cereal Grains/Crops Seeds											
Barley	grain	4-00-549	CC	STMR	88	45	40	85	45	60	85
Bean	seed	4-00-515	PC	STMR	88	*	20	85	*	20	85
Corn, field	grain	4-20-698	CC	STMR	88	45	30	85	45	30	85
Corn, pop	grain	4-02-964	CC	STMR	88	45	30	85	45	30	85
Cotton	undelinted seed	5-01-614	PC	STMR	88	10	*	25	10	*	25
Cowpea	seed	5-01-661	PC	STMR	88	*	20	75	*	20	75
Lupin	seed	5-02-707	PC	STMR	88	*	10	100	*	10	100
Millet	grain	4-03-102	CC	STMR	88	20	30	*	20	30	*
Oat	grain	4-03-309	CC	STMR	89	20	40	90	20	60	90
Pea	seed	5-03-600	PC	STMR	90	*	20	*	*	20	*
Rice	grain	4-03-939	CC	STMR	88	20	*	*	20	*	*
Rye	grain	4-04-047	CC	STMR	88	20	40	*	20	45	*
Sorghum, grain	grain	4-04-383	CC	STMR	86	45	40	80	45	40	80
Soybean	seed	5-64-610	PC	STMR	89	10	10	40	10	20	40
Triticale	grain	4-20-362	CC	STMR	89	20	30	85	20	40	85
Vetch	seed	5-26-351	PC	STMR	89	*	*	*	*	*	*
Wheat	grain	4-05-211	CC	STMR	89	20	40	80	20	60	80
By-Products											
Almond	hulls	4-00-359	R	STMR	90	10	*	*	10	*	*
Apple	pomace, wet	4-00-419	CC	STMR	40	10	10	*	10	10	*
Barley	bran fractions	NA	CC	STMR	90	*	*	*	*	*	*
Beet, sugar	dried pulp	4-29-307	R	STMR	88	15	40	*	15	40	*
Beet, sugar	ensiled pulp	4-00-662	R	STMR	15	*	*	*	*	*	*

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)					
Beet, sugar	molasses	4-30-289	CC	STMR	75	10	5	*	10	5	*
Brewer's grain	dried	5-00-516	CC	STMR	92	*	30	*	*	10	*
Canola	meal	5-08-136	PC	STMR	88	10	*	35	10	*	35
Citrus	dried pulp	4-01-237	R	STMR	91	10	*	*	10	*	*
Coconut	meal	5-01-572	PC	STMR	91	*	20	35	*	20	35
Corn, field	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*
Corn, field	milled bypdts	5-28-235	CC	STMR	85	25	30	*	25	30	*
Corn, field	hominy meal	4-03-010	CC	STMR	88	25	*	*	25	*	*
Corn, sweet	cannery waste	2-02-975	CC	STMR	30	10	*	*	10	*	*
Corn, field	gluten feed	5-28-243	CC	STMR	40	25	30	80	25	30	80
Corn, field	gluten meal	5-28-242	CC	STMR	40	25	30	*	25	30	*
Cotton	meal	5-01-617	PC	STMR	89	10	15	45	10	10	45
Cotton	hulls	1-01-599	R	STMR	90	*	*	20	*	*	20
Cotton	gin by-products	1-08-413	R	STMR	90	*	*	*	*	*	*
Distiller's grain	dried	5-00-518	CC	STMR	92	25	10	*	25	10	*
Flaxseed/linseed	meal	5-02-043	PC	STMR	88	10	20	*	10	10	*
Grape	pomace, wet	2-02-206	CC	STMR	15	*	*	*	*	*	*
Lupin seed	meal	NA	PC	STMR	85	*	25	*	*	20	*
Palm	kernel meal	5-03-486	PC	STMR	90	*	*	*	*	*	*
Peanut	meal	5-03-649	PC	STMR	85	10	20	*	10	20	*
Pineapple	process waste	4-03-722	R	STMR	25	10	*	*	10	*	*
Potato	process waste	4-03-777	CC	STMR	12	10	40	*	10	20	*
Potato	dried pulp	4-03-775	CC	STMR	88	*	40	*	*	20	*
Rape	meal	5-26-093	PC	STMR	88	*	15	*	*	15	*
Rice	hulls	1-08-075	R	STMR	90	*	*	20	*	*	15

FEEDSTUFFS				Reference Animals		SHEEP					
						RAM/EWE			LAMB		
				Regions		USA/ CAN	EU	AUS	USA/ CAN	EU	AUS
				Body weight (kg)		85	75	85	40	40	60
				Daily intake (DM in kg)		2	2.5	2.5	1.5	1.7	2.5
Crop	Commodity	IFN Code	Classif ication	Residue Input	DM (%)	% of Diet (as fed)					
Rice	bran/pollard	4-03-928	R	STMR	90	15	30	*	15	30	*
Sesame seed	meal	5-04-220	PC	STMR	90	*	*	*	*	*	*
Safflower	meal	5-26-095	PC	STMR	91	10	*	*	10	*	*
Sorghum grain	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*
Soybean	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*
Soybean	meal	5-20-638	PC	STMR	92	10	25	35	10	25	35
Soybean	hulls	1-04-560	R	STMR	90	10	20	20	10	20	*
Soybean	okara, dried	NA	PC	STMR	92	*	*	*	*	*	*
Sugarcane	molasses	4-13-251	CC	STMR	75	10	5	10	10	5	10
Sugarcane	bagasse	1-04-686	R	STMR	32	*	*	10	*	*	*
Sunflower	meal	5-26-098	PC	STMR	92	10	20	40	10	20	40
Tomato	pomace, wet	NA	CC	STMR	20	*	*	8	*	*	*
Wheat	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*
Wheat gluten	meal	5-05-221	CC	STMR	40	10	30	*	10	30	*
Wheat	milled bypdts	4-06-749	CC	STMR	88	30	40	*	30	50	*

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			FINISHING			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)						
Forages/Fodders												
Alfalfa	forage	2-00-196	R	HR	35	*	*	*	*	*	*	*
Alfalfa	hay	1-00-054	R	HR	89	*	*	10	*	*	10	*
Alfalfa	meal	1-00-023	R	HR	89	5	10	10	5	10	10	5
Alfalfa	silage	3-08-150	R	HR	40	*	*	*	*	*	*	*
Barley	forage	2-00-511	R	HR	30	*	*	*	*	*	*	*
Barley	hay	1-00-495	R	HR	88	*	*	10	*	*	5	*
Barley	straw	1-00-498	R	HR	89	*	*	10	*	*	10	*
Barley	silage	3-00-512	R	HR	40	*	*	*	*	*	*	*
Bean	vines	2-14-388	R	HR	35	*	*	*	*	*	*	*
Beet, mangel	fodder	2-00-632	R	HR	15	*	15	*	*	*	*	*
Beet, sugar	tops	2-00-649	R	HR	23	*	10	*	*	*	*	*
Cabbage, heads	leaves	2-01-046	R	HR	15	*	10	*	*	*	*	*
Clover	forage	2-01-434	R	HR	30	*	20	*	*	*	*	*
Clover	hay	1-01-415	R	HR	89	*	20	10	*	*	10	*
Clover	silage	3-01-441	R	HR	30	*	20	*	*	*	*	*
Corn, field	forage/silage	3-28-345	R	HR	40	*	20	*	*	*	*	*
Corn, field	stover	3-28-251	R	HR	83	*	20	*	*	*	*	*
Corn, pop	stover	2-02-963	R	HR	85	*	20	*	*	*	*	*
Corn, sweet	forage	1-08-407	R	HR	48	*	*	*	*	*	*	*
Corn, sweet	stover	NA	R	HR	83	*	*	*	*	*	*	*
Cowpea	forage	2-01-655	R	HR	30	*	20	*	*	*	*	*
Cowpea	hay	1-01-645	R	HR	86	*	20	10	*	*	10	*
Crown, vetch	forage	2-19-834	R	HR	30	*	*	*	*	*	*	*
Crown, vetch	hay	1-20-803	R	HR	90	*	*	*	*	*	*	*

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			FINISHING			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)						
Grass	forage (fresh)	2-02-260	R	HR	25	*	20	*	*	*	*	*
Grass	hay	1-02-250	R	HR	88	*	20	10	*	*	10	*
Grass	silage	3-02-222	R	HR	40	*	20	*	*	*	*	*
Kale	leaves	2-02-446	R	HR	15	*	10	*	*	*	*	*
Lespedeza	forage	2-07-058	R	HR	22	*	*	*	*	10	*	*
Lespedeza	hay	1-02-522	R	HR	88	*	*	*	*	10	*	*
Millet	forage	2-03-801	R	HR	30	*	*	*	*	*	*	*
Millet	hay	1-03-119	R	HR	85	*	*	10	*	*	10	*
Millet	straw	1-23-802	R	HR	90	*	*	10	*	*	10	*
Oat	forage	2-03-292	R	HR	30	*	20	*	*	*	*	*
Oat	hay	1-03-280	R	HR	90	*	20	10	*	*	10	*
Oat	straw	1-03-283	R	HR	90	*	*	10	*	*	10	*
Oat	silage	3-03-298	R	HR	35	*	*	*	*	*	*	*
Pea	vines	3-03-596	R	HR	25	*	20	*	*	*	*	*
Pea	hay	1-03-572	R	HR	88	*	20	15	*	*	10	*
Pea	silage	3-03-590	R	HR	40	*	20	*	*	*	*	*
Peanut	hay	1-03-619	R	HR	85	*	*	*	*	*	*	*
Rape	forage	2-03-867	R	HR	30	*	20	*	*	*	*	*
Rice	straw	1-03-925	R	HR	90	*	*	10	*	*	10	*
Rice	whole crop silage	NA	R	HR	40	8	*	*	*	*	*	*
Rye	forage	2-04-018	R	HR	30	*	20	*	*	*	*	*
Rye	straw	1-04-007	R	HR	88	*	*	*	*	*	*	*
Rye	silage	3-04-020	R	HR	28	8	*	*	*	*	*`	*
Sorghum, forage	see Grasses											
Sorghum, grain	forage	2-04-465	R	HR	35	*	20	10	*	*	*	*

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			FINISHING			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)						
Sorghum, grain	stover	1-07-960	R	HR	88	*	20	*	*	*	*	*
Sorghum, grain	silage	3-04-323	R	HR	21	8	*	*	*	*	*	*
Soybean	forage	2-04-574	R	HR	56	*	*	*	*	*	*	*
Soybean	hay	1-04-558	R	HR	85	*	*	*	*	*	*	*
Soybean	silage	3-04-581	R	HR	30	*	*	*	*	*	*	*
Sugarcane	tops	2-04-692	R	HR	25	*	*	*	*	*	*	*
Trefoil	forage	2-20-786	R	HR	30	*	20	*	*	*	*	*
Trefoil	hay	1-05-044	R	HR	85	*	20	15	*	*	10	*
Triticale	forage	2-02-647	R	HR	30	*	20	*	*	*	*	*
Triticale	hay	NA	R	HR	88	*	20	10	*	*	10	*
Triticale	straw	NA	R	HR	90	*	*	10	*	*	10	*
Triticale	silage	3-26-208	R	HR	35	*	*	*	*	*	*	*
Turnip	tops (leaves)	2-05-063	R	HR	30	*	*	*	*	*	*	*
Vetch	forage	2-05-112	R	HR	30	*	*	10	*	*	*	*
Vetch	hay	1-05-122	R	HR	85	*	*	10	*	*	10	*
Vetch	silage	3-26-357	R	HR	30	*	*	*	*	*	*	*
Wheat	forage	2-08-078	R	HR	25	*	20	10	*	*	*	*
Wheat	hay	1-05-172	R	HR	88	*	20	10	*	*	10	*
Wheat	straw	1-05-175	R	HR	88	*	*	10	*	*	10	*
Wheat	silage	3-05-186	R	HR	30	*	*	*	*	*	*	*
Roots & Tubers												
Carrot	culls	2-01-146	CC	HR	12	*	25	10	*	25	5	*
Cassava/tapioca	roots	2-01-156	CC	HR	37	*	40	*	*	40	*	*
Potato	culls	4-03-787	CC	HR	20	*	50	10	*	50	*	*
Swede	roots	4-04-001	CC	HR	10	*	40	5	*	40	*	*

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			FINISHING			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classific ation	Residue Input	DM (%)	% of Diet (as fed)						
Turnip	roots	4-05-067	CC	HR	15	*	40	5	*	40	5	*
Cereal Grains/Crops Seeds												
Barley	grain	4-00-549	CC	STMR	88	20	80	85	20	80	80	30
Bean	seed	4-00-515	PC	STMR	88	*	20	20	*	20	20	*
Corn, field	grain	4-20-698	CC	STMR	88	85	70	80	85	70	80	85
Corn, pop	grain	4-02-964	CC	STMR	88	*	*	*	*	*	*	*
Cotton	undelinted seed	5-01-614	PC	STMR	88	*	*	*	*	*	*	*
Cowpea	seed	5-01-661	PC	STMR	88	10	10	10	10	20	10	*
Lupin	seed	5-02-707	PC	STMR	88	*	15	25	*	20	25	*
Millet	grain	4-03-102	CC	STMR	88	20	70	70	20	70	70	*
Oat	grain	4-03-309	CC	STMR	89	*	70	80	*	70	80	*
Pea	seed	5-03-600	PC	STMR	90	20	20	40	15	20	40	*
Rice	grain	4-03-939	CC	STMR	88	20	*	60	20	*	65	*
Rye	grain	4-04-047	CC	STMR	88	*	70	80	*	70	70	35
Sorghum, grain	grain	4-04-383	CC	STMR	86	80	70	80	80	70	80	55
Soybean	seed	5-64-610	PC	STMR	89	15	10	10	15	20	10	*
Triticale	grain	4-20-362	CC	STMR	89	*	60	80	*	60	80	*
Vetch	seed	5-26-351	PC	STMR	89	*	*	10	*	*	10	*
Wheat	grain	4-05-211	CC	STMR	89	*	70	80	*	70	80	35
By-Products												
Almond	hulls	4-00-359	R	STMR	90	*	*	*	*	*	*	*
Apple	pomace, wet	4-00-419	CC	STMR	40	*	*	*	*	*	*	*
Barley	bran fractions	NA	CC	STMR	90	*	*	*	*	*	*	*
Beet, sugar	dried pulp	4-29-307	R	STMR	88	*	20	*	*	20	*	*
Beet, sugar	ensiled pulp	4-00-662	R	STMR	15	*	*	*	*	*	*	*

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			**FINISHING**			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)						
Beet, sugar	molasses	4-30-289	CC	STMR	75	*	5	*	*	5	*	*
Brewer's grain	dried	5-00-516	CC	STMR	92	*	10	10	*	10	10	*
Canola	meal	5-08-136	PC	STMR	88	15	20	20	15	20	20	*
Citrus	dried pulp	4-01-237	R	STMR	91	*	15	10	*	*	10	*
Coconut	meal	5-01-572	PC	STMR	91	*	*	10	*	*	10	*
Corn, field	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*	*
Corn, field	milled bypdts	5-28-235	CC	STMR	85	60	75	70	60	75	70	*
Corn, field	hominy meal	4-03-010	CC	STMR	88	20	*	40	20	*	40	*
Corn, sweet	cannery waste	2-02-975	CC	STMR	30	*	*	*	*	*	*	*
Corn, field	gluten feed	5-28-243	CC	STMR	40	20	20	20	20	20	20	10
Corn, field	gluten meal	5-28-242	CC	STMR	40	20	10	25	20	10	25	5
Cotton	meal	5-01-617	PC	STMR	89	15	10	10	15	5	10	*
Cotton	hulls	1-01-599	R	STMR	90	*	*	*	*	*	*	*
Cotton	gin by-products	1-08-413	R	STMR	90	*	*	*	*	*	*	*
Distiller's grain	dried	5-00-518	CC	STMR	92	*	20	20	*	20	20	*
Flaxseed/linseed	meal	5-02-043	PC	STMR	88	10	20	10	10	20	10	*
Grape	pomace, wet	2-02-206	CC	STMR	15	*	*	10	*	*	10	*
Lupin seed	meal	NA	PC	STMR	85	*	10	25	*	10	25	*
Palm	kernel meal	5-03-486	PC	STMR	90	*	10	10	*	10	10	15
Peanut	meal	5-03-649	PC	STMR	85	15	20	10	15	20	10	*
Pineapple	process waste	4-03-722	R	STMR	25	*	*	*	*	*	*	*
Potato	process waste	4-03-777	CC	STMR	12	*	20	*	*	*	*	*
Potato	dried pulp	4-03-775	CC	STMR	88	*	10	*	*	20	*	*
Rape	meal	5-26-093	PC	STMR	88	*	10	15	*	20	15	20

FEEDSTUFFS				Reference Animals		SWINE						
						BREEDING			FINISHING			
				Regions		USA/ CAN	EU	AUS	USA /CAN	EU	AUS	JP
				Body weight (kg)		270	260	270	100	100	100	110
				Daily intake (DM in kg)		2	6	2.5	3.1	3	2.5	1
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)						
Rice	hulls	1-08-075	R	STMR	90	*	*	10	*	0	10	*
Rice	bran/pollard	4-03-928	R	STMR	90	10	10	30	10	0	20	10
Sesame seed	meal	5-04-220	PC	STMR	90	*	*	*	*	*	*	*
Safflower	meal	5-26-095	PC	STMR	91	15	*	20	15	*	20	*
Sorghum grain	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*	*
Soybean	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*	*
Soybean	Meal	5-20-638	PC	STMR	92	15	30	30	15	30	30	70
Soybean	Hulls	1-04-560	R	STMR	90	*	10	*	*	10	*	*
Soybean	okara, dried	NA	PC	STMR	92	*	*	*	*	*	*	*
Sugarcane	molasses	4-13-251	CC	STMR	75	*	*	*	*	*	*	*
Sugarcane	Bagasse	1-04-686	R	STMR	32	*	*	*	*	*	*	*
Sunflower	Meal	5-26-098	PC	STMR	92	15	10	30	15	10	30	*
Tomato	pomace, wet	NA	CC	STMR	20	*	*	*	*	*	*	*
Wheat	aspirated grain fraction	4-12-208	CC	STMR	85	*	*	*	*	*	*	*
Wheat gluten	meal	5-05-221	CC	STMR	40	10	10	25	10	10	25	*
Wheat	milled bypdts	4-06-749	CC	STMR	88	50	50	40	50	50	40	15

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Forages/Fodders																
Alfalfa	forage	2-00-196	R	HR	35	*	*	*	*	*	*	*	*	*	*	*
Alfalfa	hay	1-00-054	R	HR	89	*	*	*	*	*	*	*	*	*	*	*
Alfalfa	meal	1-00-023	R	HR	89	5	5	10	5	5	10	10	*	5	5	10
Alfalfa	silage	3-08-150	R	HR	40	*	*	*	*	*	*	*	*	*	*	*
Barley	forage	2-00-511	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Barley	hay	1-00-495	R	HR	88	*	*	*	*	*	*	*	*	*	*	*
Barley	straw	1-00-498	R	HR	89	*	*	*	*	*	5	*	*	*	*	*
Barley	silage	3-00-512	R	HR	40	*	*	*	*	*	*	*	*	*	*	*
Bean	vines	2-14-388	R	HR	35	*	*	*	*	*	*	*	*	*	*	*
Beet, mangel	fodder	2-00-632	R	HR	15	*	*	*	*	*	*	*	*	*	*	*
Beet, sugar	tops	2-00-649	R	HR	23	*	*	*	*	*	5	*	*	*	*	*
Cabbage, heads	leaves	2-01-046	R	HR	15	*	*	*	*	*	5	*	*	*	*	*
Clover	forage	2-01-434	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Clover	hay	1-01-415	R	HR	89	*	*	*	*	*	10	*	*	*	*	*
Clover	silage	3-01-441	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Corn, field	forage/silage	3-28-345	R	HR	40	*	*	*	*	*	10	*	*	*	*	*
Corn, field	stover	3-28-251	R	HR	83	*	*	*	*	*	*	*	*	*	*	*
Corn, pop	stover	2-02-963	R	HR	85	*	*	*	*	*	*	*	*	*	*	*
Corn, sweet	forage	1-08-407	R	HR	48	*	*	*	*	*	*	*	*	*	*	*
Corn, sweet	stover	NA	R	HR	83	*	*	*	*	*	*	*	*	*	*	*
Cowpea	forage	2-01-655	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Cowpea	hay	1-01-645	R	HR	86	*	*	*	*	*	*	*	*	*	*	*
Crown, vetch	forage	2-19-834	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Crown, vetch	hay	1-20-803	R	HR	90	*	*	*	*	*	*	*	*	*	*	*

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Grass	forage (fresh)	2-02-260	R	HR	25	*	*	*	*	*	*	*	*	*	*	*
Grass	hay	1-02-250	R	HR	88	*	*	*	*	*	*	*	*	*	*	*
Grass	silage	3-02-222	R	HR	40	*	*	*	*	*	*	*	*	*	*	*
Kale	leaves	2-02-446	R	HR	15	*	*	*	*	*	*	*	*	*	*	*
Lespedeza	forage	2-07-058	R	HR	22	*	*	*	*	*	*	*	*	*	*	*
Lespedeza	hay	1-02-522	R	HR	88	*	*	*	*	*	*	*	*	*	*	*
Millet	forage	2-03-801	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Millet	hay	1-03-119	R	HR	85	*	*	*	*	*	*	*	*	*	*	*
Millet	straw	1-23-802	R	HR	90	*	*	*	*	*	*	*	*	*	*	*
Oat	forage	2-03-292	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Oat	hay	1-03-280	R	HR	90	*	*	*	*	*	*	*	*	*	*	*
Oat	straw	1-03-283	R	HR	90	*	*	*	*	*	*	*	*	*	*	*
Oat	silage	3-03-298	R	HR	35	*	*	*	*	*	*	*	*	*	*	*
Pea	vines	3-03-596	R	HR	25	*	*	*	*	*	10	*	*	*	*	*
Pea	hay	1-03-572	R	HR	88	*	*	*	*	*	10	*	*	*	*	*
Pea	silage	3-03-590	R	HR	40	*	*	*	*	*	10	*	*	*	*	*
Peanut	hay	1-03-619	R	HR	85	*	*	*	*	*	*	*	*	*	*	*
Rape	forage	2-03-867	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Rice	straw	1-03-925	R	HR	90	*	*	*	*	*	*	*	*	*	*	*
Rice	whole crop silage	NA	R	HR	40	*	*	*	*	*	*	*	*	*	*	*
Rye	forage	2-04-018	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Rye	straw	1-04-007	R	HR	88	*	*	*	*	*	*	*	*	*	*	*
Rye	silage	3-04-020	R	HR	28	*	*	*	*	*	*	*	*	*	*	*
Sorghum, forage	see Grasses															

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Sorghum, grain	forage	2-04-465	R	HR	35	*	*	*	*	*	10	*	*	*	*	*
Sorghum, grain	stover	1-07-960	R	HR	88	*	*	*	*	*	10	*	*	*	*	*
Sorghum, grain	silage	3-04-323	R	HR	21	*	*	*	*	*	*	*	*	*	*	*
Soybean	forage	2-04-574	R	HR	56	*	*	*	*	*	10	*	*	*	*	*
Soybean	hay	1-04-558	R	HR	85	*	*	*	*	*	10	*	*	*	*	*
Soybean	silage	3-04-581	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Sugarcane	tops	2-04-692	R	HR	25	*	*	*	*	*	*	*	*	*	*	*
Trefoil	forage	2-20-786	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Trefoil	hay	1-05-044	R	HR	85	*	*	*	*	*	10	*	*	*	*	*
Triticale	forage	2-02-647	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Triticale	hay	NA	R	HR	88	*	*	*	*	*	*	*	*	*	*	*
Triticale	straw	NA	R	HR	90	*	*	*	*	*	*	*	*	*	*	*
Triticale	silage	3-26-208	R	HR	35	*	*	*	*	*	*	*	*	*	*	*
Turnip	tops (leaves)	2-05-063	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Vetch	forage	2-05-112	R	HR	30	*	*	*	*	*	10	*	*	*	*	*
Vetch	hay	1-05-122	R	HR	85	*	*	*	*	*	10	*	*	*	*	*
Vetch	silage	3-26-357	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Wheat	forage	2-08-078	R	HR	25	*	*	*	*	*	10	*	*	*	*	*
Wheat	hay	1-05-172	R	HR	88	*	*	*	*	*	10	*	*	*	*	*
Wheat	straw	1-05-175	R	HR	88	*	*	*	*	*	10	*	*	*	*	*
Wheat	silage	3-05-186	R	HR	30	*	*	*	*	*	*	*	*	*	*	*
Roots & Tubers																
Carrot	culls	2-01-146	CC	HR	12	*	10	*	*	*	10	*	*	*	10	*
Cassava/tapioca	roots	2-01-156	CC	HR	37	*	20	*	*	*	15	*	*	*	5	*
Potato	culls	4-03-787	CC	HR	20	*	10	*	*	*	10	*	*	*	20	*

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Swede	roots	4-04-001	CC	HR	10	*	10	*	*	*	10	*	*	*	10	*
Turnip	roots	4-05-067	CC	HR	15	*	10	*	*	*	10	*	*	*	10	*
Cereal Grains/Crops Seeds																
Barley	grain	4-00-549	CC	STMR	88	75	70	15	10	75	100	15	*	75	50	15
Bean	seed	4-00-515	PC	STMR	88	*	20	70	*	*	20	70	*	*	20	70
Corn, field	grain	4-20-698	CC	STMR	88	75	70	*	70	75	70	*	80	75	50	*
Corn, pop	grain	4-02-964	CC	STMR	88	75	*	*	70	75	*	*	80	75	*	*
Cotton	undelinted seed	5-01-614	PC	STMR	88	*	*	*	*	*	*	*	*	*	*	*
Cowpea	seed	5-01-661	PC	STMR	88	10	5	5	*	10	10	5	*	10	5	10
Lupin	seed	5-02-707	PC	STMR	88	10	15	15	*	10	10	10	*	10	10	50
Millet	grain	4-03-102	CC	STMR	88	60	70	70	*	60	70	60	*	60	50	15
Oat	grain	4-03-309	CC	STMR	89	75	70	15	*	75	70	15	*	75	50	5
Pea	seed	5-03-600	PC	STMR	90	20	20	5	*	20	20	5	*	20	20	40
Rice	grain	4-03-939	CC	STMR	88	20	*	50	*	20	*	50	*	20	*	60
Rye	grain	4-04-047	CC	STMR	88	35	70	50	*	35	35	35	*	35	60	60
Sorghum, grain	grain	4-04-383	CC	STMR	86	75	70	70	65	75	70	70	55	75	50	15
Soybean	seed	5-64-610	PC	STMR	89	20	20	15	*	20	15	15	*	20	15	15
Triticale	grain	4-20-362	CC	STMR	89	75	15	*	*	75	15	*	*	75	15	60
Vetch	seed	5-26-351	PC	STMR	89	*	*	*	*	*	*	*	*	*	*	*
Wheat	grain	4-05-211	CC	STMR	89	75	70	70	10	75	70	55	*	75	50	*
By-Products																
Almond	hulls	4-00-359	R	STMR	90	*	*	*	*	*	*	*	*	*	*	*
Apple	pomace, wet	4-00-419	CC	STMR	40	*	*	*	*	*	*	*	*	*	*	*
Barley	bran fractions	NA	CC	STMR	90	8	*	*	*	*	*	*	5	*	*	5
Beet, sugar	dried pulp	4-29-307	R	STMR	88	*	*	*	*	*	*	*	*	*	*	*

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Beet, sugar	ensiled pulp	4-00-662	R	STMR	15	*	*	*	*	*	*	*	*	*	*	*
Beet, sugar	molasses	4-30-289	CC	STMR	75	*	*	*	*	*	*	*	*	*	*	*
Brewer's grain	dried	5-00-516	CC	STMR	92	*	10	*	*	*	10	*	*	*	10	5
Canola	meal	5-08-136	PC	STMR	88	15	18	5	*	15	10	5	*	15	20	*
Citrus	dried pulp	4-01-237	R	STMR	91	*	*	*	*	*	*	*	*	*	*	*
Coconut	meal	5-01-572	PC	STMR	91	*	*	*	*	*	*	*	*	*	*	*
Corn, field	asp. grain fract.	4-12-208	CC	STMR	85	*	*	*	*	*	*	*	*	*	*	*
Corn, field	milled bypdts	5-28-235	CC	STMR	85	50	60	*	*	50	50	*	*	50	50	20
Corn, field	hominy meal	4-03-010	CC	STMR	88	20	*	20	*	20	20	20	*	20	20	*
Corn, sweet	cannery waste	2-02-975	CC	STMR	30	*	*	*	*	*	*	*	*	*	*	*
Corn, field	gluten feed	5-28-243	CC	STMR	40	*	10	*	*	*	*	*	10	*	*	*
Corn, field	gluten meal	5-28-242	CC	STMR	40	*	10	*	*	*	10	*	10	*	10	10
Cotton	meal	5-01-617	PC	STMR	89	20	5	10	*	20	5	10	*	20	10	*
Cotton	hulls	1-01-599	R	STMR	90	*	*	*	*	*	*	*	*	*	*	*
Cotton	gin by-products	1-08-413	R	STMR	90	*	*	*	*	*	*	*	*	*	*	*
Distiller's grain	dried	5-00-518	CC	STMR	92	*	10	*	5	*	10	*	5	*	10	*
Flaxseed/ linseed	meal	5-02-043	PC	STMR	88	20	10	*	*	20	10	*	*	20	10	*
Grape	pomace, wet	2-02-206	CC	STMR	15	*	*	*	*	*	*	*	*	*	*	20
Lupin seed	meal	NA	PC	STMR	85	*	10	20	*	*	10	20	*	*	10	*
Palm	kernel meal	5-03-486	PC	STMR	90	*	*	*	*	*	*	*	*	*	5	10
Peanut	meal	5-03-649	PC	STMR	85	25	10	10	*	25	10	10	*	25	10	*
Pineapple	process waste	4-03-722	R	STMR	25	*	*	*	*	*	*	*	*	*	*	*
Potato	process waste	4-03-777	CC	STMR	12	*	*	*	*	*	*	*	*	*	*	*
Potato	dried pulp	4-03-775	CC	STMR	88	*	20	*	*	*	15	*	*	*	*	5

Feedstuffs				Reference Animals		POULTRY										
						BROILER				LAYER				TURKEY		
				Regions		USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS	JP	USA/ CAN	EU	AUS
				Body weight (kg)		2	1.7	2	3	1.9	1.9	2	2	8	7	10
				Daily intake (kg DM)		0.16	0.12	0.15	0.11	0.12	0.13	0.15	0.1	0.5	0.5	0.4
Crop	Commodity	IFN Code	Classification	Residue Input	DM (%)	% of Diet (as fed)										
Rape	meal	5-26-093	PC	STMR	88	*	*	5	5	*	10	5	15	*	20	*
Rice	hulls	1-08-075	R	STMR	90	*	*	*	*	*	*	*	*	*	*	20
Rice	bran/pollard	4-03-928	R	STMR	90	10	10	20	5	10	5	20	20	10	*	15
Sesame seed	meal	5-04-220	PC	STMR	90	*	*	*	*	*	*	*	5	*	*	*
Safflower	meal	5-26-095	PC	STMR	91	25	10	15	*	25	5	15	*	25	5	*
Sorghum grain	asp. grain fract.	4-12-208	CC	STMR	85	*	*	*	*	*	*	*	*	*	*	*
Soybean	asp. grain fract.	4-12-208	CC	STMR	85	*	*	*	*	*	*	*	*	*	*	25
Soybean	meal	5-20-638	PC	STMR	92	25	40	25	35	25	25	25	30	25	45	*
Soybean	hulls	1-04-560	R	STMR	90	*	5	*	*	*	5	*	*	*	*	*
Soybean	okara, dried	NA	PC	STMR	92	*	*	*	*	*	*	*	*	*	*	*
Sugarcane	molasses	4-13-251	CC	STMR	75	*	*	*	*	*	*	*	*	*	*	*
Sugarcane	bagasse	1-04-686	R	STMR	32	*	*	*	*	*	*	*	*	*	*	15
Sunflower	meal	5-26-098	PC	STMR	92	25	10	15	*	25	10	15	*	25	10	*
Tomato	pomace, wet	NA	CC	STMR	20	*	*	*	*	*	*	*	*	*	*	*
Wheat	asp. grain fract.	4-12-208	CC	STMR	85	*	*	*	*	*	*	*	*	*	*	20
Wheat gluten	meal	5-05-221	CC	STMR	40	*	10	*	*	*	10	*	*	*	10	10
Wheat	milled bypdts	4-06-749	CC	STMR	88	50	20	20	5	50	20	20	30	50	20	20

Notes on the OECD Table of Feedstuffs Derived from Field Crops

10. The following parameters were taken into consideration to tabulate regional/national livestock feedstuffs and diets:

- Estimates of crop acreage for RACs with feedstuffs commodities/production volumes/availabilities (local vs. national; all year vs. seasonal);

- Specific crops grown only as feedstuff including locations/production and volumes/availabilities (local vs. national; all year vs. seasonal);

- Production volumes of livestock meat, milk, eggs for consumer markets; • Information about exports;

- Locations of meat/milk/egg production areas, random/centralized;

- Feedstuffs (RACs) imported;

- Livestock production trends including consideration of the relative importance of intensive (lot feeding) production systems and non-intensive (grazing) production systems, the likelihood of livestock consuming more defined and consistent rations;

- Production operations centralized/decentralized/intensive/non-intensive;

- Size of animals at slaughter or in milk or egg production;

- Type of feedstuff, based on local agricultural practice, e.g., growth stage or percent of dry matter in crops or pastures consumed.

11. The percent of feedstuffs in livestock daily rations for mature and marketable animals are best estimates based upon production data of livestock meat, milk, and eggs for human consumption. The percent of diet is expressed on a dry weight basis. The reference animals used for the table values are based on the listed body weights and daily dry matter intake. For data for feedstuffs other than those listed here, contact the appropriate regulatory authority.

12. IFN Codes stand for International Feed Nomenclature codes, which are listed for most commonly used feedstuffs from crops.

13. The classification of the feedstuff is represented by R: roughage; CC: carbohydrate concentrate; PC: protein concentrate.

14. The entry for residue input can be the highest residue (HR) or the supervised trial median residue (STMR), as appropriate. See the Feedstuffs Table 'Residue Input' column. Typically, in deriving appropriate values for the determination of MRLs/tolerances for livestock commodities, the HR would be used for raw agricultural commodities (RACs), except for blended RACs where the STMR is more appropriate. The STMR (or STMR-P) is used for most processed livestock feed commodities.

15. % DM represents the % dry matter. The % moisture should be reported for representative samples of raw agricultural and processed commodities.

16. An asterisk in the table indicates that item is not used or is a minor feedstuff (less than 5 % of livestock diet).

17. Label restrictions against feeding may be allowed; e.g., "Do not feed green immature growing plants to livestock", or, "Do not harvest for livestock feed." Registrant should contact the appropriate regulatory agency for allowable restrictions.

18. Information on the various crop commodities that represent forages, roots and tubers, cereal grains/crop seeds, and by-products is tabulated below (table 1).

Table 1. Information on Crop Commodities Representing Forages, Roots and Tubers, Cereal Grains/Crop Seeds, and By-products.

FORAGES	
Alfalfa	Residue data are needed from a minimum of three cuttings, unless climatic conditions restrict the number of cuttings. Cut sample at late bud to early bloom stage (first cut), and/or at early (one-tenth) bloom stage (later cuts).
Alfalfa meal (17% protein)	Residue data are not needed for meal; however, the meal should be included in the livestock diet, using the hay (HR/MRL). Alfalfa meal is chopped or ground alfalfa hay and is not significantly processed.
Alfalfa hay	Hay should be field dried to a moisture content of 10 to 20 %.
Alfalfa silage	Residue data on silage are optional, but are desirable for assessment of dietary exposure. Cut at late bud to one-tenth bloom stage for alfalfa, allow to wilt to approximately 60 % moisture, then chop fine, pack tight, and allow to ferment for three weeks maximum in an air-tight environment until it reaches pH 4. This applies to both silage and hay. In the absence of silage data, residues in forage will be used for silage, with correction for dry matter.
Barley Hay	Cut when the grain is in the milk to soft dough stage. Hay should be field dried to a moisture content of 10 to 20 %, BBCH 73 – 85.
Barley straw	Plant residue (dried stalks or stems with leaves) left after the grain has been harvested (threshed).
Barley silage	Residue data on silage are optional, but are desirable for assessment of dietary exposure. Growth stage for harvest varies. In the US, cut sample at boot to early head stage (BBCH 41 – 73), allow to wilt to 55 to 65 % moisture, then chop fine, pack tight, and allow to ferment for three weeks maximum in an air-tight environment until it reaches pH 4. In Europe, the growth stage at harvest is typically grain development (medium milk through soft dough), BBCH 75 – 85. In the absence of silage data, residues in forage will be used for silage, with correction for DM.
Beet, sugar, tops	Sugar beet tops are fed only to grazing beef cattle and sheep in some agricultural practices. The feeding practices may vary in different countries.
Cabbage, head	Heads at 80 % head formed. BBCH 41-48.
Clover forage	Cut sample at the 4-8 inch to pre-bloom stage, at approximately 30 % DM.
Clover hay	Cut at early to full bloom stage. Hay should be field dried to a moisture content of 10 to 20 %. Residue data for clover seeds are not needed.
Clover silage	Residue data on silage are optional, but are desirable for assessment of dietary exposure. Cut sample at early to one-fourth bloom stage for clover, allow to wilt to approximately 60 % moisture, then chop fine, pack tight, and allow to ferment

	for three weeks maximum in an air-tight environment until it reaches pH 4. This applies to both silage and hay. In the absence of silage data, residues in forage will be used for silage, with correction for dry matter. IFN codes are given for most commonly used red clover.
Corn, field and pop forage	Cut sample (whole aerial portion of the plant) at late dough/early dent stage (BBCH 81-BBCH 85); (black ring/layer stage (BBCH 87) for corn only).
Corn, field and pop stover	Mature dried stalks from which the grain or whole ear (cob + grain) have been removed; contains 80 to 85 % DM.
Corn, field and pop silage	Freshly cut samples may be analyzed, or ensiled samples after ensiling for three weeks maximum, and reaching pH 5 or less, with correction for % DM. Moisture content of forage for silage should be between 60% and 70%.
Corn, sweet forage	Samples should be taken when sweet corn is normally harvested for fresh market, and may or may not include the ears. Freshly cut samples may be analyzed, or ensiled samples after ensiling for three weeks maximum, and reaching pH 5 or less, with correction for % DM.
Cowpea forage	Cut sample at 6 inch to pre-bloom stage, at approximately 30 % DM.
Cowpea hay	Cut when pods are one-half to fully mature. Hay should be field dried to a moisture content of 10 to 20 %.
Crownvetch forage	Cut sample at 6 inch to pre-bloom stage, at approximately 30 % DM.
Crownvetch hay	Cut at full bloom stage. Hay should be field dried to a moisture content of 10 to 20 %.
Grass	Zero day crop field residue data for grasses grazed or cut for fodder should be provided unless it is not feasible, e.g., pre-plant/pre-emergent pesticide uses. A reasonable interval before cutting for hay is allowed.
Grass forage	Cut sample at 6-8 inch to boot stage, at approximately 25 % DM. BBCH 30 – 45.
Grass hay	Cut in boot to early head stage, BBCH 41 - 51. Hay should be field dried to a moisture content of 10 to 20 %. Included are sudangrass and sorghum forages and their hybrids. For grass grown for seed only, PGIs (pre-grazing interval) and PHIs (pre-harvest interval) are acceptable. Residue data may be based on the re-growth after harvesting the seed.
Grass silage	Residue data on silage are optional, but are desirable for assessment of dietary exposure. Cut sample at boot to early head stage, allow to wilt to 55 to 65 % moisture, then chop fine, pack tight, and allow to ferment for three weeks maximum in an air-tight environment until it reaches pH 4. In the absence of silage data, residues in forage will be used for silage, with correction for dry matter. For the three grass feed types in Japan, the listed values are the highest of % of Italian rye grass, orchard grass and timothy in diet for beef cattle and dairy cattle.
Lespedeza forage	Cut sample at 4-6 inch to pre-bloom stage, at 20 to 25 % DM.
Lespedeza hay	Annual/Korean. Cut at early blossom to full bloom stage. Sericea: Cut when 12-15 inches tall. Hay should be field dried to a moisture content of 10 to 20 %.
Millet forage	Cut sample at 10 inch to early boot stage, at approximately 30 % DM.
Millet hay	Cut at early boot stage or approximately 40 inches tall, whichever is reached first. Hay should be field dried to a moisture content of 10 to 20 %. Millet includes pearl millet.
Millet straw	Data are required for proso millet only.
Proso millet straw	Plant residue (dried stalks or stems with leaves) left after the grain has been harvested.

Oats forage	Cut sample from BBCH 30 (stem elongation) until BBCH 49 (end of booting stage)
Oats hay	Cut sample from early head or flower stage to soft dough stage, BBCH 51 - 85. Hay should be field-dried to a moisture content of 10 to 20 %.
Oats straw	Cut plant residue (dried stalks or stems with leaves) left after the grain has been harvested (threshed).
Pea, field	Does not include the canning field pea cultivars used for human food. It includes cultivars grown for livestock feeding only such as “Austrian winter pea”.
Pea, field vines	Cut sample anytime after pods begin to form, at approximately 25 % DM.
Pea, field hay	Succulent plant cut from full bloom through pod formation. Hay should be field-dried to a moisture content of 10 to 20 %.
Pea, field silage	Use field pea vine residue data for field pea silage, with correction for DM.
Peanut hay	Peanut hay consists of the dried vines and leaves left after the mechanical harvesting of peanuts from vines that have been sun-dried to a moisture content of 10 to 20 %.
Rapeseed forage	Cut sample up to the end of inflorescence emergence (BBCH 59)
Rice straw	Stubble (basal portion of the stems) left standing after harvesting the grain
Rye forage	Cut sample from BBCH 30 (stem elongation) until BBCH 49 (end of booting stage).
Rye straw	Cut plant residue (dried stalks or stems with leaves) left after the grain has been harvested (threshed).
Sorghum forage	Cut sample (whole aerial portion of the plant) at soft dough to hard dough stage, BBCH 83 - 85. Forage samples should be analyzed as is, or may be analyzed after ensiling for three weeks maximum, and reaching pH 5 or less, with correction for DM.
Sorghum stover	Mature dried stalks from which the grain have been removed; contains approximately 85 % DM.
Soybean forage	Cut samples at 6-8 inches tall (sixth node) to beginning pod formation, at approximately 35 % DM, BBCH 16 - 71.
Soybean hay	Cut samples at mid-to-full bloom and before bottom leaves begin to fall or when pods are approximately 50 % developed BBCH 65 - 91. Hay should be field dried to a moisture content of 10 to 20 %.
Soybean silage	Residue data on silage are optional. Harvest sample when pods are one-half to fully mature (full pod stage). In the absence of silage data, residues in forage will be used for silage, with correction for DM.
Trefoil forage	Cut sample at 5-10 inch or early bloom stage, at approximately 30 % DM.
Trefoil hay	Cut at first flower to full bloom. Hay should be field dried to a moisture content of 10 to 20 %.
Vetch forage	Cut sample at 6 inch to pre-bloom stage, at approximately 30 % DM.
Vetch hay	Cut at early bloom stage to when seeds in the lower half of the plant are approximately 50 % developed. Hay should be field dried to a moisture content of 10 to 20 %. Vetch does not include crownvetch.
Wheat	Includes emmer wheat and triticale.
Wheat forage	Cut sample from BBCH 30 (stem elongation) until BBCH 49 (end of booting stage). It is noted that this procedure usually applies to emergency situations (drought, crop failure, lack of feedstuff).
Wheat hay	Cut samples at early flower (boot) to soft dough stage, BBCH 41 - 85. Hay should be field dried to a moisture content of 10 to 20 %.

Wheat straw	Cut plant residue (dried stalks or stems with leaves) left after the grain has been harvested (threshed).
ROOTS AND TUBERS	
Carrot culls	Residue data for the raw agricultural commodity will cover residues on culls.
Cassava/tapioca roots	The whole root chipped mechanically into small pieces, then dried, and the dried chips pelted.
Potato culls	Whole unpeeled potato not suited for fresh market or processing.
CEREAL GRAINS/CROP SEEDS	
Barley or oat grain	Residue data are needed for kernel (caryopsis) with hull (lemma and palea).
Bean, cowpea, lupin, soybean, vetch seed	Residue data are needed for mature, dried seed.
Corn, field and pop grain	Residue data are needed for mature kernel (caryopsis) with cob removed.
Cotton, undelinted seed	Whole seed removed in the ginning process and still has fine cotton fibers attached.
Millet grain	Residue data are needed for kernel plus hull (lemma and palea).
Pearl millet grain	Residue data are needed for kernel with hull (lemma and palea) removed.
Rice grain	Residue data are needed for kernel (caryopsis) either with hull **or** without hull. Registrant should contact appropriate regulatory agency for their specific data needs for rice grain.
Rye, triticale, wheat, or sorghum grain	Residue data are needed for kernel (caryopsis) with hull (lemma and palea) removed.
BY-PRODUCTS	
Note: In the USA/CAN region, no more than one by-product per reference animal of those listed with an asterisk (*) would be included in a diet.	
Almond hulls*	Dried pericarp which surrounds the nut.
Apple pomace, wet*	Wet apple pomace includes by-products of the apple processing industry, such as remains from cider production; stems, cores, and peelings after the preparation of apple juice and sauce for human consumption.
Aspirated grain fractions (grain dust)*	Dust collected at grain elevators during the moving/handling of grains/oilseeds for environmental and safety reasons. Residue data should be provided for any post-harvest use on corn, sorghum, soybeans or wheat. For a pre-harvest use after the reproduction stage begins and seed heads are formed, data are needed unless residues in the grain are less than the limit of quantitation of the analytical method. For a pre-harvest use during the vegetative stage (before the reproduction stage begins), data will not normally be needed unless the plant metabolism or processing study shows a concentration of residues of regulatory concern in an outer seed coat (e.g., wheat bran, soybean hulls).
Beet, sugar, dried pulp	Dried material remaining from sugar beets which have been cleaned and freed from crowns, leaves and sand which has been extracted in the process of manufacturing sugar. Moisture content should be defined.
Beet, sugar molasses	The by-product of the manufacture of sucrose from sugar beets, and contains not less than 48% total sugars expresses as invert and its density determined by double dilution must not be less than 79.5 Brix.
Brewer's grain	Dried extracted residue of barley malt alone or in a mixture with other cereal grain or cereal products resulting from the manufacture of wort or beer and may contain pulverized dried spent hops in an amount not to exceed 3%, evenly distributed. Moisture content should be defined.

Canola meal	Meal obtained after the removal of most of the oil by direct solvent or prepress solvent extraction process.
Citrus dried pulp*	The ground peel, residue of the inside portions, and occasional fruits of the citrus family which have been dried, producing a coarse, flaky product. It may contain dried citrus meal or pellets and whole citrus seeds.
Coconut meal	The ground residue which remains after removal of most of the oil from dried meat of coconut by a mechanical or solvent extraction process.
Corn, field milled by-products	Dry milled: grits, meal, flour and refined oil. For the calculation of dietary burdens the highest concentration for grits, meal, and flour should be considered.
Corn, field hominy meal	A mixture of corn bran, germ, and part of starchy portion of corn kernels as produced in making of pearl hominy, hominy grits, or table meal (< 4% fat).
Corn, field gluten feed	Part of the commercial shelled corn that remains after the extraction of the larger portion of the starch, gluten, and germ by the processes employed in wet milling of field corn.
Corn, field gluten meal	The dried residue from corn after the removal of the larger portion of the starch and germ, and the separation of the bran by the process employed in wet milling of field corn.
Corn, sweet	Residue data on early sampled field corn should suffice to provide residue data on sweet corn, provided the residue data are generated at the milk stage on kernel plus cob with husk removed and there are adequate numbers of trials and geographical representation from the sweet corn growing regions.
Corn, sweet cannery waste*	Includes husks, leaves, cobs, and kernels. Residue data for forage will cover sweet corn cannery waste.
Cotton meal	Material obtained by finely grinding the cake which remains after removal of most of the oil from the cottonseed either by a mechanical or solvent extraction process.
Cotton hulls	Consists primarily of the outer covering of the harvested cottonseed.
Cotton gin by-products*	Commonly called gin trash. Includes the plant residues from ginning cotton, and consist of burrs, leaves, stems, lint, immature seeds, and sand and/or dirt. Cotton must be harvested by commercial equipment to provide an adequate representation of plant residue for the ginning process. Two field trials for harvesting of stripper cotton are needed. No data are needed for picker cotton.
Distiller's grains	The material obtained after distillation of ethyl alcohol from grain or grain mixture which has under gone yeast fermentation. Moisture content should be defined.
Flaxseed/linseed meal	The ground residue which remains after removal of most of the oil from the whole flaxseed by a mechanical or solvent extraction process.
Grape pomace, wet	Wet debris left behind after fruit have been pressed for juice, also called "marc". Moisture content should be defined.
Lupin seed meal	The ground residue which remains after removal of most of the oil from the whole lupin seed by a mechanical or solvent extraction process.
Palm kernel meal	The ground residue which remains after removal of most of the oil from the whole palm kernel by a mechanical or solvent extraction process.
Peanut meal	The ground residue which remains after removal of most of the oil from the shelled nut by a mechanical or solvent extraction process.
Pineapple process residue (wet bran)*	A wet waste by-product from the fresh-cut product line that includes pineapple tops (minus crown), bottoms, peels, any trimmings with peel cut up, and the pulp (left after squeezing for juice); it can include culls.

Potato, processed waste*	Includes wet and dry peel, raw chip, French fries, and cooked potatoes. Highest residues for wet peel should be used for dietary burden calculations. Residue data may be provided from actual processed potato waste generated using a pilot or commercial scale process that gives the highest % of wet peel in the waste.
Rapeseed meal	Meal obtained after the removal of most of the oil by direct solvent or prepress solvent extraction process Residue data are not needed for rapeseed meal in cases where it is produced for industrial uses and use for feedstuff is excluded. In North America the edible meal is only produced from canola seeds. (See canola meal).
Rice hulls	Consist primarily of the outer covering of the rice grain (with bran).
Safflower meal	The ground residue which remains after removal of most of the oil from the whole safflower seed by a mechanical or solvent extraction process.
Soybean okara	Okara or soy pulp is a white or yellowish pulp consisting of insoluble parts of the soybean which remain in the filter sack when pureed soybeans are filtered in the production of soy milk. As a significant by-product of soy milk and tofu manufacturing, okara (dried) is used as animal feed.
Soybean meal	Material obtained by grinding the cake or chips which remain after the removal of most of the oil by solvent extraction process.
Sugarcane molasses	Residue data are needed for blackstrap molasses.
Sugarcane bagasse	Sugarcane bagasse is mainly used for fuel in some countries, but its uses may vary depending on the agricultural practices of the country.
Sunflower meal	The ground residue which remains after removal of most of the oil from the whole sunflower seed by a mechanical or solvent extraction process.
Tomato pomace, wet	By-product of tomato paste production consisting mainly of skins and seeds.
Wheat milled by-products	For the calculation of dietary burdens the highest value for wheat middlings, bran and shorts should be considered.

ANNEX II: EXAMPLE OF DIETARY BURDEN CALCULATION FOR BEEF CATTLE AND SELECTION OF APPROPRIATE DOSE LEVELS FOR LIVESTOCK FEEDING STUDY TO SUPPORT GLOBAL REGISTRATION FOR MRL SETTING

1. Two types of dietary burden can be calculated. Maximum burdens, addressed herein, are used for the estimation of MRLs for livestock commodities and also for acute dietary risk assessment. The other type, STMR (supervised trial median residue) burden, is utilized for chronic dietary risk assessment and is not considered here**.**

2. Steps to follow:

- Prepare a list of all of the potential feedstuffs associated with the target crop(s), sorted by commodity categories as indicated in the Harmonised Table of Feedstuffs (see Annex I). For example, for a use proposed on field corn, associated feedstuffs include forage/silage, stover, grain, aspirated grain fractions, milled by-products, hominy meal, corn gluten meal, and corn gluten feed.

- Determine the appropriate residue input for each feedstuff. For example, for forages, the highest residue (HR) from the supervised field trials is used; for potentially blended commodities (grains, by-products), the median residue (STMR) from the supervised field trials is used.

- For calculation in a given region (US/Canada, EU, etc), consider imported treated feeds. In addition to the domestic or regional uses, it is necessary to consider imported feed items significant in trade that might contain the pesticide of interest where a domestic (or regional) use does not exist. Generally use the highest/STMR level available for commodities that are in substantial international trade. This would exclude fresh forages and silages and some other feed commodities that are mainly domestic. Codex MRL lists and the related reports may be consulted to obtain information on livestock feed commodities treated with a specific pesticide that may be imported (see http://www.codexalimentarius.net/pestres/data/index.html?lang=en). However, this source is not comprehensive and lack of information may often make this refinement impossible.

- Calculate the total potential dietary contribution (for cattle) for each commodity according to the equation below.

$$\text{Dietary Contribution (mg/kg bw)} = \frac{\text{Residue level (mg/kg)} \times \text{\% Diet} \times \text{Daily Feed Intake (kg)}}{\text{\% DM} \times \text{Animal Body wt (kg)}}$$

- The dietary burden is then calculated by summing up the individual dietary contributions from the appropriate feedstuffs for each reference animal, based on the predominant feeding practices within each region: a maximum reasonably balanced diet approach is used for regions where intensive feeding practices predominate (e.g. USA/CAN), while a reasonable worst case diet/feed approach (RWCF) is used for regions where non-intensive feeding practices predominate (EU, Australia, Japan).

3. An example is given for beef cattle, but the same principle would apply to other livestock species such as dairy cattle, sheep, swine, or poultry. It illustrates the calculation of a dietary burden

based on maximum reasonably balanced diet approach (intensive husbandry) and reasonable worst-case diet (non-intensive husbandry). In this simple example, an active substance is intended to be registered in the United States, Canada, member states of the European Union, Australia, and Japan for a range of food crops and feedstuffs: corn, alfalfa, and potatoes (see Tables 1 – 7 below). No information was available on the potato culls and potato dried pulp.

Table 1. Information on food crops and feedstuffs used in the example.

Feedstuffs	Commodity Category	Commodity Classification	Dry matter content (%)	Residue levels (HR or STMR) (mg/kg)
Forages				
Alfalfa	forage	R	35	5
Alfalfa	hay	R	89	10
Alfalfa	meal	R	89	10
Alfalfa	silage	R	40	5
Corn, field	forage/silage	R	40	0.02
Corn, field	stover	R	83	0.02
Roots & Tubers				
Potato	-culls	CC	20	0.9
Cereal Grains/Crops Seeds				
Corn, field	grain	CC	88	0.02
By-Products				
Corn, field	aspirated grain fractions	CC	85	2
Corn, field	milled by-products	CC	85	1
Corn, field	hominy meal	CC	88	0.3
Corn, field	gluten feed	CC	40	0.2
Corn, field	gluten meal	CC	40	0.2

Notes: CC = carbohydrate concentrate; R = roughage; PC = protein concentrate

a) Calculation using the Reasonable Worst-Case Diet (non-intensive feeding; not used in NAFTA[1] region)

i) Based on EU numbers

Several crop commodities are listed e.g. for forages, alfalfa hay and meal contains the highest residue in the RAC, but the highest dietary contribution for that commodity results from alfalfa forage, as it can contribute 70% to the total diet and when multiplied with the residue level with a correction for dry matter content, it is the highest single contributor to the dietary burden (Table 2).

Table 2. Calculation of Dietary Contribution in Beef Cattle Based on EU Numbers.

Feedstuffs	Commodity Category	DM (%)	Diet (%)	Daily intake (kg)	Body weight (kg)	HR or STMR (mg/kg)	HR or STMR (mg/kg DM)	Dietary Contribution % intake (mg/kg bw)	Dietary Contribution[2] (mg/kg bw)
Forages									
Alfalfa	forage	35	70	12	500	5	14.29	0.003	0.240
Alfalfa	silage	40	25	12	500	5	12.5	0.003	0.075
Corn, field	forage/silage	40	80	12	500	0.02	0.05	<0.001	0.001
Corn, field	stover	83	25	12	500	0.02	0.02	<0.001	<0.001
Alfalfa	hay	89	0	12	500	10	11.24	-	0
Alfalfa	meal	89	0	12	500	10	11.24	-	0
Roots/tubers									
Potato	culls	20	30	12	500	0.9	4.5	0.001	0.032
Cereal grains									
Corn, field	grain	88	80	12	500	0.02	0.02	< 0.001	< 0.001
By-products									
Corn, field	milled by-pdts	85	30	12	500	1	1.18	< 0.001	0.008
Corn, field	gluten feed	40	30	12	500	0.2	0.5	< 0.001	0.005
Corn, field	gluten meal	40	15	12	500	0.2	0.5	< 0.001	0.002
Corn, field	Asp. grain fr	85	0	12	500	2.0	2.35	-	0
Corn, field	hominy meal	88	0	12	500	0.3	0.34	-	0

[1] North American Free Trade Agreement
[2] Dry feed weight basis.

In the category roots/tubers only a use in potato is foreseen. The dietary contribution of potato culls is up to 30%. When multiplied by the residue level and corrected for dry matter content, the dietary burden is calculated as 0.0.032 mg/kg bw.

The dietary burden calculated for cereal grains and by-products is lower than for the categories forages and root/tubers. As forages and root/tuber intake sums up to 100% of the daily diet, the dietary burden from cereals and by-products will therefore not be taken into account

Within each category (Forages, Roots/tubers, etc.) the *one* feedstuff with the greatest pesticide residue contribution to the diet should be selected. Note that the percent dry weight and percent contribution to the diet of each potential feedstuff must be considered to ascertain which commodity in each category contributes the greatest residue. In some cases, selection of one feedstuff from each category may not produce 100% of the diet. In such cases, the remainder of the diet is considered to contain no pesticide residue (see Table 3).

Table 3. Calculation of Dietary Burden in Beef Cattle Based on EU Numbers.					
Category	**Commodity**	**% Diet**	**Dietary Contribution**	**Adjusted % Diet**	**Adjusted Dietary Contribution[1] (mg/kg bw)**
Forages	Alfalfa forage	70	0.240	70	0.240
Roots/tubers	Potato culls	30	0.032	30	0.032
Cereal grains	Corn grain	80	0	0	0
By-products	Corn milled by-pdts	30	0	0	0
TOTAL	-	210	0.272	**100**	**0.272**

[1] Dry feed weight basis.

ii) Based on Australia numbers

In the calculation based on Australia numbers the residue level in alfalfa forage leads to the highest dietary contribution (Table 4).

Table 4. Calculation of Dietary Contribution in Beef Cattle Based on Australia Numbers.									
Feedstuffs	Commodity Category	DM (%)	Diet (%)	Daily intake (kg)	Body weight (kg)	HR or STMR (mg/kg)	HR or STMR (mg/kg DM)	Dietary Contribution % intake (mg/kg bw)	Dietary Contribution (mg/kg bw)[1]
Forages									
Alfalfa	forage	35	100	20	500	5	14.29	0.006	0.572
Alfalfa	silage	40	100	20	500	5	12.50	0.005	0.500
Alfalfa	hay	89	80	20	500	10	11.24	0.005	0.359
Alfalfa	meal	89	40	20	500	10	11.24	0.005	0.180
Corn, field	forage/silage	40	80	20	500	0.02	0.05	<0.001	0.002
Corn, field	stover	83	40	20	500	0.02	0.024	<0.001	<0.001
Roots/tubers									
Potato	culls	20	10	20	500	0.9	4.5	0.002	0.018
Cereal grains									
Corn, field	grain	88	80	20	500	0.02	0.02	<0.001	0.001
By-products									
Corn, field	milled by-pds	85	15	20	500	1	1.18	<0.001	0.007
Corn, field	gluten feed	40	20	20	500	0.2	0.5	<0.001	0.004
Corn, field	gluten meal	40	20	20	500	0.2	0.5	<0.001	0.004
Corn, field	hominy meal	88	40	20	500	0.3	0.34	<0.001	0.005
Corn, field	Asp. grain ft	85	0	20	500	2	2.35	-	0

[1] Dry feed weight basis.

Alfalfa silage also leads to a high dietary contribution. Both commodities (alfalfa forage and alfalfa silage) can contribute 100% of the daily feed intake, but of course only one is taken into account in the RWCF approach; all other commodities do not need to be considered further (see Table 5).

Table 5. Calculation of Dietary Burden in Beef Cattle Based on Australia Numbers.					
Category	Commodity	% Diet	Dietary Contribution (mg/kg bw)	Adjusted % Diet	Adjusted Dietary Contribution (mg/kg bw)[1]
Forages	Alfalfa forage	100	0.572	100	0.572
Roots/tubers	Potato culls	10	0.018	0	0
Cereal grains	Corn grain	80	0.001	0	0
By-products	Corn milled by-pdts	15	0.007	0	0
TOTAL	-	205	0.590	**100**	**0.572**

[1] Dry feed weight basis.

iii) Based on Japan Numbers

Based on Japan numbers alfalfa hay or meal results in the highest dietary burden of 0.022 mg/kg bw (Table 6).

Table 6. Calculation of Dietary Contribution in Beef Cattle Based on Japan Numbers									
Feedstuffs	Commodity Category	DM (%)	Diet (%)	Daily intake (kg)	Body weight (kg)	HR or STMR (mg/kg)	HR or STMR (mg/kg DM)	Dietary Contribution % intake (mg/kg bw)	Dietary Contribution (mg/kg bw)[1]
Forages									
Alfalfa	hay	89	10	14	730	10	11.24	0.002	0.022
Alfalfa	meal	89	10	14	730	10	11.24	0.002	0.022
Alfalfa	forage	35	0	14	730	5	14.29	-	0
Alfalfa	silage	40	0	14	730	5	12.5	-	0
Corn, field	Forage/silage	40	0	14	730	0.02	0.05	-	0
Corn, field	stover	83	0	14	730	0.02	0.024	-	0
Roots/tubers									
Potato	culls	20	0	14	730	0.9	4.5	-	0
Cereal grains									
Corn, field	grain	88	75	14	730	0.02	0.02	0	0.001
By-products									
Corn, field	milled by-pds	85	5	14	730	1	1.18	<0.001	0.001
Corn, field	gluten feed	40	25	14	730	0.2	0.5	<0.001	0.002
Corn, field	hominy meal	88	35	14	730	0.3	0.34	<0.001	0.002
Corn, field	gluten meal	40	0	14	730	0.2	0.5	-	0
Corn, field	aspirated grain fts	85	0	14	730	2	2.35	-	0

[1] Dry feed weight basis.

One commodity from each category is considered per crop category, contributing up to the maximum allowed percentage of that commodity to the daily feed ration. The dietary burden from the category potato culls is zero. The dietary burden from field corn grain (maize grain) is very low; field corn grain could contribute 75% to the diet but the dietary contribution is low. In the category by-products, field corn gluten feed and hominy meal each contribute to the dietary burden with 0.002 mg/kg bw, and 25 %

(gluten) to the diet. When added to alfalfa hay this results in 35% to the diet, therefore another 65% needs to be added in the form of grain (field corn) (Table 7).

Table 7. Calculation of Dietary Burden in Beef Cattle Based on Japan Numbers.

Category	Commodity	% Diet	Dietary Contribution (mg/kg bw)	Adjusted % Diet	Adjusted Dietary Contribtution (mg/kg bw)[1]
Forages	Alfalfa hay and/or meal	10	0.022	10	0.022
Roots/tubers	Potato culls	0	0	0	0
Cereal grains	Corn, field	75	0.001	65	<0.001
By-products	Corn gluten feed	25	0.002	25	0.002
TOTAL	-	110	0.024	**100**	**0.024**

[1] Dry feed weight basis.

It is suggested that for practical purposes, the dietary burden is rounded to a maximum of 3 decimal places when expressed as mg/kg bw (=1µg/kg bw).

b) Calculation example using the Maximum Reasonably Balanced Diet (MRBD, Intensive Feeding)

In the USA/CAN, feedstuffs are categorized according to roughage, carbohydrate, and protein content given. Roughage (R) includes forage, silage, hay, hulls, leaves and vines. Carbohydrate Concentrate (CC) comprises cereal grains, grain milled by-products and waste. Protein Concentrate (PC) consists of oilseed meals, seeds, and alfalfa meal. Entries for the USA/CAN in Table 8 below include consideration of the maximum percentages of the three classes.

Table 8. Feedstuff Classification and Target Daily Ration for MRBD.

Classification	Beef[1]	Dairy	Poultry		Swine
			Laying	Broiler, Turkey	
Roughage (R)	15%	45%	--	--	--
Carbohydrate Concentrate (CC)	80%	45%	75%	85%	85%
Protein Concentrate (PC)	5%	10%	25%	15%	15%

[1] Also applies to sheep (ram/ewe, lamb).

Within each classification (R, CC, PC), the feedstuffs for each animal (cattle, poultry, sheep, swine) with the highest pesticide residue calculated on a dry weight basis should be selected until the Target Daily Ration is reached (Tables 9 and 10). Note that more than one feedstuff may be included in each classification until the target percent of ration is achieved (this differs from the approach for the reasonable worst-case diet (RWCF); see paragraph 13 of the Guidance Document).

Table 9. Calculation of Dietary Contributions for Beef Cattle Based on USA/CAN Input Values.

Feedstuff	**Commodity Category**	**DM (%)**	**Diet (%)**	**Animal Daily intake (kg)**	**Animal Body weight (kg)**	**Highest Residue or STMR (mg/kg)**	**Highest Residue or STMR (mg/kg DM)**	Dietary Contribution per percent intake (mg/kg bw)	**Dietary Contribution (mg/kg bw)[1]**
Roughage (R) (Maximum 15%)									
Alfalfa	hay	89	15	9.1	500	10	11.24	0.002	0.031
Alfalfa	forage	35	0	9.1	500	5	14.29	-	0
Alfalfa	silage	40	0	9.1	500	5	12.5	-	0
Corn, field	silage	40	15	9.1	500	0.02	0.05	<0.001	< 0.001
Corn, field	stover	83	15	9.1	500	0.02	0.024	<0.001	<0.001
Carbohydrate (CC) (Maximum 80%)									
Corn	gluten feed	40	75	9.1	500	0.2	0.5	<0.001	0.007
Corn	gluten meal	40	75	9.1	500	0.2	0.5	<0.001	0.007
Corn	hominy meal	88	50	9.1	500	0.3	0.34	<0.001	0.003
Corn, field	grain	88	80	9.1	500	0.02	0.02	<0.001	< 0.001
Corn, field	milled by-products	85	50	9.1	500	1	1.18	<0.001	0.011
Corn, field	aspirated grain fractions	85	5	9.1	500	2	2.35	<0.001	0.002
Potato	process cull	20	30	9.1	500	0.9	4.5	<0.001	0.025
Protein (PC) (Maximum 5%)									
Alfalfa	meal	89	0	9.1	500	10	11.24	-	0

[1] Dry feed weight basis for beef and dairy cattle.

Table 10. Dietary Burden Calculation for Beef Cattle using USA/CAN Input Values.

Category	**Commodity**	**% Diet**	**Highest Dietary Contribution (mg/kg bw)**
15% Roughage	Alfalfa hay	15	0.031
80% Carbohydrate	Potato cull	30	0.025
	Aspirated grain fraction (corn)	5	0.002
	Corn milled by-products	45	0.010
5% Protein	Alfalfa meal	0	0
TOTAL		**95**	**0.068**

c) International Dose Selection

Dietary burdens calculated for the four regions are summarised below (Table 11).

Table 11: Anticipated Dietary Burdens For Beef Cattle Across All Regions.	
Region	**Dietary Burden [mg/kg bw][1]**
EU	0.27
Australia	0.57
Japan	0.03
USA/Can	0.07

[1] values have been rounded to two decimal places; the value for Japan has been rounded to encompass the estimated burden

Based on these values, the lowest dose to be administered to beef cattle would be 0.03 mg/kg bw, (*i.e.* the Japanese dietary burden).

Table 12: International Dose Selection Based on Dietary Burden Calculations From All Regions.		
Livestock		**Dose Level (mg/kg bw)**
Beef Cattle	1×	0.03
Beef Cattle	3×	0.09
Beef Cattle	10×	0.3
Beef Cattle	20×	0.6

Therefore, a dose level of 0.03 mg/kg body weight is selected as the international 1× dose level for the livestock feeding study (Table 12). The 10× dose would therefore be 0.3 mg/kg body weight. However, a higher dose level (0.6 mg/kg bw, or 20×) is needed to encompass the anticipated Australian dietary burden. The mid-range dose might be selected at 0.3 mg/kg bw (10×) to accommodate the anticipated European dietary burden. Note that even a dose level of 20× offers little flexibility to change good agricultural practices that might lead to an even higher dietary burden in Australia.

Given the variability of the dietary burdens in the different regions, it would be recommended to add a fourth dose level (3×) to ensure an appropriate distribution of doses for a more accurate estimation of the anticipated residues. Note that in practice, it would be necessary to also calculate the anticipated dietary exposure of dairy cattle. The highest exposure from either dairy or beef cattle would then be selected (from within the lowest dietary exposure across the regions).

ANNEX III: USE OF JOINT FAO/WHO MEETING ON PESTICIDE RESIDUESMETHODOLOGY TO ESTIMATE AND SET MRLS FOR COMMODITIES OF ANIMAL ORIGIN

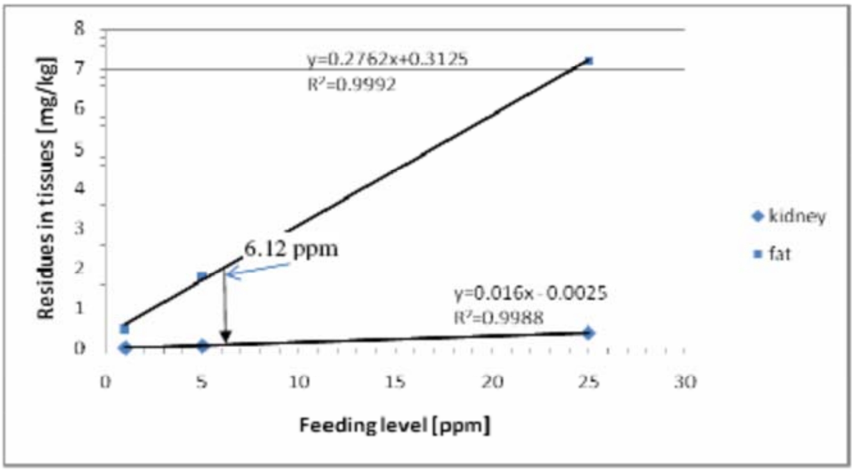
Determination of Anticipated Residues and MRL Setting from Feeding Studies

19. Two cases follow to illustrate the determination of anticipated residues from livestock feeding studies for the establishment of MRLs. This is based on documented Joint FAO/Who Meeting on Pesticide Residues (JMPR) examples used for setting MRLs for commodities of animal origin. The Food and Agriculture Organization of the United Nations (FAO) Manual (2009) (1) details the most recent JMPR procedures. The ideal situation is shown in the following text and example taken from FAO (2009) (1), section 6.12.1.1, pages 116 - 118:

> *The calculations of dietary burden are compared with the feeding levels in studies of farm animals to estimate maximum residue levels and STMR values on the basis of the following guidelines.*
>
> - *When a feeding level in a feeding study matches the dietary burden, the residue levels reported in the study can be used directly as estimates of residue levels in tissues, milk and eggs resulting from the dietary burden.*
>
> - *When a feeding levels in a feeding study differs from the dietary burden, the resulting residues in tissues, milk and eggs can be estimated either by interpolation between the closest feeding levels or calculation from the linear regression equation if good fit is observed as shown in the figure.*
>
> - *When the dietary burden is below the lowest feeding level in the study, the resulting residues in tissues, milk and eggs can be estimated by applying the transfer factor (residue level in milk or tissue ÷ residue level in diet) at the lowest feeding level to the dietary burden. [The lowest feeding level should be within about 30% of the dietary burden.]*
>
> - *When the dietary burdens of beef and dairy cattle are different, the higher value should be used for calculating the residues in muscle, fat, liver and kidney.*

For the example illustrated below (FAO, 2009; section 6.12.1.1, p. 117) (1), the maximum dietary burden is calculated as 6.12 mg/kg. The feeding study (dairy cattle) was conducted at 1, 5, and 25 ppm. FAO (2009) (1) recommends that for MRL estimation in this case, the highest residues in the tissues are calculated by interpolating the maximum dietary burden (6.12 mg/kg) between the relevant feeding levels (5 and 25 ppm) from the dairy cow feeding study and using the highest tissue concentrations from individual animals within those feeding groups. Using the linear regression equations (see figure 1 below), the residue level in fat is estimated as 2.0 mg/kg [$y = (0.2762 \times 6.12) + 0.3125$]. Using the result at the 5 ppm feeding study level (1.8 mg/kg), the residue level in fat is estimated as 2.2 mg/kg ($y = 6.12/5 \times 1.8$). Using the result of the 25 ppm feeding study (7.2 mg/kg), the residue level in fat is estimated as 1.8 mg/kg ($y = 6.12/25 \times 7.2$) Using the recommended linear interpolation {that is, $y_2 = [(x_2 – x_1).(y_3 – y_1) / (x_3 – x_1)] + y_1$, or $y_2 = [(6.12 - 5).(7.2 – 1.8)/(25 – 5)] + 1.8$} gives 2.1 mg/kg. The various techniques give very similar results (1.8, 2.0, 2.2, 2.1), because of the very good linear relationship. The higher value (2.2 mg/kg) would be selected for use in estimation of the fat MRL.

Figure 1: Residues in Tissues as a Function of Feeding Level (FAO 2009)



Reproduced from FAO (2009) (1)

Case 1: Transfer of Chlorpyrifos Residues in Cattle[2]

In most livestock feeding studies the dose response will be *approximately* linear as demonstrated in the example of chlorpyrifos in non-lactating cattle (JMPR 2000, p. 165-403[2]) (2). The residues of interest are in the fat of the animals, where residues in three fat depots, as stated in OECD TG 505, have been analysed for chlorpyrifos. It is recommended that the reader refer to JMPR (2000) to see the raw data and how the figures have been derived. In this example, data for cattle are used to demonstrate the JMPR methodology.

OECD TG 505 states that the administered dose should be reported as mg/kg in the diet, mg/animal/day and mg/kg bodyweight/day. When plotting the dose response curves, it is preferable to plot the residues observed vs the dose administered on a mg/kg bw basis. This is particularly important where two or more studies for a single species are being compared. However if a single study is being reviewed, mg/kg in the diet or feed (mg/kg or ppm (JMPR) in the feed) is acceptable, providing details of the feed intakes, individual animal bodyweights and doses administered per animal have been reviewed and meet the test guideline objectives. Individual bodyweights must be comparable.

In the chlorpyrifos 30-day cattle feeding study, the four dose levels of 3, 10, 30 and 100 ppm show a somewhat linear relationship over each of the fat depots, through zero, with the highest residues being observed in renal fat. While the mean values for each fat depot are plotted to demonstrate the degree of linearity, the range of the residue values at each dose level and for each fat depot should be noted for MRL setting, such that the MRL is set high enough to accommodate the variation in residues observed for the individual animals at each dose level.

The residue data for cattle tissues are provided in Table 1. The mean residues in cattle fat are shown below (Figure 2). While each depot shows the same trend, the linearity is only approximate. In such cases, the transfer factor approach is preferred, that is, the transfer factor nearest the feeding level of interest or the

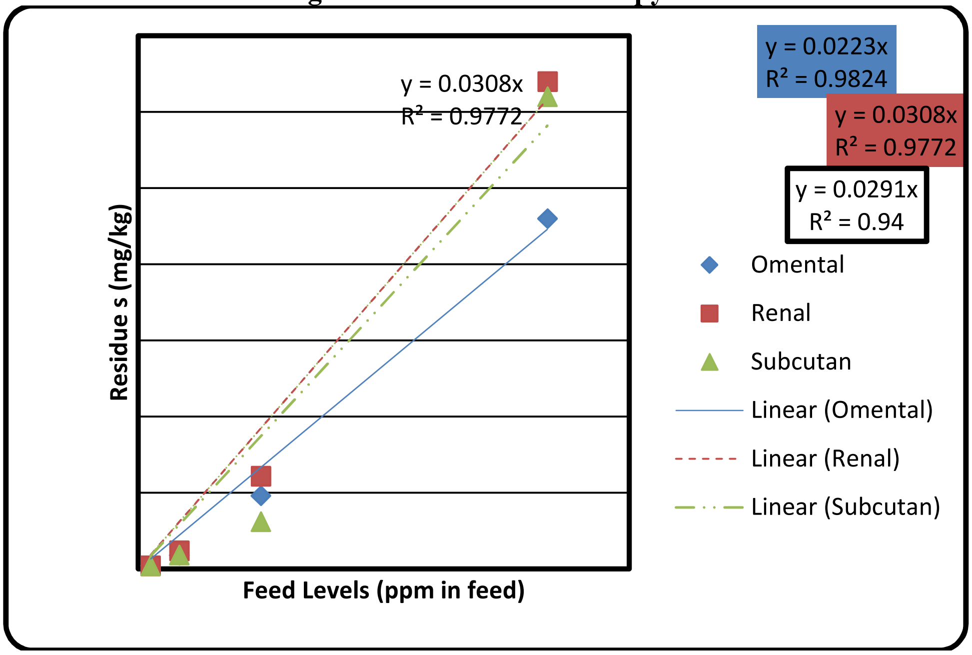
[2] Available at http://www.fao.org/ag/AGP/AGPP/Pesticid/JMPR/Download/2000_rep/cap4.pdf; http://www.fao.org/ag/AGP/AGPP/Pesticid/JMPR/Download/2000_eva/9CHLORPYRIF.pdf

transfer factors on either side of the feeding level of interest is/are used to calculate the residue. Alternatively, linear interpolation between the two transfer factors may be utilized.

Table 1: Residues in the tissues of cattle dosed with chlorpyrifos for 30 days

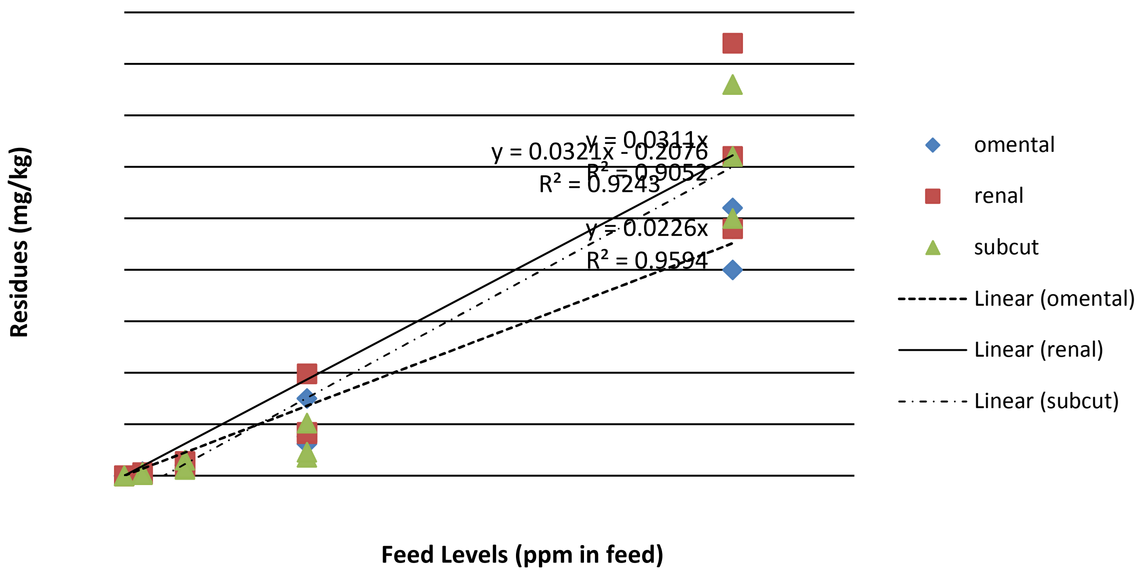
Dose (ppm in feed)	Chlorpyrifos (mg/kg)					
	Muscle	Liver	Kidney	Omental fat	Renal fat	Subcutaneous fat
0	0.00	0.00	0.00	0.00	0.00	0.00
3	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	<0.01 <0.01 <0.01	0.01 0.04 0.01 (0.02 avg)	0.01 0.03 0.01 (0.02 avg)	0.01 0.03 <0.01 (0.02 avg)
10	0.02 <0.01 <0.01	0.02 <0.01 <0.01	<0.01 <0.01 <0.01	0.10 0.07 0.10 (0.09 avg)	0.14 0.09 0.13 (0.12 avg)	0.15 0.06 0.07 (0.093 avg)
30	0.01 0.01 0.02	<0.01 0.01 <0.01	<0.01 0.01 0.01	0.38 0.75 0.31 (0.48 avg)	0.41 0.98 0.42 (0.61 avg)	0.18 0.51 0.23 (0.31 avg)
100	0.11 0.19 0.29	0.01 0.02 <0.01	0.02 0.01 <0.01	2.6 2.4 2.0 (2.3 avg)	3.1 4.2 2.4 (3.2 avg)	3.1 3.8 2.5 (3.1 avg)

Figure 2: Plot of mean chlorpyrifos residues in cattle fats



The residue values for all of the animals in the study are shown in the plot below (Figure 3). The range of values at the 30 ppm and 100 ppm feed levels, particularly in the renal and subcutaneous fats, indicate the variation between different animals in the study. Such ranges should be accommodated in the MRL setting. Generally the highest fat residue value per fat type at each feeding level would be used to estimate MRLs. The mean values are more appropriate for estimation of commodity residue levels for use in chronic dietary intake calculations.

Figure 3: Plot of Chlorpyrifos Residues in Cattle Fats



As an example, the mean residues, highest residues, and MRL recommendations for cattle meat fat are estimated for dietary burdens of 20 and 60 ppm below.

For a dietary burden of 20 ppm in the feed, the mean residues in renal, subcutaneous and omental fats from the linear plots above[3] are 0.62, 0.58 and 0.46 mg/kg, respectively (Figure 2). Using transfer factors from the 10 ppm feeding level, the mean residues are 0.24, 0.19, and 0.18 mg/kg in renal, subcutaneous, and omental fats, respectively, and using transfer factors from the 30 ppm feeding level, the mean residues are 0.41, 0.21, and 0.32 mg/kg in renal, subcutaneous, and omental fats, respectively. Using linear interpolation between 10 and 30 ppm feeding levels the mean residues are 0.36, 0.20, and 0.28 mg/kg in renal, subcutaneous, and omental fats, respectively. An appropriate value for cattle fat as an input into the chronic dietary risk assessment would be 0.41 mg/kg. Note that the assumption of linearity will overstate the results at 0.62 mg/kg; Figure 2 suggests that linearity is not the best assumption ($R^2 = 0.97$).

The highest residues of all three depots are observed in renal fat. For the input into the short-term dietary risk assessment and for estimation of MRL, the highest residue is estimated in one of two ways. Using the transfer factor from the highest observed value of 0.98 mg/kg at 30 ppm and correcting for the 20 ppm dietary burden (20/30 × 0.99) gives a value of 0.66 mg/kg. Using the transfer factor from the highest observed value of 0.14 mg/kg at 10 ppm and correcting for the 20 ppm dietary burden (20/10 × 0.14) gives a value of 0.28 mg/kg. Interpolation between the two feeding levels gives 0.56 mg/kg. JMPR practice is to use the higher result of 0.66 mg/kg. Note also that in some instances, e.g., non-fat soluble pesticides, only a composite sample from each animal is analyzed, and in those cases the highest composite analysis value at each dose level would be utilized.

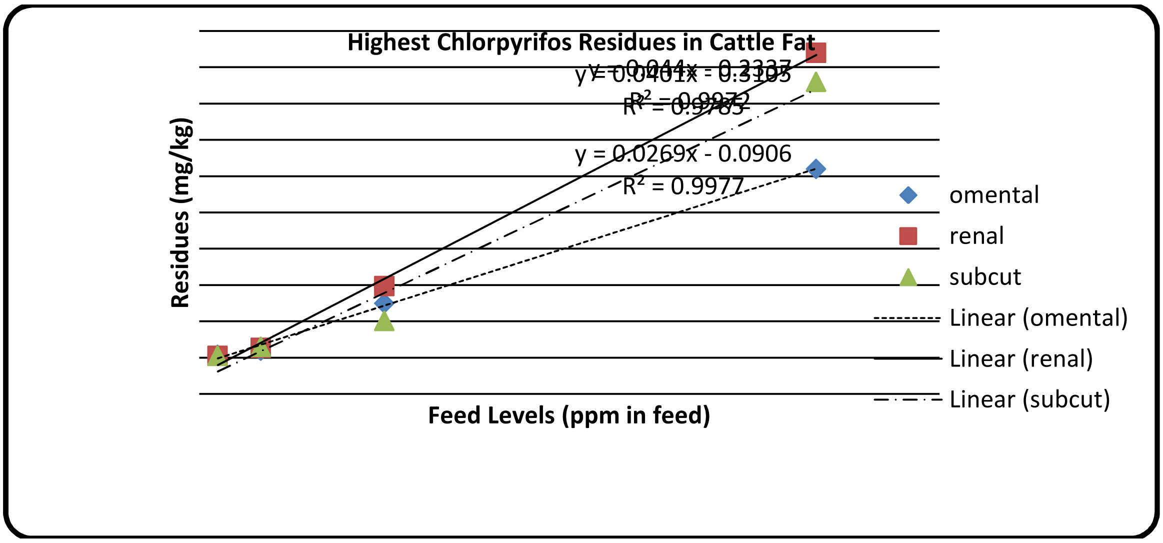
The JMPR recommendation would be to round up the estimated value to 1 mg/kg as an appropriate MRL for cattle meat fat. This practice of using the transfer factors (TF) on either side of the exposure of interest

[3] Renal fat y = 0.031x, and $R^2 = 0.9765$; Subcutaneous fat y = 0.029x ; Omental fat y = 0.023x

or correcting the residue value from results at the dose level closest to the anticipated dietary burden is routinely used by the JMPR for MRL setting purposes.

Alternatively, linear regression may be considered (Figure 4). The linear equation for renal fat is $y = 0.041x$, $R^2 = 0.988$. This provides an estimated residue of 0.82 mg/kg at the 20 ppm feeding level.

Figure 4: Highest Residue at Each Feed Level



Repeating the exercise for a dietary burden of 60 ppm, the *mean* residues in renal, subcutaneous and omental fats from the linear plots above are 1.86, 1.74 and 1.38 mg/kg, respectively. Using the transfer factors at 30 and 100 ppm feeding levels, the mean residues in renal, subcutaneous, and omental fats are 1.2, 0.62, and 0.96 mg/kg and 1.9, 1.9, and 1.4 mg/kg, respectively. Interpolation between the two feeding levels yields 1.72, 1.50, and 1.26 mg/kg for renal, subcutaneous, and omental fats, respectively. An appropriate value for cattle fat as an input into the chronic dietary risk assessment would be 1.9 mg/kg, based on the highest calculated renal fat value.

The data points on either side of the calculated (60 ppm) dietary burden may be used to estimate the residue value for MRL purposes. Thus, the *highest* residue estimated from the observed value of 4.2 mg/kg in renal fat at 100 ppm and corrected for the 60 ppm dietary burden (60/100 × 4.2) gives a highest residue value of 2.52 mg/kg. The highest residue estimated from the observed value of 0.98 mg/kg in renal fat at 30 ppm and corrected for the 60 ppm diet (60/30 × 0.98) gives a highest residue value of 1.96 mg/kg. The higher value, 2.52 mg/kg, is appropriate for the short-term dietary risk assessment. This would be rounded up by JMPR to an MRL of 3 mg/kg for cattle meat (fat).

Alternatively using linear regression (based on high renal fat values, $y = 0.041x$, $R^2 = 0.988$) the estimated highest residue would be 2.56 mg/kg. In this case, the transfer factor approach is a valid method and gives an estimate very comparable to linear regression. A summary of the recommendations in the example is tabulated below (Table 2):

Table 2. Summary of Recommended MRLs for 20 and 60 ppm Feeding Levels for Chlorpyrifos in Cattle Fat.

Dietary Burden (ppm in feed)	Mean Residue (mg/kg)	Highest Residue (mg/kg)	Recommended MRL in cattle meat fat (mg/kg)
20	0.41	0.66	1
60	1.9	2.5	3

It should be noted that when the dose response at higher doses starts to deviate away from a linear dose-response pattern observed at low or intermediate doses, then care should be taken to ascertain whether the higher doses that were administered have resulted in an adverse health effect on the animals. The health of the animals, bodyweight maintenance or changes and the feed intakes at the higher doses should be checked to ensure that the animals are still in a condition comparable to that reported in the pre-dosing (acclimatisation) phase of the study. If there are reported health effects that correlate with the observed responses at high doses, the results should be interpreted with care or not used if the estimated dietary burden is well below the higher dose level.

Case 2: Indoxacarb Residues in Meat fat, Milk fats and Edible Offal of Cattle

Indoxacarb was reviewed (JMPR, 2005)[4] (3) and the information included herein has been drawn from that evaluation. It is recommended that the reader refer to JMPR (2005) to see the raw data and how the figures have been derived.

Lactating Holstein cows were administered indoxacarb 3*S*+1*R* doses for 28 consecutive days, equivalent to 7.5 (low dose), 22.5 (medium dose) and 75 (high dose) ppm in the feed. The estimated maximum dietary burden for beef cattle is 35 ppm and for dairy cattle 31.6 ppm based on the livestock diet used by the JMPR at the time. The anticipated highest residues at the calculated dietary burden can be estimated using a transfer factor approach or interpolation between doses since the calculated dietary burdens (31.6 ppm, 35 ppm) are between the medium (22.5 ppm) and high (75 ppm) dose levels.

For the purpose of this example, residues in cream are compared with residues in meat fat, as indoxacarb is designated as being fat-soluble and milk is considered to be an elimination pathway for indoxacarb residues when doses are administered to lactating cattle. In addition, muscle, kidney and liver dose responses are shown as they demonstrate important points to consider, when <LOQ residues are found at some of the dose levels. Decisions are then required as to whether it is appropriate to use interpolation and a transfer factor approach or alternatively whether linear regression can be applied.

The data are summarized in Table 3. Figure 5 provides the plots of dose vs residues for fat (composite samples) and cream from lactating cattle dosed with indoxacarb equivalent to 7.5, 22.5 and 75 ppm in the feed. Both show *approximate* dose response linearity.

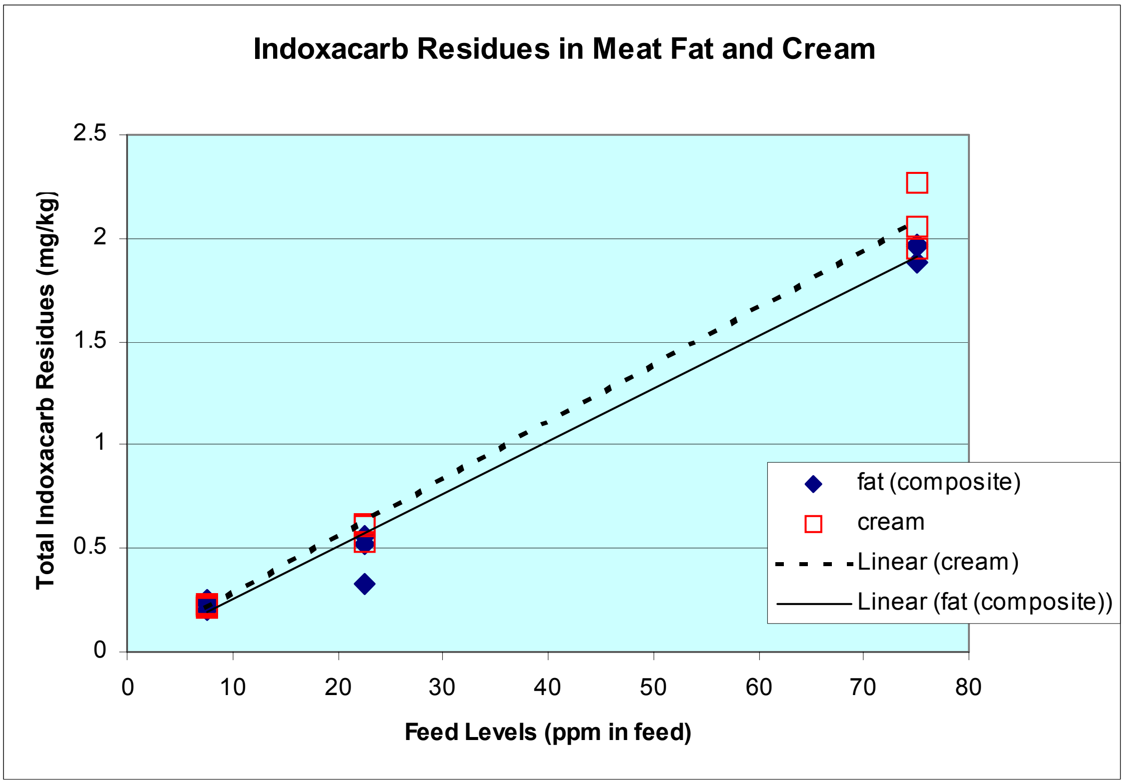
[4] Available at
http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/report2005jmpr.pdf

Table 3: Residues in the tissues of cattle dosed with indoxacarb for 28 days

Dose (ppm in feed)	Indoxacarb (mg/kg)					
	Milk[1]	Cream[1]	Fat[2] (composite)	Muscle	Liver	Kidney
7.5	0.020 0.019 0.021	0.22 0.20 0.21 0.21 avg	0.22 0.24 0.20 0.22 avg	<0.01 <0.01 <0.01 <0.01 avg	<0.01 <0.01 <0.01 <0.01 avg	<0.01 <0.01 <0.01 <0.01 avg
22.5	0.054 0.052 0.054	0.60 0.51 0.59 0.57 avg	0.50 0.54 0.30 0.45 avg	<0.01 <0.01 <0.01 <0.01 avg	<0.01 <0.01 0.013 0.01 avg	0.018 0.012 0.020 0.017 avg
75	0.18 0.18 0.19	2.0 1.9 2.2 2.0 avg	1.9 1.8 1.9 1.9 avg	0.093 0.030 0.076 0.066 avg	0.019 0.019 0.017 0.018 avg	0.049 0.036 0.032 0.039 avg

[1] Composite samples from day 14, day 21, and day 28.
[2] Composite of perirenal and omental fats.

Figure 5: Indoxacarb Residues in Meat Fat (Composite) and Cream



At the 7.5 ppm feed level, the three composite fat values (0.20, 0.22, and 0.24 mg/kg) and the three composite cream values (0.20, 0.21, 0.22 mg/kg) show very little spread (relative standard deviations of 9.1% for fat and 4.8% for cream). Also, the magnitude of residues is comparable for both sample types, average 0.22 mg/kg for fat and 0.21 mg/kg for cream.

On this basis, it would be concluded that the magnitude of residues in fat from non-lactating cattle would be different, as milk as an elimination pathway for residues would not be available in non-lactating cattle[5]. In addition, as individual fat depots were not analysed, the variability of residues in different fat depots is unknown. Therefore the MRL that is estimated for meat fat needs to accommodate lactating and non-lactating cattle, individual animal variation as well as individual fat depot variation.

For the estimated dietary burden of 35 ppm, the JMPR used transfer factors and interpolation by taking the highest observed residues at the two dose levels that encompass the estimated dietary burden and rounding up the estimate. For beef cattle meat fat, the highest residues of indoxacarb + *R* isomer at 22.5 and 75 ppm are 0.54 and 1.9 mg/kg, respectively. The estimated highest residue for 35 ppm is calculated as 0.86 mg/kg[6] by linear interpolation ($y = y_a + [(y_b – y_a) (x-x_a)/(x_b-x_a)]$). This is rounded up to 1 mg/kg. Using the procedure of estimation from the experimental values at each of the two surrounding doses, the estimated highest residue for 35 ppm is calculated as (35/22.5 × 0.54) 0.84 mg/kg and (35/75 × 1.9) 0.89 mg/kg.

Using linear regression should give similar result for fat as linearity between doses is demonstrated. In addition, a larger number of animals are used for the linear regression compared to the transfer factor approach. The estimated highest residue from the plot above is 0.86 mg/kg[7], which is comparable to the value of 0.84 – 0.89 mg/kg calculated by interpolation and transfer factors. The linear regression approach based on all individual data points leads to similar results as the transfer factor approach based on the highest residues at each dose level because the response is fairly linear and because the residue data within each dose group are not widely spread.

The anticipated dietary burden for dairy cattle is 31.6 ppm. The same approach of using a transfer factor for cream from the highest residues at the 22.5 and 75 ppm doses (0.60 and 2.2 mg/kg) gives a highest residue of 0.93 mg/kg, the higher of the 0.84 and 0.93 mg/kg values. Linear interpolaton gives an estimated residue of 0.88 mg/kg. Linear regression gives an estimated residue of 0.92 mg/kg[8].

Using the assumption that cream is 50% fat (fat content of milk varies, but is typically 38 – 60% in double or extra heavy cream), the residue value is doubled giving a highest residue of 1.8 - 1.9 mg/kg for milk fat. Both can be rounded up to 2 mg/kg for MRL setting purposes.

For liver, kidney and muscle, there are a number of <LOQ residues found following dosing at 7.5 and 22.5 ppm (Table 3). The plot below (Figure 6) shows the residues for individual animals for each of the sample types.

[5] The JMPR noted that the residue concentration in cream was almost 11× the residues in milk once residue plateau had been reached.

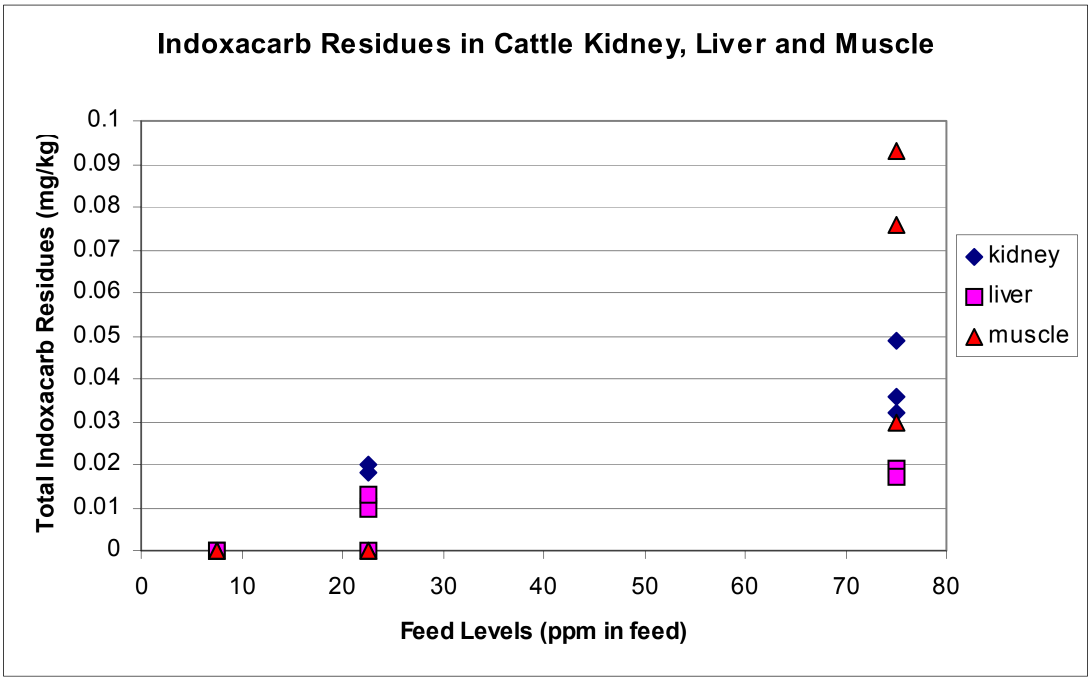
[6] Interpolation is the calculation of the residue using each transfer factor according to the following equation: 0.54 + (1.9 - 0.54) × (35 - 22.5)/(75 - 22.5) = 0.86 mg/kg.

[7] Equation is $y = 0.0245x$ for fat; $R^2 = 0.9844$

[8] 0.60 + (2.2 – 0.60) × (31.6 – 22.5) / (75 – 22.5) = 0.88 for linear interpolation of cream.

Equation is $y = 0.029x$, for cream; $R^2 = 0.999$. Based on high value at each dose level. Note that if all values are considered, the equation is $y = 0.027x$ and $R^2 = 0.990$. Note that if average values are considered, the equation is $y = 0.027 x$ and $R^2 = 0.999$.

Figure 6: Feeding Level Versus Residues in Cattle Tissues (Except Fat)



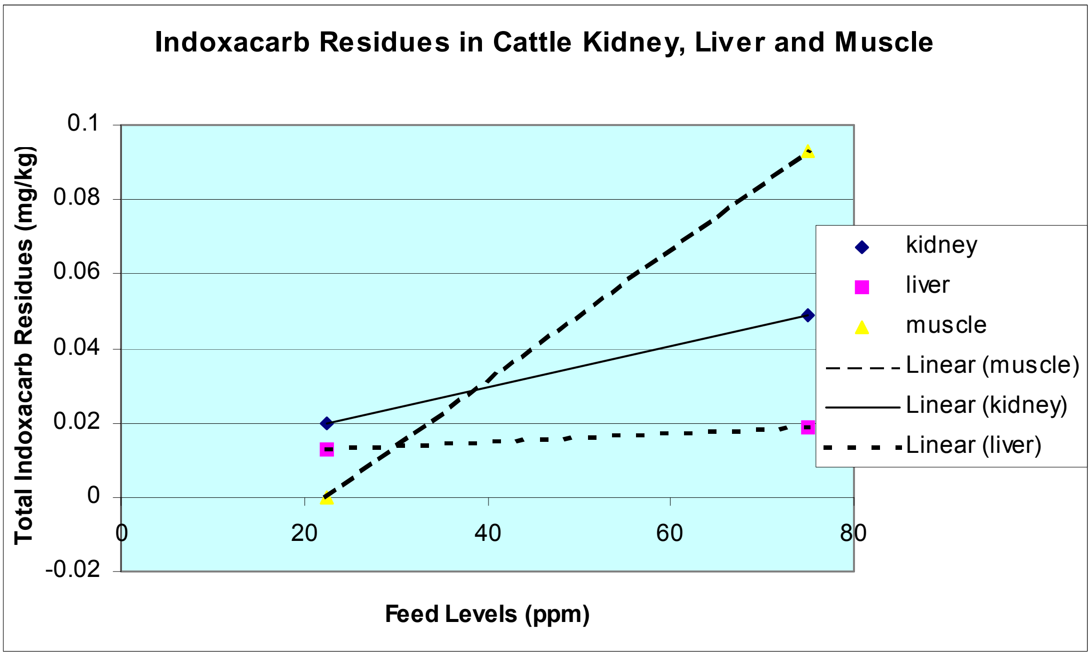
For muscle, residues above LOQ are found following dosing at 75 ppm only. Here again, JMPR (2005) used interpolation between 22.5 and 75 ppm, although the highest residue at the 22.5 ppm is <0.01 mg/kg. Using the transfer factors from the 22.5 and 75 ppm dose levels and the highest residue found at each level, the residue at the dietary burden of 35 ppm is calculated to be 0.03 mg/kg[9].

Alternatively it is also valid to use the transfer factor from the highest dose level where residues are above LOQ. This gives an estimate of 0.043 mg/kg (35/75 × 0.093 mg/kg). Although this provides a conservative estimate for the MRL, there is less uncertainty about the residues below LOQ. The final MRL for cattle meat is set by JMPR on a fat basis, as described above, as indoxacarb is designated as being fat-soluble.

Linear regression can be used to estimate the residue at the maximum dietary burden, provided that a linear relationship can be demonstrated between at least three adjacent experimental points, and that the maximum dietary burden falls within the linear range. This approach also makes use of all of the data points in the feeding study, rather than limiting the useable number of data points to those at the dose levels close to the dietary burden, or higher than the dietary burden which is the case for interpolation between doses.

[9] Use the following equation: 0.01 + (0.093 – 0.01) × (35 – 22.5)/(75 – 22.5) = 0.03 mg/kg.

Figure 7: Feeding Level Versus Highest Residues in Cattle Tissues (Except Fat)



The highest residue in liver at the anticipated dietary burden of 35 ppm is calculated to be 0.014 mg/kg, using interpolation between the highest values observed at 22.5 (0.013 mg/kg) and 75 ppm (0.019 mg/kg) (see Figure 7). Here the transfer factor approach using the highest residue at 75 ppm is not appropriate, as the outcome gives a lower value than the highest residue found at 22.5 ppm, i.e. 0.008 mg/kg using TF at 75 ppm (35/75 × 0.019 mg/kg) vs 0.013 mg/kg HR at 22.5 ppm.

For kidney, JMPR (2005) estimated a highest residue of 0.027 mg/kg by interpolation between the highest residues at 22.5 and 75 ppm[10], whereas using the transfer factor from the highest dose gives a value of 0.023 mg/kg (35/75 × 0.049 mg/kg) and using the transfer factor from the lower dose gives a value of 0.031 mg/kg (35/22.5 × 0.02 mg/kg). Both approaches are valid and give comparable results.

Based on the estimated highest residues in muscle and liver or kidney, estimates of MRLs for indoxacarb in meat and offal (meat by-products) can be made. Codex established an MRL of 1 mg/kg for meat *based on fat* and an MRL of 0.05 mg/kg for edible (offal) mammalian based on residues in kidney, which were higher than residues in the liver example above. These values were taken from the Codex alimentarius website[11].

Summary of Examples

Both examples show approaches in JMPR (2005) used to set MRLs for commodities of animal origin. Although linear regression is a useful method where clear linear dose responses are observed, there may be situations where the use of linear regression is affected by several LOQ observations for some doses. In other cases, the response is simply not linear. In those cases, interpolation and use of transfer factors provides conservative but valid estimates of highest residues, although use of the whole data set is limited.

[10] 0.020 + (0.049 – 0.020) × (35-22.5)/(75 - 22.5) = 0.027 mg/kg

[11] http://www.codexalimentarius.net/pestres/data/pesticides/details.html?d-16497-o=2&id=216&d-16497-s=2

No single approach to calculation of the MRL level is possible. If the response is linear over the entire range studied, then any of the three procedures (linear regression, interpolation between two feeding levels, transfer factor from nearest feeding level or surrounding levels) will give the same answer. To the extent that deviation from linearity occurs, the three approaches may give divergent answers. The default is to select the highest value from the available techniques, but judgment must be applied on a case-by-case basis.

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