Australian Government
Department of Agriculture, Fisheries and Forestry

Feed Risk Assessment in Australia

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Australia – relevant regulators

1. FSANZ (food)
   -PPP standards (paddock to plate approach)
   "….must manage hazards arising from inputs…."

2. APVMA
   -pesticides, veterinary drugs, feed additives

3. Department of Agriculture
   -imported/exported feed (biosecurity)

4. Office of the Gene Technology Regulator (OGTR)
   -GMOs including feeds

5. State and territory departments
   -feed legislation, contaminants, weeds/seeds

Risk assessment in Australia:

Australian Standard for Animal Feeding

Australian Feed Standard - guiding principles

Codex Alimentarius Commission

Working Principles for Risk Analysis for Application in the Framework of the Codex Alimentarius

Code of Practice on Good Animal Feeding CAC/RCP 54-2004

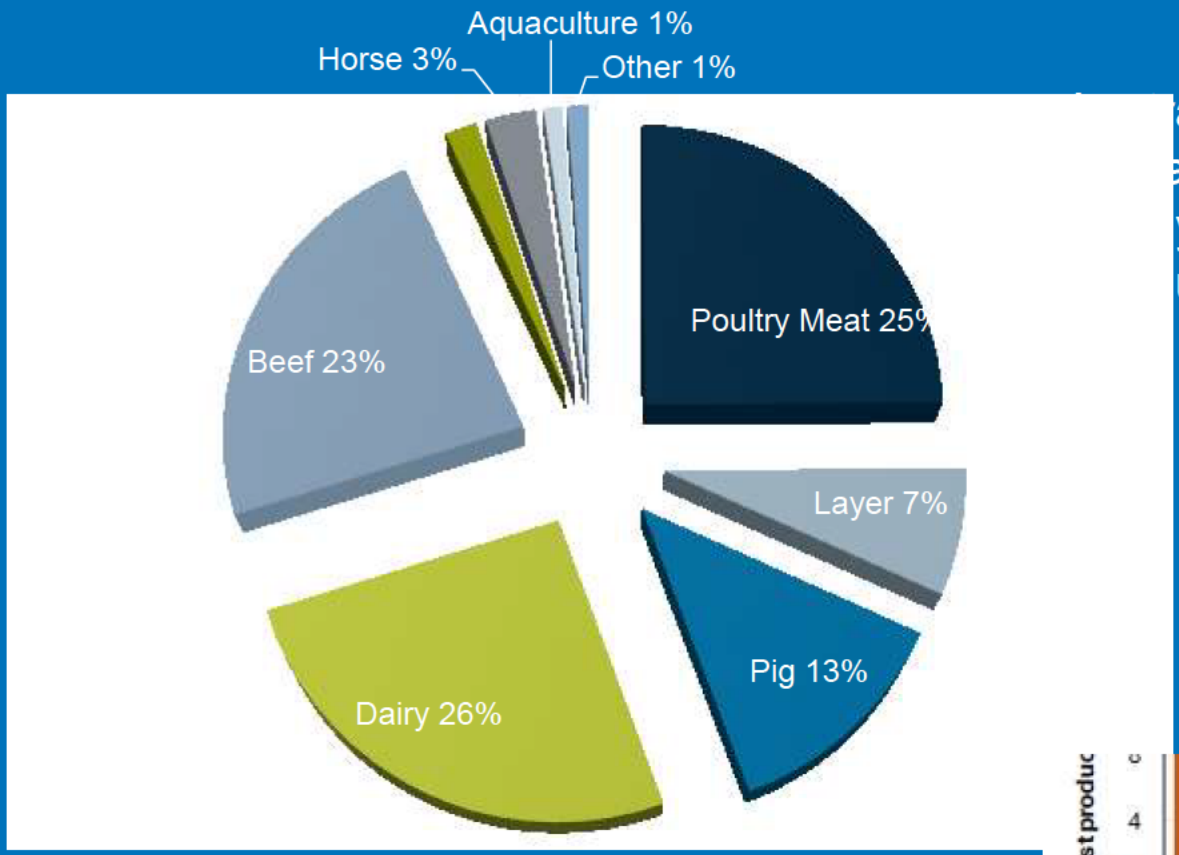
Guidelines on the Application of Risk Assessment for Feed

"*... address the potential risks to human health associated with the presence of hazards in the feed of food-producing animals and the subsequent transfer of hazards to edible products*."

Australian animal production systems

1. Cattle/beef
   -forage-based, grain finished, manufactured feed
2. Dairy
   -forage-based, increasing use of concentrates
3. Sheep
   -forage-based
4. Pigs
   -manufactured feed, grain-based
5. Poultry
   -manufactured feed, grain-based

Feed other than pasture, hay, silage Australia ≈11.6 Mt in 2011/2012



alian feed grains:
at 40%
y 26%
um 11%

Source: JCS Solutions. Feed Grain 2011-12 Update Report.
A report for the Feed Grain Partnership. February 2012

Ranking feed hazards

Feed hazards

1. Biological hazards (Salmonella spp.)
2. Endoparasites (Toxoplasma, Taenia spp.)
3. Prions (TSE)
4. Potentially toxic elements (As, Cd, Pb, Hg)
5. Radionuclides (^{134}Cs, ^{137}Cs, ^{90}Sr, ^{131}I)
6. Mycotoxins (aflatoxins, OTA, fumonisins etc)
7. Phytotoxins (pyrrolizidine alkaloids, gossypol etc)
8. Organic chemicals (pesticides, dioxins, PCBs etc)

Ranking hazards: controlled, low risk

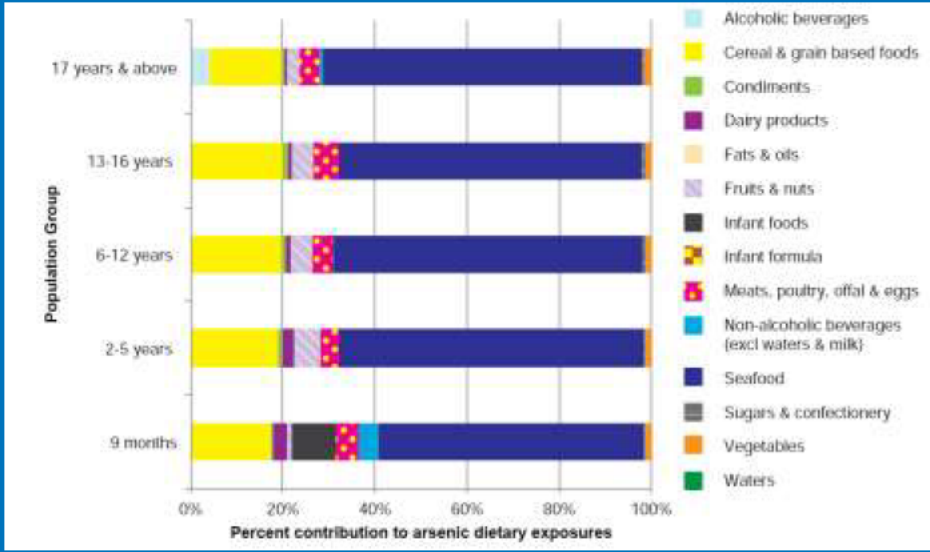
1. Biological hazards
   Salmonella in feed ingredients
   - generally low cfu/g, heterogeneous distribution, low probability detecting.
   - apply GMP and HACCP principles to the manufacturing process.
   "Australian Standard for Hygienic Rendering of Animal Products"
   FeedSafe® = industry HACCP-based QA program
2. Endoparasites (Toxoplasma, Taenia spp.)
   - low probability of occurrence in feed
3. Prions
   -Australia is assessed as a negligible risk country
   -from 1997 no RAM in ruminant feed
   Code of Practice for the Collection, Processing and Recycling of Fats and Oils

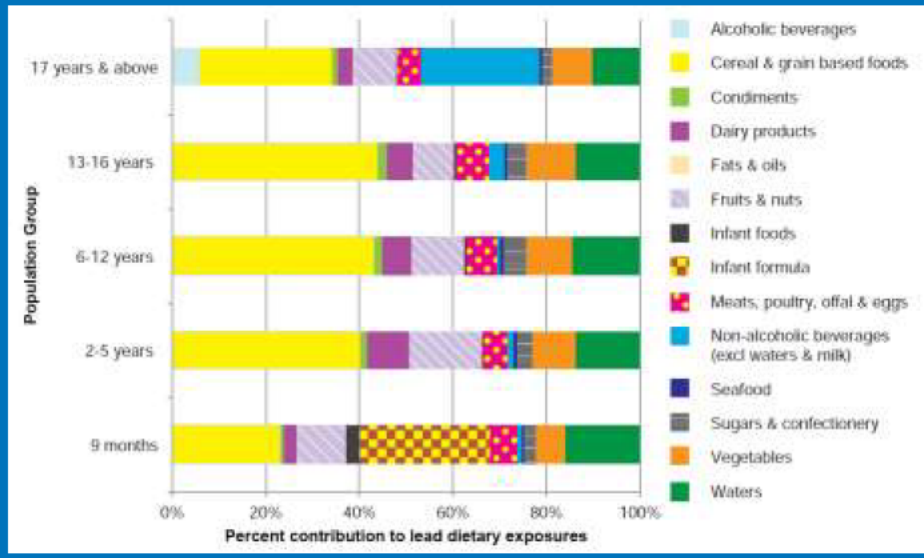
Ranking hazards: consumer risk?

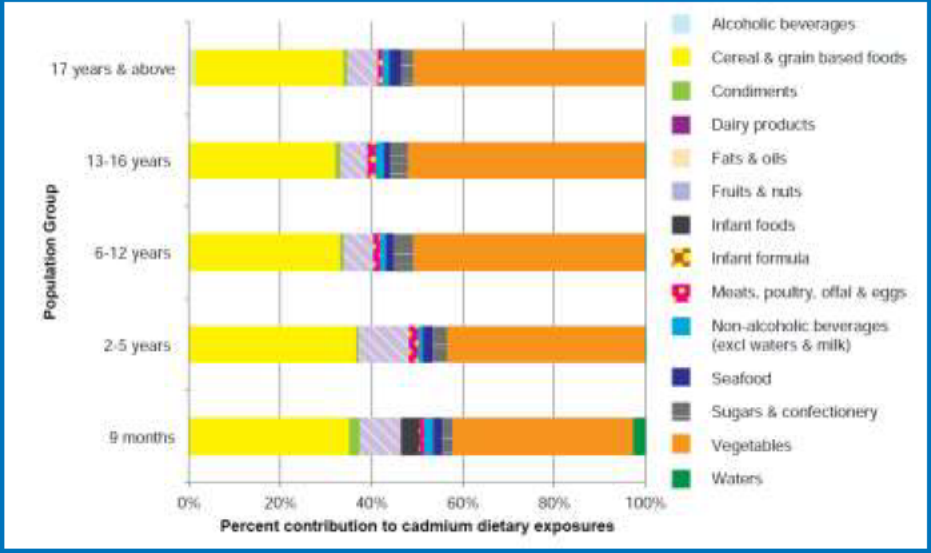
	Exposure concern	Food Standards Code limits for meat, offal, eggs or milk
Potentially toxic elements	No	MLs: Cd, Pb GELs: As, Cu, Hg, Sb, Se, Zn
Radionuclides	No	No (Codex for emergency response)
Mycotoxins	No*	No
Phytotoxins	?	No
Organic compounds	No**	MRLs: legacy pesticides, pesticides, veterinary drugs

* 23rd Australian Total Diet Survey, FSANZ November 2011 included aflatoxins ,DON, fumonisins, OTA, patulin, zearalenone
**23rd Australian Total Diet Survey, FSANZ November 2011 included legacy pesticides (aldrin, chlordane, DDT, dieldrin, dicofol, endrin, HCH, heptachlor, lindane);
Dioxins in Food Dietary Exposure Assessment and Risk Characterisation. Technical Report Series No. 27 FSANZ May 2004

Potentially toxic elements in food







Source: 23rd Australian Total Diet Survey, FSANZ Nov 2011

Ranking hazards: trade (export market standards)?

	Market limits for meat, offal, eggs or milk*
Potentially toxic elements	MLs: As, Cd, Cr, Pb, Hg
Radionuclides	MLs: also Codex guides for emergency response
Mycotoxins	MLs: aflatoxins, zearalenone
Phytotoxins	No
Organic compounds	MLs: legacy pesticides, dioxins, PCBs, PAH, melamine

*China, Codex, EU, Japan, Republic of Korea, Russian Federation, Taiwan, USA

Ranking hazards: feed-related livestock poisoning

Poisonings 2003-2012	Cattle (n=279)	Sheep (n=173)
Nitrate (forage)	18%	2.3%
Lead (mostly access to batteries)	12%	-
Ptaquiloside (Brackern fern)	7.2%	-
Lantana camara	6.1%	-
Arsenic (mine sites, old pesticides)	3.9%	-
Pyrrolizidine alkaloids	2.2%	6.4%
Oxalate (forage, weeds)	2.2%	13%
Lupinosis (*Diaporthe toxica*)	1.4%	17%
Tribulus terrrestris (caltrop)	0.4%	8.7%
Phalaris spp.	-	6.9%

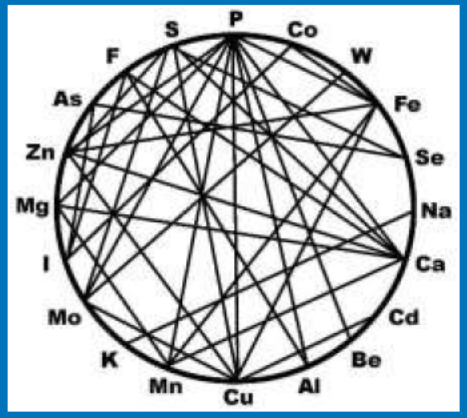
Hazard ranking for feed

	Food ML	Trade	Overall rank
High to moderate = set feed ML			
PTE (Cd, Pb, Hg)	+	+	++
Radionuclides (emergencies)	+	+	++
Phytotoxins (PAs, THC)	?	?	??
Organic compounds (aldrin/dieldrin, chlordane, DDT, endrin, HCB, heptachlor, HCH, PCBs)	+	+	++
Mycotoxins (aflatoxins)	-	+	-+
Low = set feed guidance level			
PTE (As, Cr, Cu, F, Sb, Se, Zn)	-	-/+	- (unlikely)
Phytotoxins (gossypol, nitrates, oxalate)	-	-	-
Organic compounds (melamine)	-	+	+ (unlikely)
Mycotoxins (OTA, fumonisins, zearalenone, DON+NIV, ergots)	-	-	-

Estimation of guidance and maximum levels

Transfer studies

Considerations:



Duration of exposure
-steady state?
-relevant to scenario?

Feed composition
- interactions?
- lipid content?
- source (bioavailability)

Animal parameters
-Age
-Sex
-Physiological status: lactating/laying, ruminating

Using Transfer Factors

$TF_i = C_i/C_{feed}$

C_i = concentration in tissue, milk or eggs (mg/kg WW)
C_{feed} = concentration in complete diet (mg/kg DM)

$C_{feed} = C_i/(R \times TF)$

R= bioavailability of feed source relative to material in transfer studies (if unknown assume R = 1)

ML for Pb in feed

ML Australia edible offal = 0.5 mg/kg WW

TF_{kidney} = 0.12 for cattle kidney (MacLachlan 2011)

C_{feed} < 0.5 / 0.12 = 4.2 mg/kg DM.

ML Codex milk = 0.02 mg/kg

TF_{milk} = 0.0024 (MacLachlan 2011)

C_{feed} < 0.02 / 0.0024 = 8.3 mg/kg DM.

Lowest estimated C_{feed} used to set a ML for feed of 5 mg/kg DM
Lead in the diet should be ALARA and not >5 mg/kg DM.

ML for Cd in feed

Elimination half-life >900 days,
$C_i = C_0 + R \times (dC_i/dt) \times C_{feed} \times days$ -if initial level in tissue $C_0 = 0$
$C_{feed} = C_i/[R \times (dC_i/dt) \times days]$

Cattle, slaughter at 5 yrs (1825 days) or 2 yrs (730 days)
dC_{kidney}/dt = 0.0069 (mean), 0.025 (max)
ML = C_{kidney} = 1 mg/kg WW

If R = 1, max C_{feed} = 0.08 (5 yr) or 0.2 (2 yr) mg/kg DM mean
max C_{feed} = 0.02 (5 yr) or 0.05 (2 yr) mg/kg DM max

(R_{soil} = 0.1-0.8, $R_{forage/fodder} \approx 0.3$?)

Cadmium issue for liver and kidney (IF extreme exposure all tissues!)
Environment major source, interactions diet components
Keep feed levels ALARA, MLs feed ingredients based on EFSA
Restrict harvest of liver and kidney (age/region)

GL for ochratoxin A in feed

Detected in maize (infrequently, 0.001-0.004 mg/kg) and grapes
Detected in stored grain (barley etc) infrequently in Australia
No reports OTA poisoning of cattle, goats, sheep, pigs or poultry in Australia

Denmark pigs C_{kidney} <0.01 mg/kg WW
TF_{kidney} = 0.11
C_{feed} <0.01/0.11 = 0.1 mg/kg DM

Microscopic kidney lesions female pigs fed 1 mg/kg feed for 2 yrs
Reduced growth pigs fed 0.2-2 mg/kg feed
Ruminants less sensitive than pigs (OTA→α-OTA in rumen)
Minor kidney damage in young pigs fed 0.1 mg/kg feed

Guidance levels
0.1 mg/kg DM for ruminants, adult pigs
0.05 mg/kg DM for young pigs and pre-ruminant cattle, goats and sheep

Risk assessment in Australia:

Pesticides in feed

Pesticides in feed: trade concerns meat, milk?

Beef >60% production exported

		Cost?
Mid 1980s	Persistent OCs: grazing old cropping areas, cotton trash, access to areas treated for termites	>$500 m
Mid 1990s	Chlorfluazuron: cotton trash used as feed	>$120 m
Late 1990s	Endosulfan: cotton trash used as feed, spray drift	>$10 m

1994 APVMA legislation requires consider trade
>1994 APVMA: Do not feed cotton trash to livestock
2005 cattle industry MOU with cotton mills, no supply of cotton trash for feed

What about pesticides registered prior to 1994?

What about changes in MRLs since last evaluated?

Potential feed items

Acorns
Almond hulls
Apples /pomace
Apple pulp silage
Apricots
Bananas
Brewers grains
Broccoli
Brussel sprouts
Buckwheat
Cabbages/leaves
Canola meal
Carrots/pulp
Cassava meal
Cauliflower
Citrus pulp
Copra meal
Corn cobs
Cottonseed/meal
DDGS
Grape marc/pomace
Grapefruit
Lemon pulp
Lettuce
Linseed meal
Macadamia meal
Melons
Molasses, cane
Oat hulls/straw
Onions
Oranges/pulp
Palm kernel meal
Pea hay
Peaches
Peanut meal/skins
Pears / pomace
Pineapple forage/bran
Potatoes/meal
Pumpkins
Raisin pulp/culls
Rice bran
Soya bean meal
Sugarcane tops
Sugarcane bagasse
Sunflower meal
Sweet corn trash
Sweet potato
Tomatoes / pomace

Trade risk assessments

Assumed crop treated at max label rate
Assumed fed at:
10% almond hulls
30% fruit waste
100% grains, forage, fodder, cotton trash

IF predicted tissue and milk (worst-case) residues < market MRLs OK

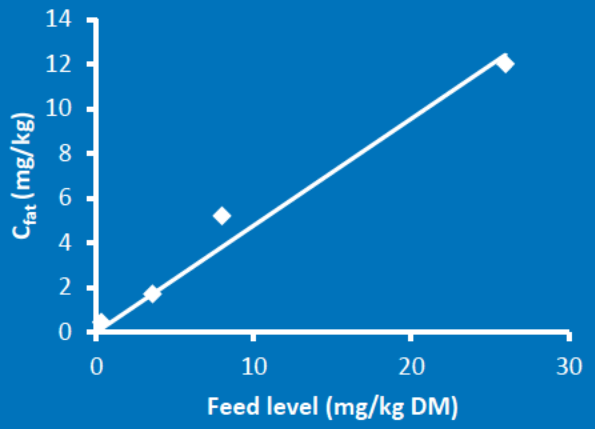
ELSE refine estimates, IF > major market MRLs, management required.

Asessments for:

Apples & pomace
Almond hulls
Avocado
Bananas
Cereal forage/stubble/straw
Cereal grain
Citrus pulp
Cotton gin trash
Grape marc
Oilseed forage & fodder (except peanut & cotton)
Oilseed grain (including cottonseed & peanuts)
Pasture
Peanut forage, stubble/straw
Pineapple forage & bran
Pulse forage & stubble/straw
Pulse grain
Mango
Stone fruit waste
Sugarcane tops
Vegetable waste & culls

Pesticide transfer information sources

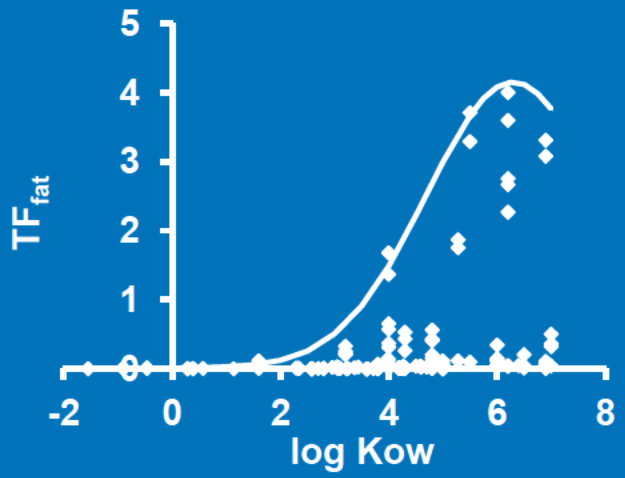
1. Transfer studies
   -JMPR
   -DARs (EFSA)
   -APVMA
   -scientific literature



2. Models
   -simple pharmacokinetic
   -PBPK

3. Empirical relationships –lipid solubility and transfer

Pesticides: empirical sources of TF



Cattle:

Pesticides other than OCs

$TF_{fat} = 0.01 + 10^{(1.07 \times logKow - 0.085 \times logKow \times logKow - 2.75)}$

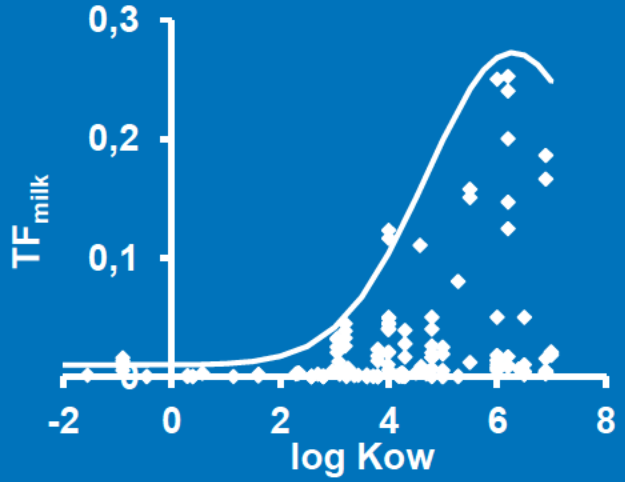
$TF_{offal} = 0.02 + 10^{(1.07 \times logKow - 0.085 \times logKow \times logKow - 3.3)}$

$TF_{milk} = 0.01 + 0.04 \times [10^{(1.07 \times logKow - 0.085 \times logKow \times logKow - 2.55)}]$

Pesticides all

$TF_{fat} = 0.01 + 10^{(1.07 \times logKow - 0.085 \times logKow \times logKow - 2.51)}$

$TF_{milk} = 0.01 + 0.04 \times [10^{(1.07 \times logKow - 0.085 \times logKow \times logKow - 1.9)}]$



Information on pesticide levels in feed

1. Residues in feeds
   -JMPR
   -DARs (EFSA)
   -APVMA
   -published scientific literature
   -residue monitoring (NRS)

2. Models available for:
   -initial deposit
   -decline

Example: cotton trash - chlorfenapyr

Pyrrole insecticide/miticide. log Kow 5.3
Application rate is 0.4 kg ai/ha, harvest WHP 28d.
Do not allow livestock to graze crops, stubble or trash

	Meat (fat)	Edible offal	Milk	Cottonseed
Australian MRL (mg/kg)	0.05	*0.05	*0.01	0.5

No Codex, EU or US MRLs (revoked 2001)

Feed residues: range 1.4 - 42 mg/kg, median 8.5 mg/kg in residue trials

Meat: $C_{fat} = TF_{fat} \times$median residue = 0.09×8.5 = 0.8 mg/kg
Milk: $C_{milk} = TF_{milk} \times$median residue = 0.006×8.5 = 0.05 mg/kg

Decline residues in fat, t½ ≈ 4 days.

<u>Conclusion:</u> potential risk to trade IF fed at 100% diet.

Thank you