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Pesticide risk profile for the feeding of banana fruit and stalks to cattle and sheep

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Abbreviations

ai	active ingredient
APVMA	Australian Pesticide and Veterinary Medicines Authority
bw	body weight
DM	dry matter
ECRP	Existing Chemical Review Program
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
g	gram
GAP	good agricultural practice
ha	hectare
HAFT	Highest average field trial
JMPR	Joint Meeting on Pesticide Residues
kg	kilogram
LOD	Limit of detection for the analytical method, sometimes also used for limit of determination which is the same as LOQ
LOQ	limit of analytical quantitation
mby	meat by products
mg	milligram = 0.001 grams
MRL	maximum residue limit
N	Negligible residue (when next to US MRL)
PAFC	primary animal feed commodity
PHI	pre-harvest interval
P _{ow}	octanol water partition coefficient
ppm	parts per million = mg/kg
PSD	Pesticide Safety Directorate
TF	transfer factor = concentration in animal tissue or milk divided by concentration in feed
TRR	total radioactive residue
US EPA	United States of America Environmental Protection Agency
WHP	withholding period
*	before MRL indicates that the residue is at or about the LOQ, <i>i.e.</i> should be less than the LOQ.

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Potential for violative residues in cattle and sheep fed banana fruit and stalks

For by-products to be useful as animal feeds, they must not present safety or health problems to the animals nor present a risk of contaminating the animal product to be sold. In the production and utilization of by-products, all parties must take care to prevent contamination with pesticides, mycotoxins, and other materials that could be dangerous to the animals or contaminate the animal product.

By-products of the banana industry that can be used in animal feeds are banana fruit and stalks. Bananas are a fast-growing plant 3-5 m high with a herbaceous stem. The fruits grow in bunches of up to 200 banana fingers each. The banana is picked green and ripened in sheds. Large quantities of rejected bananas are potentially available for animal feed. It has been estimated that approximately 4% of the crop is rejected. When the bunch has been harvested, the pseudostem (trunk) of the plant is cut down to allow the emergence of new shoots.

The dry matter of the green immature banana consists mainly of starch, which with ripening changes into simple sugars (sucrose, glucose, etc.). Bananas contain tannins which may affect the digestibility of protein in the diet. Ripe bananas are of interest as a source of easily available energy in the feeding of urea. On average, banana rejects have a mean dry matter content of 20-25%. Banana fruit and stalks contains 3.5-4.0% crude fibre, 5.0-6.5% crude protein, 72-3% crude starch (depends on maturity, first figure is for green fruit) and 2-74% crude sugars.

Cattle are reported to relish bananas, which are usually fed green, chopped and sprinkled with salt. Bananas are less palatable to sheep and goats.

It is reported that banana peels are very rich in active tannins when green and thus cannot be fed until they are completely yellow, when the tannins are bound in an inactive form.

Chemical residues in animal feeds may be transferred to the tissues of livestock on feeding. While it is unlikely that the chemical residues present in meat and offal arising from feeding of contaminated feeds represent a concern regarding food safety they can result in disruption to trade where the relevant Australian and overseas market standards differ.

The observation of chemical product withholding periods does not guarantee that the chemical residues in the feed are such that when fed to livestock, the residues in meat and offal will meet export market requirements.

The aim of the current report is to profile the risk of violative residues in export meat and edible offal posed by the presence of pesticide residues in banana fruit and stalks fed to cattle and sheep.

Assessment of currently registered chemicals that may be used on banana crops

Estimates of residues in livestock tissues and milk are usually made on the basis of the propensity of a chemical to transfer to tissues and milk combined with anticipated animal dietary exposure.

Most experiments in the area of transfer of pesticide residues to animal tissues and milk following ingestion have been designed based on the requirements of regulators. The relevant studies required are livestock metabolism studies (lactating goat or dairy cow) and animal transfer (feeding) studies.

The feeding studies are used to determine transfer factors (TF) that are defined as the ratio of the pesticide residue in the tissue or commodity of interest (fat, muscle, liver, kidney or milk) to the residue in the diet (expressed on a dry matter intake basis).

In utilizing transfer factors derived from feeding or metabolism studies for risk assessment management purposes, the user needs to be aware of the limitations and assumptions used. The TF derived is dependent on the duration of the feeding or dosing, the concentration in the feed or dose level, the nature of the feed (if added to the feed), lactational status, body weight, age, sex and breed of the animal studied. For chemicals administered as a mixture, the presence of other chemicals may alter the metabolism and/or rate of excretion by induction of the various routes of decontamination. The duration of a feeding study required for the steady state concentration to be reached in tissue or milk is a function of the elimination half-life. Residue definitions set by different regulators are not always the same and residue definition is a factor that should also be taken into account when utilizing TF for managing residue risks and trade. Care must be taken in extrapolating TFs from goat metabolism studies to all ruminants as is demonstrated by endosulfan, for which the residue definition is the sum of α -endosulfan, β -endosulfan and endosulfan sulphate, where only low levels of residues are found in goats but significant transfer to tissues occurs for cattle^{1,2}.

The transfer factors utilised here were calculated from residues reported in the scientific literature using the highest individual animal tissue divided by the nominal feed level. If the highest residue was not reported the average residue divided by the nominal feed level were used instead. In the case of milk the average residue was divided by the nominal feed level.

For the purposes of profiling risk conservative estimates of animal dietary burden (intake) are required. The maximum proportion of banana included in animal feed was assumed to be 100%. Estimates of residues in banana waste (fruit and stalks) were obtained from scaling of literature studies, MRLs or based on conservative assumptions. The dietary burden is then the residue in crop \times maximum proportion in the diet. To overcome errors that may result from differences in moisture contents of feed items it is accepted practice to calculate dietary burdens for a ration on a dry matter basis. A correction for dry matter content was not undertaken as it was felt the assumption of feeding at 100% of the diet is sufficiently conservative.

The estimated residue in animal commodities is:

$$\text{Residue} = TF \times \text{dietary burden} \text{ [ppm DM basis]}$$

Unless stated otherwise, the following assumptions have been used in the risk assessment:

- The bananas are harvested at maturity and that the fruit and stalks are derived on processing.
- The crop has been treated at the maximum rate and with the shortest interval between application and harvest permitted by the product label³
- The maximum rate of incorporation in the ration/diet is 100%.
- That residue transfer for cattle is greater than for sheep and therefore that the assessment of residues in cattle also covers sheep.

¹ Indraningsih, McSweeney, C.S. & Ladds, P.W. (1993) Residues of endosulfan in the tissues of lactating goats. *Aust. Vet. J.*, **70**, 59-62.

² Reregistration Eligibility Decision for Endosulfan Case No. 0014 EPA 738-R-02-013 November 2002 Environmental Protection Agency, Office of Pesticide Programs, Special Review and Reregistration Division. <http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg>

³ In general, only one or two product labels were selected per pesticide. There is a possibility that the maximum permitted rate may be higher than identified.

The potential for violative residues in animals is assessed against the Australian, Codex and US tolerances as listed in December 2005⁴. Other markets may have different standards however, for the bulk of Australian meat exports it is assumed that if the lower of these tolerances (or the LOQ of the analytical method if no Codex or US tolerance exists) can be met, the feeding of banana fruit and stalks will not pose an unacceptable risk.

Appendix 1 provides the details of a risk assessment for each of the compounds registered in Australia for use on bananas.

Most of the compounds registered for use on bananas also have registrations in other crops that are major animal feed commodities. Indeed, for most compounds listed in appendix 1 the major route of exposure for animals to the chemical is expected to be through feeding of these other crops (pasture, cereal waste etc).

The conclusion of the analysis is the risk of residue violations in meat and edible offal posed by the feeding of banana fruit and stalks derived from banana crops treated with currently registered products is low for the majority of chemicals. Based on the available information, the following pesticides are identified as requiring further investigation and/or development of additional risk management strategies:

Pesticide	Tissue	Residue (mg/kg)		Decline information located	
		Estimated ¹	Target ²	Crop	Animal
Carbaryl	Kidney	0.7	0.2	No	No
Chlorothalonil	Kidney	0.3	0.01	No	No
Dicofol	Fat	0.5/2.5	0.01	No	No
Prochloraz ³	Liver	1.4	0.01	No	No

¹residue in tissue estimated using assumptions outlined above

²target residue = lowest of Australian, Codex and US MRL or in absence of these the LOQ (often assumed to be 0.01 mg/kg)

³Note the current label contains a feeding restraint "Do not graze stock on ... treated fruit or by-products from treated processed fruit to livestock

Adequate data were not located to enable an assessment to be made for the following compounds: rotenone.

The current assessment has only identified pesticides of concern and not considered industry based QA programs that address the potential for residues in animal feeds to transfer to animals and mitigate risks; The National Vendor Declaration (NVD) form for traded livestock and the Commodity Vendor Declaration (CVD) and By-product Vendor Declaration (BVD) forms which are used for traded livestock feedstuffs.

⁴ MRLs and approved use patterns change with time. The assessments include the most recent decisions of the Codex Alimentarius Commission (28th Session, July 2005) with regard to Codex MRLs, US tolerances as listed in the Code of Federal Regulations at December 2005 and MRLs as they appear in Table 1 of the APVMA *MRL Standard* as at December 2005.

Appendix 1

2,2-DPA (2,2-dichloropropionic acid also known as dalapon)

- is a systemic herbicide used for the control of annual and perennial grasses and rushes. It is registered on a variety of crops including potential animal feeds sunflower, maize, soybean and pastures. The application rates are 1.5-3.7 kg ai/ha for the crops mentioned above and up to 7.4-11.1 kg ai/ha for bananas. Application to bananas is to annual and perennial grasses with contact with banana suckers to be avoided. The annual rate is not to exceed 22 kg ai/ha.

The harvest WHP is 7 days.

All crops have the following grazing restraint:

DO NOT graze or cut for stock food for 2 days after application

There are no Codex or USA MRLs for 2,2-DPA in animal tissues. The critical Australian MRL are 0.2 mg/kg for meat (mammalian) and *0.1 mg/kg for milks. Residues are not expected in bananas at harvest, the relevant MRL is *0.1 mg/kg. Dalapon and all of its known breakdown products dissolve easily in water. They are readily washed from cells and tissues. Because dalapon is insoluble in organic solvents and lipids, it does not build up in animal tissues.

Note: Utilising the US EPA revoked tolerances a conservative TF of 0.01 is estimated for meat and offal and 0.006 for milk.

It is anticipated that animal product residues will be below typical method LOQs.

2,4-D

- is a selective herbicide used widely for the control of emerged broadleaf weeds prior to sowing crops. It is registered on a variety of crops including potential animal feeds pasture and cereals at rates up to 2.2 kg ai/ha. Use on bananas is to destroy suckers, a use pattern that is not expected to lead to residues.

No harvest WHP is required.

There are Australian, Codex and USA MRLs for 2,4-D in animal tissues however, the residue definitions that apply differ. The residue definition for Codex and Australia is parent compound. For the USA the residue definition is the sum of 2,4-D and 2,4-DCP. This added complication potentially makes comparison of the respective MRLs more difficult. The Australian MRLs are 0.2 mg/kg for meat (mammalian), 2 mg/kg for edible offal (mammalian) and *0.05 mg/kg for milks. The critical USA tolerance is 2 mg/kg for cattle kidney while the MRL for milk is 0.1 mg/kg. The critical Codex tolerances are 5 mg/kg for edible offal, 0.2 mg/kg for meat (mammalian) while the MRL for milk is 0.01 mg/kg. The Australian use-pattern is such that no residues are expected and no MRL has been established.

It is anticipated that animal product residues will be below typical method LOQs.

Acephate

- is an organophosphate insecticide used to control insect pests in a variety of fruits and vegetables. Application rates are up to 13 g ai/10 L water with application as a bell injection or a bunch spray. A harvest WHP is not required when used as directed.

Acephate residues decline with typical half-lives of 30 and 5 days for soil and foliage respectively.

There are Australian, Codex and US MRLs for acephate in animal commodities, however the residue definitions differ. The Australian residue definition is parent compound though the metabolite methamidophos also has its own set of MRLs. The Australian MRLs are 0.2 mg/kg for edible offal and meat mammalian [except sheep meat] and *0.01 mg/kg for sheep meat. The Codex and US residue definitions are the sum of acephate and methamidophos. The US MRLs have all been set at 0.1 mg/kg including milk. The Codex MRLs are 0.05 mg/kg for meat and 0.02 mg/kg for milk. The Australian MRL for banana is 1 mg/kg.

In animal transfer studies with lactating cattle the transfer factors for muscle, kidney and milk were 0.008, 0.017 and 0.015 respectively⁵. It is considered unlikely that residues of acephate in animal tissues would exceed international tolerances.

Livestock residues are not anticipated to exceed international and/or domestic market standards.

Bendiocarb

-is an insecticide used to control banana scab moth and flower thrip. The application rate for bananas is 0.1 g ai/bunch applied to emerging bells with re-treatment at 3-4 day intervals until flowering stops.

Do not apply later than 56 days before harvest

There are Australian but no Codex or US MRLs for bendiocarb in animal commodities. The Australian MRLs are 0.1 for cattle meat, 0.2 mg/kg for cattle edible offal (no sheep MRLs) and 0.1 for milks.

Australian MRL for bananas is *0.02 mg/kg. In feeding studies with lactating dairy cattle fed at up to 25 ppm in the diet, residues in muscle and fat were <0.02 mg/kg, in liver <0.05 mg/kg and kidney <0.1 mg/kg (<LOQs for individual tissues) and <0.02 mg/kg in milk⁶.

It is anticipated that animal product residues will be below typical method LOQs.

Bifenthrin

- is a synthetic pyrethroid insecticide used for the control of various insects in crops. It is registered on bananas for control of banana weevil borer, banana rust thrips and strawberry spider mites. The application rate is up to 66 g ai/100 L with application as a band or spot treatment for borer and thrips and as a spray for strawberry mites at 20 g ai/ha. Bifenthrin residues decline with typical half-lives of 26 and 7 days for soil and foliage respectively.

The harvest WHP is 1 day for the ground borer/thrip treatment and 8 days for the foliar mite treatment.

There are Australian, Codex and USA MRLs for bifenthrin in animal tissues. The relevant MRLs for cattle fat are 2, 0.5 and 1 mg/kg for Australia, Codex and the USA respectively. The MRLs for milk are 0.5 mg/kg, *0.05 mg/kg (cattle milk) and 1 mg/kg (milk fat, 0.1 mg/kg for whole milk). The Australian MRL for bananas is 0.1 mg/kg. There are also MRLs for fodder and forage of pulses at 1 and 5 ppm respectively. Assuming levels in Australian banana fruit and stalks as the MRL and

⁵ 2003 JMPR. Pesticide Residues in Food - 2003 Evaluations – Part I: Residues, FAO Plant Production and Protection Paper xxx. FAO and WHO 2004

⁶ 1982 JMPR Pesticide Residues in Food - 1982 Evaluations, FAO Plant Production and Protection Paper 49. FAO and WHO 1983

a maximum TF of 0.3⁷ would give residues in fat of $0.1 \times 0.3 = 0.03$ mg/kg, lower than the relevant international tolerances. The TF for milk is 0.02 giving anticipated residues in milk of $0.1 \times 0.02 = 0.002$ mg/kg.

Livestock residues are not anticipated to exceed international and/or domestic market standards.

Cadusafos

- is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for nematode and weevil control. The application rate is up to 2-3 g ai/stool as a spot treatment or 0.4 kg ai/100 m row.

The harvest WHP is 14 days.

Note for citrus the following grazing restraints apply:

Do not allow graze treated area

Do not cut for stock food

It is not clear why these should not also apply to bananas.

There are no Australian, Codex and USA MRLs for cadusafos in animal tissues despite MRLs having been set for crops. The Australian MRL for bananas is *0.01 mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Carbaryl

- is a carbamate insecticide used for the control of various insects in crops. It is registered on bananas for control of wingless grasshopper. The application rate is up to 87.5 g ai/hL.

The harvest WHP is 3 days.

Carbaryl residues decline with typical half-lives of 10 and 7 days for soil and foliage respectively.

There are Australian, Codex and USA MRLs for carbaryl in animal tissues. The Australian and Codex residue definition is carbaryl for both plant and animal commodities. The Australian MRLs for edible offal and meat are 0.2 mg/kg while that for milk is 0.05 mg/kg. The Codex MRL for kidney is 3 mg/kg and liver 1 mg/kg while the MRL for meat is 0.05 mg/kg. The Codex milk MRL is 0.05 mg/kg. The Australian MRL for bananas [in the pulp] is 5 mg/kg.

The USA residue definition is the sum of carbaryl and 1-naphthol expressed as carbaryl for plant commodities, the sum of carbaryl, 1-naphthol, 5,6-dihydrodihydroxycarbaryl and 5,6-dihydrodihydroxynaphthol expressed as carbaryl for animal tissues. The US tolerance for cattle kidney and liver is 1 mg/kg and that for milk 0.3 mg/kg. The US also has tolerances of 100 ppm for various forages.

No data were located for residues of carbaryl in banana fruit and stalks. However, it is considered unlikely that residues in whole fruit and stalks would exceed 100 ppm when prepared from fruit with maximum pulp residues of 5 ppm. The TF for kidney is 0.007 for the Australian/Codex residue definition and 0.012 for the US residue definition⁸ giving rise to anticipated maximum residues in kidney from feeding banana fruit and stalks of the diet of $0.007 \times 100 = 0.7$ mg/kg and $0.012 \times 100 = 1.2$ mg/kg respectively for the Australian/Codex and USA residue definitions.

⁷ 1992 JMPR - Pesticide Residues in Food – 1992 evaluations. Part II. Toxicology. WHO, WHO/PCS/93.34, Geneva, 1993

⁸ 2002 JMPR. Pesticide Residues in Food - 2002 Evaluations – Part I: Residues Volume 1, FAO Plant Production and Protection Paper 175/1. FAO and WHO 2003

The TF for milk is 0.0002 for the Australian/Codex residue definition and 0.002 for the US residue definition giving rise to anticipated maximum residues in milk from feeding banana fruit and stalks of $0.0002 \times 100 = 0.02$ mg/kg and $0.002 \times 100 = 0.2$ mg/kg respectively for the Australian/Codex and USA residue definitions.

Livestock residues may exceed international and/or domestic market standards.

Carbendazim

- is a systemic fungicide used for the post-harvest control of crown rot in bananas. It is registered on bananas as a post-harvest dip at 20 g ai/100L (200 ppm).

There are Australian and Codex but no US MRLs for carbendazim. The relevant MRL for cattle meat is 0.2 mg/kg for Australia. MRLs for milk are all 0.1 mg/kg. There is an Australian MRL for bananas at 1 mg/kg. The Codex MRL for bananas is 0.2 mg/kg.

In studies in which dairy cows were fed either carbendazim or benomyl at levels of 2, 10, or 50 ppm in the diet for 28 days, no carbendazim residues were found in samples of lean muscle, liver, kidney or fat although in the carbendazim feeding study low-level residues of 5-HBC were observed in the liver (0.01 mg/kg) and kidneys (0.06 mg/kg) of cows in the group receiving 50 ppm carbendazim⁹. However, residues of this compound were also apparent in a kidney sample in the control group. One week after the end of treatment with the test material no residues were detectable in any tissue sample.

It is anticipated that animal product residues will be below typical method LOQs.

Chlorothalonil

- is a systemic fungicide used for the control of banana leaf spot and speckle in bananas. It is registered at an application rate of 2.15 kg ai/ha.

The harvest WHP is 1 day.

There are Australian and US but no Codex MRLs for chlorothalonil. The Australian residue definition is the sum of chlorothalonil and 4-hydroxy-2,5,6-trichloroisophthalonitrile metabolite expressed as chlorothalonil. The Australian MRLs are T3 mg/kg for edible offal, T2 mg/kg for meat in the fat and T0.05 mg/kg for milk. The US residue definition for animal commodities is 4-hydroxy-2,5,6-trichloroisophthalonitrile. The relevant MRLs for cattle commodities are 0.1, 0.5, 0.05 and 0.03 mg/kg for fat, kidney, meat by-products (except kidney) and meat respectively and 0.1 mg/kg for milk. There is an Australian MRL for bananas at 3 mg/kg. The US MRL for bananas is 0.5 mg/kg with not more than 0.05 mg/kg in edible pulp.

The TF for kidney (target tissue, US def) is 0.09^{10} . Assuming residues of chlorothalonil do not concentrate in banana stalks, anticipated residues in kidney would be $3 \times 0.09 = 0.27$ mg/kg if fed at 100% of the diet.

The TF for milk (US def) is 0.03. Assuming residues of chlorothalonil do not concentrate in stalks, anticipated residues in milk would be $3 \times 0.03 = 0.09$ mg/kg if fed at 100% of the diet.

⁹ 1998 JMPR - Pesticide Residues in Food - 1998 Evaluations, Part I Residues FAO Plant Production and Protection Paper 152/1. FAO and WHO 1999.

¹⁰ Pesticide Residues in Food - 1997 evaluations, FAO Plant Production and Protection Paper 146. FAO and WHO 1998

Livestock residues may exceed international and/or domestic market standards.

Chlorothalonil can contain up to 100 mg/kg hexachlorobenzene (HCB)¹¹, an application rate of 2.15 kg ai/ha corresponds to a potential application of HCB at 0.215 g/ha. Estimates of the potential for transfer of HCB residues are given below:

(a) Uptake from soil. Noting the half-life for HCB in soil is 3-6 years. Uptake of HCB by various crops was such that the ratio of soil to crop residues ranges from 0.03 – 2.4 for aerial parts. The contribution from previous years applications (assumed 12 years of additions 1 spray per year at the maximum rate = 0.215 g HCB/ha = 2.58 g HCB/ha), distributed in the top 20 cm soil with density 1 g/mL would be 2580 mg/2000000 kg = 0.0013 ppm. Assuming a ratio of 0.1 for crop to soil, residues in aerial plant parts would account for no more than 0.00013 mg/kg.

The TF for fat and milk fat are assumed to be 8 and 8.4 respectively. Feeding banana rejects/stalks with HCB residues of 0.00013 ppm at 100% of the diet would give rise to residues of $0.00013 \times 8 = 0.0010$ mg/kg in fat and $0.00013 \times 8.4 = 0.0011$ mg/kg in milk fat.

(b) Foliar residues. If assume residues in un-bagged banana bunches at day 0 from application of a pesticide at 1 kg ai/ha are 13 ppm and scale for application rate, reject/stalk residues are expected to be $0.000215 \times 13 = 0.002795$ ppm for HCB

Residues in cattle fat and milk would be $0.002795 \times 8 = 0.022$ mg/kg for fat and $0.002795 \times 8.4 = 0.023$ mg/kg in milk fat.

Livestock residues (HCB) are not anticipated to exceed international and/or domestic market standards.

Chlorpyrifos

- is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for the control of banana scab moth, caterpillars and banana borer weevil. The application rate is up to 100 g ai/ha.

The harvest WHP is 14 days.

There are Australian, Codex and USA MRLs for chlorpyrifos in animal tissues. The Australian and Codex residue definition is chlorpyrifos while the USA definition includes the metabolite TCP. The MRLs for cattle fat are 0.5, 1 and 0.3 mg/kg for Australia, Codex and the USA respectively. The MRLs for milk are 0.2 [milk in the fat] mg/kg, *0.01 mg/kg and 0.01 mg/kg (0.25 mg/kg for milk fat). There is an Australian MRL for bananas of 0.5 mg/kg. The US MRLs for bananas whole and pulp are 0.1 and 0.01 mg/kg respectively.

The maximum transfer factor for feeding cattle at 10 ppm in the diet was 0.016 for cattle fat and at 30 ppm 0.0007 for milk¹². Residues from feeding banana fruit and stalks with residues of 0.5 ppm at 100% of the diet would be $0.5 \times 0.016 = 0.008$ mg/kg; below the Australian, Codex and USA MRLs USA MRL for fat. Anticipated residues for milk would be $0.5 \times 0.0007 = 0.00035$ mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Clofentezine

¹¹ Australian Pesticides And Veterinary Medicines Authority, Minimum Compositional Standards (MCS) for Active Constituents as of 30 January 2004, <http://www.apvma.gov.au/tgac/mincompstandards.pdf>

¹² 2000 JMPR. Pesticide Residues in Food - 2000 Evaluations – Part I, FAO Plant Production and Protection Paper 165. FAO and WHO 2001

-is a miticide used for the control of two spotted and strawberry spider mites on bananas. The application rate is up to 125 g ai/ha. A harvest WHP is not required.

There are Australian, Codex and USA MRLs for clofentezine in animal tissues. The Australian MRLs are all $T \times 0.05$ mg/kg. The Codex and USA definitions for animal commodities include the metabolite 3-(2-chloro-4-hydroxyphenyl)-6-(2-chlorophenyl)-1,2,4,5-tetrazine. The Codex MRLs are cattle meat are $\times 0.05$, cattle milk $\times 0.01$ mg/kg and cattle edible offal 0.1 mg/kg. The US MRLs are 0.4 mg/kg for liver, 0.05 mg/kg for other tissues and 0.01 mg/kg for milk. There is an Australian MRL for bananas of $\times 0.01$ mg/kg. The TF for liver is 0.026^{13} .

It is anticipated that animal product residues will be below typical method LOQs.

Diazinon

- is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for the control of banana beetle borer and banana rust thrip. The application rate is up to 100 g ai/hL.

The harvest WHP is 14 days.

Do not graze pastures or forage crops or cut for stock food crops for 2 days after application

There are Australian, Codex and USA MRLs for diazinon in animal tissues. The MRLs for cattle fat are 0.7 mg/kg for Australia, Codex and the US. For milk the MRLs are 0.5 [in the fat], 0.02 F mg/kg and not specified. There is an Australian MRLs for bananas at 0.5 mg/kg (fruits MRL). The US MRL for bananas is 0.2 mg/kg with not more than 0.1 mg/kg in the pulp.

The TF for diazinon in animal fat is 0.001^{14} . Anticipated residues in cattle fat from feeding banana fruit and stalks are $0.5 \times 0.001 = 0.0005$ mg/kg, below the relevant international MRLs (Note assumed 100% of the diet). No residues were detected in milk of cows dosed at the equivalent of 120 ppm in the diet.

It is anticipated that animal product residues will be below typical method LOQs.

Dicofol

- is an organochlorine miticide used for the control of various pests in a variety of crops. In bananas it is used for the control of two spotted and banana mites. The application rate is up to 60 g ai/hL.

The harvest WHP is 7 days.

Do not graze or cut for stock food.

There are no Australian or USA MRLs for animal commodities. The Australian and Codex residue definitions differ. The Australian residue definition is the sum of dicofol + 2,2,2-trichloro-1-(4-chlorophenyl)-1-(2-chlorophenyl)ethanol calculated as dicofol while the Codex residue definition for animal commodities is the sum of dicofol + 2,2-dichloro-1,1-bis(4-chlorophenyl)ethanol (p,p'-FW152) calculated as dicofol. There is a Codex MRL of 3 for cattle fat, 0.1 mg/kg for milk (F) and 1 mg/kg for cattle edible offal. There is an Australian MRL for bananas which has been set at 5 mg/kg (fruits other than strawberries).

¹³ data reported in the 1986 and 1990 JMPRs - Pesticide Residues in Food - 1986 Evaluations, Part I Residues FAO Plant Production and Protection Paper 78. FAO and WHO 1986 and Pesticide Residues in Food - 1990 Evaluations, Part I Residues FAO Plant Production and Protection Paper 103/1. FAO and WHO 1990

¹⁴ 1996 JMPR - Pesticide Residues in Food - 1996 Evaluations, Part I: Residues FAO Plant Production and Protection Paper 142. FAO and WHO 1997

Residues in soil and foliage decline with typical half-lives of 16- 60 days and >6 months respectively.

The TF for fat for the Australian and Codex residue definitions are 0.05-0.1 for Australia and 0.3-0.5 for the Codex residue definition¹⁵. Assuming residues in bananas and stalks are at the same level as the MRL and are fed at 100% of the ration, the anticipated residues in fat are $5 \times 0.5 = 2.5$ mg/kg for the Codex residue definition. Anticipated residues in milk are $5 \times 0.04 = 0.2$ mg/kg for the Codex and $5 \times 0.006 = 0.03$ for the Australian residue definition. Residues above LOQ are expected if banana fruit and stalks derived from dicofol treated bananas are fed to animals.

Dicofol can contain up to 1000 mg/kg DDT and related compounds¹⁶, an application rate of 60 g ai/hL corresponds to a potential application of DDT at 1.2 g/ha assuming 2000L/ha spray volume. The TF for fat and milk fat are estimated to be 1.8 and 2.1 respectively. If residues DDT are present at the same ratio to dicofol as in the technical active ingredient the anticipated residues in bananas and stalks are $5/1000 \times 1.8 = 0.009$ mg/kg in subcutaneous fat and $5/1000 \times 2.1 = 0.01$ mg/kg in milk fat.

Livestock residues (dicofol) may exceed international and/or domestic market standards.

Difenoconazole

-is a triazole fungicide that is used in bananas for the control of Yellow and Black Sigatoka. The application rate is 100 g ai/ha.

Do not harvest for 1 day after application

There are Australian and US but no Codex MRLs for difenoconazole in animal tissues. The Australian and US MRLs have all been set at *0.05 mg/kg for tissues and *0.01 mg/kg for milk. The Australian banana MRL is *0.02 mg/kg.

The US EPA reported¹⁷ “two metabolism studies were performed on ruminants (lactating goats) in a 10-day study with a dose rate of 4.17 ppm ($14 \times$ the 0.30 ppm estimated dietary burden) and a 3-day study with a dose rate of 100 ppm ($333 \times$ the 0.30 ppm estimated dietary burden). The total radioactive residue (TRR) in the goat tissues was used to estimate the expected residues in a feeding study with a dose rate of 0.30 ppm. The maximum residue observed was in liver, estimated to be at a level of 0.02 ppm from both metabolism studies. This value is $2.5 \times$ below the LOQ of the proposed analytical enforcement method (0.05 ppm).”

It is anticipated that animal product residues will be below typical method LOQs.

Dimethoate

- is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for the control of silvering thrips and mites for which the application rate is up to 30 g ai/hL. The harvest WHP is 7 days.

¹⁵ 1994 JMPR - Pesticide Residues in Food - 1994 Evaluations, Part I Residues FAO Plant Production and Protection Paper 78. FAO and WHO 1995

¹⁶ Australian Pesticides And Veterinary Medicines Authority, Minimum Compositional Standards (MCS) for Active Constituents as of 30 January 2004, <http://www.apvma.gov.au/tgac/mincompstandards.pdf>

¹⁷ Difenoconazole Pesticide Tolerance Federal Register: September 15, 2000 (Volume 65, Number 180) Page 55911-55921

It is also registered as a post-harvest dip for the control of fruit fly with an application rate of 40 g ai/100 L (400 ppm).

There are Australian, Codex and USA MRLs for dimethoate in animal tissues. The Australian and Codex MRLs for animal commodities have been set at *0.05 mg/kg while the US ones are set at 0.02 mg/kg. There are Australian MRLs of 5 mg/kg for fruits (includes bananas).

A metabolism study with lactating goats dosed orally with dimethoate suggests that residues are not expected in animal tissues¹⁸.

It is anticipated that animal product residues will be below typical method LOQs.

Diuron

- is a herbicide used for the control of weeds in crop. It is used as a directed spray (to ground) with an instruction to not allow spray or drift to contact banana suckers. The application rate is up to 3.6 kg ai/ha.

No harvest or grazing WHP is required.

There are no Codex MRLs for diuron. The US and Australian residue definitions differ with the Australian definition including a metabolite in addition to the parent compound. The relevant US MRL for animal tissues is 1 mg/kg for cattle mbyop while the Australian MRL for edible offal of cattle is 3 mg/kg (the higher value probably reflecting the inclusion of the metabolite in the residue definition). The Australian MRL for milk is 0.1 mg/kg. Residues in soil and foliage decline with typical half-lives of 90 and 30 days respectively. Australia has a primary animal feed commodity MRL of 50 mg/kg while the MRL for bananas (fruits) is 0.5 mg/kg. The USA MRL for bananas is 0.1 mg/kg.

It is considered unlikely that residues bananas would exceed the Australian primary animal feed commodity MRL. Feeding of banana fruit and stalks should not significantly increase the risk of residues of diuron in animal tissues.

NOTE: US MRLs have been established for animal feed items (including alfalfa forage and hay at 2 ppm and banana fruit and stalks dry at 4 ppm) as well as for animal commodities. If the US MRLs are used to estimate the dietary burden using the US EPA Guideline, a dietary burden of *ca.* 4.8 ppm is estimated. An anticipated TF is the 1 ppm (animal commodity tolerances) ÷ 4.8 ppm (dietary burden) = 0.2 (crude estimate).

Scaling the US tolerance for residues in bananas for the Australian MRL, and assuming bananas are fed at 100% of the ration, the anticipated residues in tissues are $0.5 \times 0.2 = 0.1$ mg/kg for the US residue definition.

It is anticipated that animal product residues will be below typical method LOQs.

Epoxiconazole

-is a conazole fungicide used to treat banana leaf spot and leaf speckle, including those interplanted into avocados. The application rate is up to 75 g ai/ha.

The harvest WHP is 1 day for avocados and bananas.

¹⁸ 1998 JMPR - Pesticide Residues in Food - 1998 Evaluations, Part I Residues FAO Plant Production and Protection Paper 152/1. FAO and WHO 1999

The Australian MRLs (mg/kg) are Edible offal (mammalian) T0.05, Meat (mammalian) *0.01, Milks T0.01 and Avocado 0.5 and Banana 1.

Lactating dairy cattle were dosed at 4 ppm (0.12 mg/kg bw) and 41 ppm (1.2 mg/kg bw) for 28 days¹⁹. Residues in milk for the 4 ppm dose group were <0.001 mg/kg for 20 of 27 daily samples, with a maximum observable residue of 0.002 mg/kg. Residues in tissues at slaughter were <LOD except for liver for which the maximum residue was 0.04 mg/kg. For the 41 ppm dose group a detectable residue in fat of 0.02 mg/kg was observed in a single animal. Residues partitioned into cream such that the concentration relative to whole milk was 14×.

It is anticipated that animal product residues will be below typical method LOQs.

Fenamiphos

- is an organophosphate insecticide used for the control of various insects and nematodes. It is registered on bananas for the control of soil borne plant pathogenic nematodes. The application rate is up to 2.5 g ai/stool or 250 g ai/100 m row.

No harvest or grazing WHPs are required.

There is no Codex MRL for fenamiphos in animal tissues. The relevant Australian and USA MRLs for fenamiphos in animal tissues are *0.05 mg/kg for meat. The Australian and US MRLs for milk are *0.005 and 0.01 mg/kg respectively. The primary animal feed commodity MRL for fenamiphos is 1 mg/kg. Australian use-pattern is such residues are not expected in bananas at harvest (MRL *0.05 mg/kg). The USA MRL for bananas is 0.1 mg/kg as is the Codex MRL. In a dairy cattle feeding study, residues in tissues of cattle fed at the equivalent of 20 ppm in the diet were ≤0.01 mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Fenbuconazole

-is a triazole fungicide used for the control of leaf spot (yellow sigatoka) and Black Sigatoka in bananas. The application rate is 101 g ai/ha.

The harvest WHP is 1 day.

Do not allow livestock to graze orchards or plantations or cut fodder from treated areas as stock food for 4 weeks after application.

There are Australian, Codex and USA (due to expire 31/12/05) MRLs for fenbuconazole in animal commodities. The Australian MRLs (fenbuconazole) are all *0.01 mg/kg. The Codex MRLs (fenbuconazole) are all *0.05 mg/kg for cattle commodities except liver which is 0.05 mg/kg. The USA tolerances, residue definition fenbuconazole and its metabolites, cis-5-(4-chlorophenyl)-dihydro-3-phenyl-3-(1H-1,2,4-triazole-1-ylmethyl)-2-3H-furanone and trans-5-(4-chlorophenyl)dihydro-3-phenyl-3-(1H-1,2,4-triazole-1-ylmethyl)-2-3H-furanone, expressed as fenbuconazole are all 0.01 mg/kg. The Australian MRL for bananas is 0.5 mg/kg.

Cattle dosed at a level equivalent to 6.5 ppm in the feed, showed total fenbuconazole residues of 0.01 mg/kg in one sample of muscle and up to 0.09 mg/kg in 3 samples of liver²⁰. No quantifiable

¹⁹ Public Release Summary on Evaluation of the new active EPOXICONAZOLE in the product OPUS 75 FUNGICIDE, APVMA November 2003, Canberra, Australia.

²⁰ 1997 JMPR Pesticide Residues in Food - 1997 evaluations, FAO Plant Production and Protection Paper 146. FAO and WHO 1998

residues were found in the milk, fat or kidney. At a dose level equivalent to 19.5 ppm in the feed the only residues were 0.02 mg/kg in one sample of milk and 0.1-0.2 mg/kg in three samples of liver.

It is anticipated that animal product residues will be below typical method LOQs.

Fenbutatin oxide

- is a miticide. Application to bananas is for control of two spotted and banana spider mites and is at an application rate of 204 g ai/ha.

The harvest WHP is 1 days.

Do not graze or feed animals on cover crops in sprayed orchards

There are Codex but no Australian or US MRLs for fenbutatin oxide in animal tissues. The Codex MRLs are 0.2 mg/kg for edible offal and *0.05 mg/kg for meat mammalian and milk. The Codex MRL for bananas is 10 mg/kg. The Australian MRL for bananas is 5 mg/kg.

Feeding at 96 ppm for 28 days resulted in residues of up to 0.06 mg/kg in fat and 0.22 mg/kg in liver/kidney and 0.11 mg/kg in cream and <0.02 mg/kg in skim milk (US residue definition)²¹. Anticipated residues in fat are $5 \times 0.0006 = 0.003$ mg/kg (feeding at 100% of diet), less than likely regulatory method LOQs for fat.

It is anticipated that animal product residues will be below typical method LOQs.

Fenthion

- is an organophosphate insecticide used for the control of various insects and nematodes. It is registered on bananas for the control of fruit fly. The application rate is up to 41.25 g ai/hL.

The harvest WHP is 7 days.

There is also a post-harvest application for fruit fly with a dip rate of 41.25 g ai/100 L (412 ppm).

There are Australian and US (due to expire 1/4/06) but no Codex MRLs for fenthion in animal tissues. The relevant Australian and USA MRLs for fenthion in animal tissues are 1 mg/kg in Australia and 0.1 mg/kg in the US. The relevant milk MRLs are 0.2 and 0.01 (N) mg/kg respectively. The MRL for bananas is 5 mg/kg.

Residues in tissues of lactating dairy cows fed at a nominal feed level of 7.6 ppm were all <0.05 mg/kg²². The TF for milk is 0.002.

It is anticipated that animal product residues will be below typical method LOQs.

Fipronil

- is a phenylpyrazole insecticide used for control of banana rust thrips and banana weevil borer.

Application to bananas is by butt application (30 g ai/100 L or 0.3 g ai/stool) or by band application (8 g ai/100 m²) and is to the trash and ground.

A harvest WHP is not required.

The relevant Australian, Codex and US tolerances for fipronil in animal fat are 0.1, 0.5 (cattle meat in the fat) and 0.4 mg/kg respectively while the milk MRLs are 0.01, 0.02 mg/kg while the US

²¹ 1979 JMPR - Pesticide Residues in Food - 1979 Evaluations, Part I Residues FAO Plant Production and Protection Paper 20 Suppl. FAO and WHO 1980

²² 2000 JMPR. Pesticide Residues in Food - 2000 Evaluations – Part I, FAO Plant Production and Protection Paper 165. FAO and WHO 2001

MRL is 1.5 mg/kg for milk fat (representing 0.05 mg/kg in whole milk). The MRL for bananas is *0.01 mg/kg. There is an animal feed MRL for pasture (mixed grasses/leguminous)[fresh weight] of 0.02 ppm. Foliar residues of fipronil are reported to decline with a typical half-life of 2-4 days.

If maximum residues in bananas and stalks are assumed to be <0.01 ppm and using the transfer factor for fat reported by the 2001 JMPR²³ (TF = 1.1-1.2), anticipated maximum residues in cattle fat are $\approx <0.01 \times 1.2 = <0.012$ mg/kg. The TF for milk is 0.1 giving anticipated residues in milk of $\approx <0.01 \times 0.1 = <0.001$ mg/kg.

Livestock residues are not anticipated to exceed international and/or domestic market standards.

Fluazifop-p

- is a selective post-emergent herbicide used for the control of certain grasses in crops such as canola, cotton, sunflower, legumes and pastures. The application rate for bananas is up to 0.212 kg ai/ha.

A WHP is not required when used as directed

There are Australian and USA but no Codex animal tissue MRLs for fluazifop. The relevant Australian MRLs are *0.05 for edible offal and meat and 0.1 for milk. The US tolerances for animal commodities have all been set at 0.05 mg/kg (fluazifop-butyl). The Australian MRL relevant to bananas is *0.02 mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Glufosinate ammonium

-is a non-selective foliar herbicide used for the control of broadleaf weeds and grasses in crops such as cotton, maize, sorghum and winter cereals as well as pastures. It is applied as a shielded spray to bananas. The application rate is up to 1 kg ai/ha.

No harvest WHPs are required.

Do not graze or cut treated areas for stock food for 8 weeks after application

The relevant Australian MRLs are the same at 5 mg/kg for offal, 0.1 mg/kg for meat and *0.05 mg/kg for milks. The Codex MRLs are *0.1 mg/kg for edible offal, *0.05 mg/kg for meat mammalian and *0.02 mg/kg for milks. The relevant USA MRL is 6 mg/kg for cattle mbyp while the MRLs for meat and fat are 0.15 and 0.4 mg/kg respectively. The US MRL for milk is 0.02 mg/kg. There is an Australian MRL for mixed pasture of 15 mg/kg.

The JMPR have reported that residues were <0.01 mg/kg in edible offal and meat of cattle fed at the equivalent of 27 ppm in the diet²⁴.

It is anticipated that animal product residues will be below typical method LOQs.

Glyphosate

-is a non-selective foliar herbicide used for the control of broadleaf weeds and grasses in crops such as cotton, maize, sorghum and winter cereals as well as pastures. It is applied as a shielded spray to bananas. The application rate is up to 3.24 kg ai/ha (bananas not treated, shielded spray).

²³ 2001 JMPR Pesticide Residues in Food - 2001 Evaluations – Part I, FAO Plant Production and Protection Paper 171. FAO and WHO 2002

²⁴ 1998 JMPR - Pesticide Residues in Food - 1998 Evaluations, Part I Residues FAO Plant Production and Protection Paper 152/1. FAO and WHO 1999

No harvest or grazing WHPs are required.

The relevant Australian and Codex MRLs are the same at 2 mg/kg for offal and *0.1 mg/kg for milk. The relevant USA MRL is 4 mg/kg for cattle kidney. The primary animal feed commodity MRL for glyphosate is 150 mg/kg, the banana MRL is 0.2 mg/kg. The US MRL for bananas is 0.2 mg/kg.

Residues in cattle, pig and poultry meat, eggs and milk were determined after the animals were fed with a diet containing 100 ppm glyphosate and aminoglyphosate acid²⁵. The highest residues were in pig liver and kidney (up to 0.16 and 0.91 mg/kg, respectively) and cattle kidney (up to 1.4 mg/kg). TF cattle kidney = 0.014

It is anticipated that animal product residues will be below typical method LOQs.

Haloxifop-R

- is a selective post-emergent herbicide used for the control of certain grasses in crops such as grain legumes, oilseeds (including cotton) and legume pastures. The application rate for bananas is up to 416 g ai/ha as a directed spray.

No harvest WHP required

There are Australian but no USA or Codex animal tissue MRLs for haloxifop. The relevant Australian MRLs are 0.5 mg/kg for edible offal, 0.02 mg/kg for meat (fat) and 0.02 mg/kg for milk. The Australian MRL relevant to bananas is *0.05 mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Mancozeb

- is a dithiocarbamate fungicide used on a variety of crops. It is used on bananas for the control of leaf spot and speckle at an application rate of 1.25 kg ai/ha.

The harvest WHP is 1 day (NB: Can also be 7 days or 14 days on some labels)

Do not feed crops and or trash to livestock.

There are Australian, Codex and US MRLs for mancozeb in animal commodities. The Australian MRL for edible offal is 2 mg/kg while the Codex MRL is 0.5 mg/kg, both as CS₂. The USA residue definition is zinc ethylenebisdithiocarbamate and the MRL 0.5 mg/kg for liver and kidney. The MRLs for milk are *0.2 mg/kg and *0.05 mg/kg respectively.

The Australian PAFC MRL is 50 ppm and the bananas MRL 2 mg/kg. Residues in banana fruit and stalks would be expected to be much less than 50 ppm. The target tissue is liver. The TF for liver (45 ppm feeding study)²⁶ was 0.003 giving an anticipated maximum residue from the feeding of banana fruit and stalks at 100% of the diet of $2 \times 0.003 = 0.006$ mg/kg, less than the relevant international MRLs. The TF for milk was <0.008.

It is anticipated that animal product residues will be below typical method LOQs.

²⁵ 1986 JMPR Pesticide Residues in Food - 1986 Evaluations, Part I Residues FAO Plant Production and Protection Paper 78. FAO and WHO 1986

²⁶ 1993 JMPR - Pesticide Residues in Food - 1993 Evaluations, Part I Residues FAO Plant Production and Protection Paper 124. FAO and WHO 1994

Omethoate

- is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for the control of corky scab caused by flower thrips. The application rate is up to 100 g ai/100 L for throat spray (500 mL applied to the throat of the plant at the bunch leaf stage during flower thrip activity) or by bell injection (40-60 mL of a 40 g ai/5 L solution to the emerging bell). The harvest WHP is 6 weeks for bell injection and 4 days for throat spray.

There are Australian but no Codex or US MRLs for omethoate in animal tissues. The Australian MRLs for animal commodities including milk have been set at *0.05 mg/kg. There are Australian MRLs of 2 mg/kg for fruits and 20 ppm for a series of miscellaneous forage and fodder crops.

A metabolism study with lactating goats dosed orally with dimethoate suggests that residues of omethoate are not expected in animal tissues²⁷.

It is anticipated that animal product residues will be below typical method LOQs.

Oryzalin

- is a dinitroaniline herbicide used for the control of weeds in various crops. The application rate is up to 3.4 kg ai/ha as a directed spray. There is no harvest WHP.

There are no Australian, US or Codex MRLs for oryzalin animal commodities. The Australian MRL for bananas is 0.1 mg/kg.

The US EPA reported in their assessment on oryzalin that studies conducted at highly exaggerated feeding levels with laying hens and beef and dairy cattle indicated that oryzalin is either poorly absorbed or rapidly metabolized via hydroxylation and cleavage of the alkyl side chain to yield polar components that are excreted and that there is "No reasonable expectation of finite residues in animal commodities"²⁸.

It is anticipated that animal product residues will be below typical method LOQs.

Oxamyl

-is a nematicide used on various crops. It is used on bananas for the control of banana weevil borer and spiral and burrowing nematodes at application rates of up to 3 g ai/plant.

A harvest WHP is not required.

Do not graze any treated area or cut banana stems/fronds for stock food.

There are Australian and Codex but no US MRLs for oxamyl in animal commodities. The Australian and Codex MRLs have all been set at *0.02 mg/kg. The Australian MRL for bananas is 0.2 mg/kg.

²⁷ 1998 JMPR - Pesticide Residues in Food - 1998 Evaluations, Part I Residues FAO Plant Production and Protection Paper 152/1. FAO and WHO 1999

²⁸ Reregistration Eligibility Decision Oryzalin List A Case 0186, Environmental Protection Agency, Office of Pesticide Programs, Special Review and Reregistration Division

In a livestock-feeding study oxamyl was fed to Guernsey dairy cows at 2, 10 or 20 mg/kg in the diet for 30 days²⁹. No residues of oxamyl were detected (<0.02 mg/kg) in any sample of milk or milk fractions, liver, kidney, lean muscle or subcutaneous fat at any of the feeding levels.

It is anticipated that animal product residues will be below typical method LOQs.

Paraquat

-is a herbicide used for the control of weeds in various crops. The application rate is up to 3.2 L/ha as a directed spray = 800 g ai/ha.

No harvest WHP required

Do not graze or cut sprayed vegetation for stock food for at least 1 day.

Remove stock from treated areas 3 days before slaughter.

The Australian and Codex MRLs for paraquat in kidney and milk are the same at 0.5 and *0.01 mg/kg respectively. The US MRL for kidney is 0.3 mg/kg and for milk 0.01 (N) mg/kg. Residues in soil and foliage decline with typical half-lives of *ca.* 1000 and 30 days respectively. The MRL for bananas is *0.05 mg/kg in both Australia and the US. For residues in kidney to be less than the US MRL of 0.3 mg/kg, cattle would have to fed at less than *ca.* 80 ppm in the diet. Noting the application rates and that the MRL for bananas is *0.05 mg/kg, it is considered unlikely that residues in banana fruit and stalks would exceed 80 ppm.

It is anticipated that animal product residues will be below typical method LOQs.

Pendimethalin

-is a selective herbicide used for the control of annual ryegrass and certain broadleaf weeds in cotton, cereals etc. It is applied to bananas at an application rate of up to 3.96 kg ai/ha as a directed spray.

No harvest or grazing WHPs are required.

There are no Codex or Australian or US MRLs for pendimethalin in animal tissues. Residues decline in soil and foliage with typical half-lives of 90 and 50 days respectively. The Australian MRL for bananas is *0.05 mg/kg. The US EPA notes that animal metabolism studies in goats conducted at exaggerated feeding levels indicate that there is no reasonable expectation for residues of pendimethalin in tissues³⁰.

It is anticipated that animal product residues will be below typical method LOQs.

Piperonyl butoxide (PBO)

- is a synergist used to increase the effectiveness of various synthetic pyrethroid (SP) insecticides. It is registered for use with pyrethrin in the control of insect pests on bananas. The application rate is up to 31 g ai/hL.

The harvest WHP is 1 day

There are Australian and Codex but no US MRLs for PBO in animal commodities. PBO is exempt from the requirement for tolerances in the US. The Australian MRLs for animal tissues have all been set at 0.1 mg/kg. The Codex MRL for mammalian meat (fat) (except cattle) is 2 mg/kg and for

²⁹ 1980 JMPR Pesticide Residues in Food - 1980 Evaluations, FAO Plant Production and Protection Paper 26 Sup. FAO and WHO 1981

³⁰ Reregistration Eligibility Decision Pendimethalin List A Case 0187, Environmental Protection Agency, Office of Pesticide Programs, Special Review and Reregistration Division

cattle meat (fat) 5 mg/kg. The Australian MRL for milks is *0.05 mg/kg. There is an Australian MRL of 8 mg/kg for bananas (fruits).

The TF for PBO in fat is 0.004 (feeding at 100 ppm in the diet)³¹ resulting in an anticipated maximum residue from feeding banana rejects and stalks at 100% of the diet of $8 \times 0.004 = 0.032$ mg/kg, less than the relevant Australian, proposed Codex and US MRLs and likely regulatory method LOQ.

The TF for PBO in milk is 0.0001 (feeding at 100 ppm in the diet) resulting in an anticipated maximum residue from feeding at 100% of the diet of $8 \times 0.0001 = 0.0008$ mg/kg, less than the relevant Australian, proposed Codex and US MRLs and likely regulatory method LOQ.

It is anticipated that animal product residues will be below typical method LOQs.

Prochloraz

-is an imidazole fungicide used for the control of Anthracnose in bananas. The application rate is 25 g ai/100 L as a post-harvest spray.

Do not graze stock on ... treated fruit or by-products from treated processed fruit to livestock.

There are Codex but no Australian or US MRLs for prochloraz in animal commodities. The Codex MRLs are 5 mg/kg for cattle edible offal, 0.5 mg/kg for cattle fat and *0.1 mg/kg for cattle meat and milk. The Australian MRL for bananas is 5 mg/kg.

The 1990 JMPR reported a feeding study in which cattle were dosed at rates of 10, 30 and 100 ppm for 28 days³². At the lowest dose level, residues of 2.8, <0.05, 0.5 and 0.1-0.2 mg/kg, respectively, were found in liver, muscle, kidney and fat. Anticipated residues in liver are 1.4 mg/kg ($5 \times 0.28 = 1.4$ mg/kg).

Livestock residues may exceed international and/or domestic market standards.

Propargite

- is an acaricide used for the control of mites in various crops. The application rate for bananas is up to 375 g ai/ha. Propargite residues decline with typical half-lives of 56 and 5 days for soil and foliage respectively.

The harvest WHP is 7 days.

There are Australian, Codex and US MRLs for propargite in animal commodities. The MRLs applicable to cattle fat (target tissue) have all been set at *0.1 mg/kg. The US MRL for milk fat is 2 mg/kg (0.08 mg/kg for whole milk). The Australian MRL for milk is *0.1 mg/kg while the Codex MRL is 0.1 F mg/kg. There is an Australian MRL of 3 mg/kg for bananas.

The TF for cattle fat (50 ppm feeding study)³³ was 0.004 giving an anticipated residue in fat from feeding banana rejects and stalks at 100% of the diet of *ca.* $3 \times 0.004 = 0.012$ mg/kg, less than the relevant international MRLs. The TF for milk (50 ppm feeding study) was 0.0002 giving an

³¹ 2002 JMPR. Pesticide Residues in Food - 2002 Evaluations – Part I: Residues Volume 1, FAO Plant Production and Protection Paper 175/1. FAO and WHO 2003

³² 1990 JMPR. Pesticide Residues in Food - 1990 Evaluations, Part I Residues FAO Plant Production and Protection Paper 103/1. FAO and WHO 1990

³³ 2002 JMPR. Pesticide Residues in Food - 2002 Evaluations – Part I: Residues Volume 1, FAO Plant Production and Protection Paper 175/1. FAO and WHO 2003

anticipated residue in fat from feeding banana rejects and stalks at 100% of the diet of $3 \times 0.0002 = 0.0006$ mg/kg, less than the relevant international MRLs.

It is anticipated that animal product residues will be below typical method LOQs.

Propiconazole

-is a DMI fungicide used for the control of various fungal diseases in bananas (Black sigatoga, leaf spot and leaf speckle etc). Application is at up to 100 g ai/ha.
The harvest WHP is 1 day.

There are Australian, Codex and US MRLs for propiconazole in animal commodities. The Australian MRLs (propiconazole) are 1 mg/kg for edible offal, 0.1 mg/kg for meat and *0.01 mg/kg for milk. The Codex MRLs are (propiconazole) 0.05 mg/kg for edible offal, *0.05 mg/kg for meat (mammalian) and *0.01 mg/kg for milk. The US residue definition is the sum of propiconazole and its metabolites determined as 2,4-dichlorobenzoic acid, expressed as parent compound. The US MRLs are 2 mg/kg for liver and kidney, 0.1 mg/kg for fat and meat by-products (except liver and kidney) and 0.05 mg/kg for milk. The US MRL for bananas is 0.2 mg/kg as is the Australian MRL

The Australian use-pattern is such that low levels of residues are expected in bananas or derived animal feeds. Animal transfer studies were reported by the 1987 JMPR at feeding levels of 15-100 ppm for cows and 4.5 ppm for goats resulted in undetectable parent residues in milk and tissues (<0.05 mg/kg)³⁴. After feeding cows for 14 days at 15 ppm the total residues were undetectable in milk and 0.63 mg/kg in kidney.

It is anticipated that animal product residues will be below typical method LOQs.

Prothiofos

is an organophosphate insecticide used on bananas for the control of banana borer weevil. The application rate is 500 g ai/hL as a butt treatment in a 30 cm band around the base of plants.
A harvest WHP is not required.

There are no Australian, Codex or US MRLs for prothiofos in animal tissues. The Australian MRL for bananas is *0.01 mg/kg. No animal transfer data were located.

It is anticipated that animal product residues will be below typical method LOQs.

Pyraclostrobin

-is a strobilurin fungicide used for the control of leaf speckle and leaf spot in bagged bananas.
Application is at up to 100 g ai/ha.
A WHP is not required when used as directed.

There are Australian and US but no Codex MRLs for pyraclostrobin in animal commodities. The Australian MRLs are *0.05 mg/kg for animal commodities except milk for which the MRL is *0.01 mg/kg. The US MRLs are 1.5 mg/kg for liver, 0.2 mg/kg for other meat by-products, 0.1 mg/kg for meat, fat and milk. The MRL for bananas is *0.02 mg/kg³⁵.

³⁴ 1987 JMPR Pesticide Residues in Food - 1987 Evaluations, Part I Residues FAO Plant Production and Protection Paper 86/1. FAO and WHO 1988

³⁵ Public Release Summary on Evaluation of the new active PYRACLOSTROBIN in the product CABRIO FUNGICIDE Australian Pesticides and Veterinary Medicines Authority September 2003 Canberra Australia

It is anticipated that animal product residues will be below typical method LOQs.

Pyrethrin

- is a natural pyrethroid insecticide used for the control various insect pests in bananas and other fruit crops. The application rate is up to 7.7 g ai/hL.

The harvest WHP is 1 days.

There are US but no Australian or Codex MRLs for pyrethrins in animal commodities. The MRLs applicable to cattle fat (target tissue) have all been set at 0.1 mg/kg. There is an Australian MRL of 1 mg/kg for bananas while in the US pyrethrins are exempt from the requirement for a tolerance when applied to growing crops.

In a feeding study with lactating cows, residues in tissues of animals dosed orally at a level equivalent to 5 ppm in the feed had residues in tissues that were <LOQ (0.038 mg/kg) for muscle, liver and kidney and 0.048-0.075 mg/kg in fat³⁶. Feeding bananas with residues of 1 ppm should not result in tissues residues above typical LOQs for pyrethrins.

It is anticipated that animal product residues will be below typical method LOQs.

Pyridaben

- is an acaricide used for the control of two spotted and strawberry mites in bananas. The application rate is up to 12.5 g ai/hL.

The harvest WHP is 1 day.

There are US but no Australian or Codex for pyridaben in animal commodities. The US residue definition for animal tissues includes two metabolite and is pyridaben and (2-tert-butyl-5-(4-(1-carboxy-1-methylethyl)benzylthio)-4-chloropyridazin-3(2H)-one) and (2-tert-butyl-5-[4-(1,1-dimethyl-2-hydroxyethyl)benzylthio]-4-chloropyridazin-3(2H)-one). The MRLs for animal tissues have all been set at 0.05 mg/kg while the milk MRL is 0.01 mg/kg.

There is an Australian MRL of 0.5 mg/kg for bananas (same residue definition as US for plants, i.e. parent compound).

NOTE: US MRLs have been established for animal feed items (almond hulls, apple pomace (wet) and citrus pulp (dry)) as well as for animal commodities. If the US MRLs are used to estimate the dietary burden using the US EPA Guideline, a dietary burden of 1.5 ppm is estimated. An anticipated TF is the 0.05 ppm (animal commodity tolerances) ÷ 1.5 ppm (dietary burden) = 0.03 (crude estimate).

Anticipated residues are $0.5 \times 0.03 = 0.015$ mg/kg for tissues and 0.003 mg/kg for milk.

It is anticipated that animal product residues will be below typical method LOQs.

Rotenone

-is a insecticide used in organic banana production. The application rate is 0.05 g rotenone per bunch per application.

The harvest WHP is 7 days.

³⁶ 2000 JMPR. Pesticide Residues in Food - 2000 Evaluations – Part I, FAO Plant Production and Protection Paper 165. FAO and WHO 2001

No information is available (NB: Table 5 exemption in MRL Standard).

Insufficient data were located to provide confident opinion on livestock residue risks.

Spinosad

- is an antibiotic insecticide used for the control of Banana scab moth and banana flower and rust thrips in bananas. The application rate is up to 4.8 g ai/10L as a Bell injection or a bunch spray, the latter made no later than 2 weeks after bunch emergence.

No harvest WHP required.

Do not allow livestock to graze treated crops, stubble or waste.

There are Australian, Codex and USA MRLs for spinosad in animal commodities. The Australian and US MRLs applicable to cattle meat (fat) are 1 and 33 mg/kg respectively. The respective milk MRLs are 0.1 and 6 (75 mg/kg for whole milk fat) mg/kg. The Codex MRL is 3 mg/kg for cattle fat and 2 mg/kg for fat of other mammals and 1 mg/kg for cattle milk (5 m/kg for milk fat). The Australian MRL is 0.3 mg/kg for bananas (assorted tropical and sub-tropical fruit- inedible peel).

The TF for cattle fat is 0.5-0.6³⁷ giving an anticipated maximum residue in cattle fat from feeding of banana culls and stalks at 100% of the diet of $0.2 \times 0.6 = 0.12$ mg/kg.

The TF for milk is 0.05 giving an anticipated maximum residue in cattle fat from feeding of banana culls/stalks at 100% of the diet of $0.2 \times 0.05 = 0.01$ mg/kg.

Livestock residues are not anticipated to exceed international and/or domestic market standards.

Tebuconazole

-is a DMI fungicide used for the control of leaf spot, leaf speckle and Black Sigatoga in bananas.

The application rate is up to 99 g ai/ha.

The harvest WHPs is 1 day.

There are Australian, Codex and US MRLs for tebuconazole in animal tissues. The Australian and Codex residue definition is tebuconazole while the USA residue definition is the sum of tebuconazole and its 1-(4-chlorophenyl)-4,4-dimethyl-3-(1H-1,2,4-triazole-1-yl-methyl)-pentane-3,5-diol metabolite. The Australian MRLs 0.5 mg/kg for edible offal mammalian, 0.1 mg/kg for meat (mammalian) and 0.05 mg/kg for milk. The Codex MRLs are *0.05 mg/kg for both cattle meat and cattle edible offal and *0.01 mg/kg for milk. The US MRLs are 0.2 mg/kg for meat byp and 0.1 mg/kg for milk.

The Australian MRL for bananas is 0.2 mg/kg. There is a PAFC MRL of 50 ppm.

Residues of tebuconazole were not detected (<0.05 mg/kg) in muscle and fat of dairy cattle dosed at the equivalent of 250 ppm in the diet for 28 days³⁸. The residues in liver were 0.2 mg/kg. The TF for liver is 0.0008.

It is anticipated that animal product residues will be below typical method LOQs.

³⁷ 2001 JMPR Pesticide Residues in Food - 2001 Evaluations – Part I, FAO Plant Production and Protection Paper 171. FAO and WHO 2002

³⁸ 1994 JMPR - Pesticide Residues in Food - 1994 Evaluations, Part I Residues FAO Plant Production and Protection Paper 78. FAO and WHO 1995

Terbufos

-is an organophosphorous insecticide/nematicide used on bananas for the control of banana borer weevil. Application is at rates up to 3 g ai/plant or 600 g ai/100 m row.

A WHP is not required.

There are Australian and Codex but no US MRLs for terbufos in animal commodities. The Australian and Codex MRLs are *0.05 mg/kg for cattle edible offal and cattle meat. The Australian and Codex MRLs for milk have been set at *0.01 mg/kg.

The Australian MRL for bananas is 0.05 mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Thiabendazole

- is a systemic fungicide used for the post-harvest control of various storage fungal diseases in bananas. It is registered on bananas as a post-harvest dip at 40 g ai/100L.

Not required when used as directed.

There are Australian, Codex and US MRLs for thiabendazole in cattle tissues. The Australian MRLs for animal tissues have been set at 0.2 mg/kg while the milk MRL is 0.05 mg/kg. There is an Australian MRL for bananas at 3 mg/kg. The Codex MRL for cattle kidney is 1 mg/kg while the MRL for cattle milk is 0.1 mg/kg. The US MRL for animal tissues are all 0.1 mg/kg while the milk MRL is 0.4 mg/kg. The US MRL for bananas (whole) is 3 mg/kg and pulp 0.4 mg/kg. The Codex MRL for bananas is 5 mg/kg.

The TF for kidney (target tissue) is 0.004³⁹ giving anticipated residues of $3 \times 0.004 = 0.012$ mg/kg if fed at 100% diet, below the Australian, Codex and US tolerances.

The TF for milk is 0.001 giving anticipated residues of $3 \times 0.001 = 0.003$ mg/kg if fed at 100% diet.

Livestock residues are not anticipated to exceed international and/or domestic market standards.

Trichlorfon

-is an organophosphate insecticide used for the control of various insects in crops. It is registered on bananas for use as a fruit-fly bait and so involves application to the foliage and not the fruit.

The harvest and grazing WHP is 2 days.

There are no Codex MRLs for trichlorfon in animal tissues. The Australian MRL for cattle fat is 0.1 mg/kg, as is the US tolerance. The Australian MRL for milks is *0.05 mg/kg while no milk MRL has been set in the US. The Australian MRL for bananas is 0.2 mg/kg. Residues decline in soil and foliage with typical half-lives of 10 and 3 days respectively.

Following peroral uptake of the trichlorfon (12.5 and 20 ppm in feed), no trichlorfon residues were detected (<0.1 ppm) in any of the examined tissues and organs (brain, heart, kidney, steak, fat) after a four week feeding period⁴⁰.

It is anticipated that animal product residues will be below typical method LOQs.

³⁹ 2000 JMPR. Pesticide Residues in Food - 2000 Evaluations – Part I, FAO Plant Production and Protection Paper 165. FAO and WHO 2001

⁴⁰ 1971 JMPR. Evaluations of some pesticide residues in food. AGP/1971/M/9/1; WHO Pesticide Residues Series No. 1, 1972

Trifloxystrobin

-is a fungicide used for the control of Yellow Sigatoka in bananas. It is applied as a foliar spray at an application rate of 75 g ai/ha.

No harvest WHP required.

Do not allow stock to graze in any treated area

There are Australian and US but no Codex MRLs for trifloxystrobin. The Australian and US MRLs for animal tissues have all been set at 0.05 mg/kg. The Australian and US milk MRLs are *0.02 and 0.02 mg/kg respectively. The Australian MRL for bananas is 0.5 mg/kg.

Lactating cows dosed orally for 28 consecutive days with trifloxystrobin at levels equivalent to 2, 6 and 20 ppm in the diet had residues in tissues and milk that were <0.02 mg/kg⁴¹. The exception was fat of cows fed at 20 ppm in the diet which had residues on 0.06 mg/kg. Anticipated residues in fat from feeding banana culls at 100% of the diet are $0.5 \times 0.003 = 0.0015$ mg/kg.

It is anticipated that animal product residues will be below typical method LOQs.

Zineb

- is a dithiocarbamate fungicide used on a variety of crops. It is used on bananas for the control of leaf spot and leaf speckle at an application rate of 1.6 kg ai/ha.

The harvest WHP is 7 days

Do not graze treated turf or feed turf clippings from any treated area to poultry or livestock.

There are Australian and Codex but no US MRLs for zineb in animal commodities. The Australian MRL for edible offal is 2 mg/kg while the Codex MRL is 0.5 mg/kg, both as CS₂. The Australian PAFC MRL is 50 ppm and the bananas MRL 2 mg/kg. Residues in banana fruit and stalks would be expected to be much less than 50 ppm. The target tissue is liver. The TF for liver (45 ppm feeding study for mancozeb)⁴² was 0.003 giving an anticipated maximum residue from the feeding of banana fruit and stalks at 100% of the diet of $2 \times 0.003 = 0.006$ mg/kg, less than the relevant international MRLs.

It is anticipated that animal product residues will be below typical method LOQs.

⁴¹ Public Release Summary on Evaluation of the new active TRIFLOXYSTROBIN in the product FLINT FUNGICIDE National Registration Authority for Agricultural and Veterinary Chemicals September 2000 Canberra Australia

⁴² 1993 JMPR - Pesticide Residues in Food - 1993 Evaluations, Part I Residues FAO Plant Production and Protection Paper 124. FAO and WHO 1994