ADVISORY COMMITTEE ON THE MICROBIOLOGICAL SAFETY OF FOOD

WASTE AND RESOURCES ACTION PROGRAMME (WRAP): RISK ASSESSMENTS ON THE USE OF SOURCE SEGREGATED COMPOSTS IN AGRICULTURE

Issue

The Committee is asked to review and comment on the microbiological food safety aspects of two new related risk assessments conducted under WRAP's 'Confidence in Compost Programme'. The following draft final reports are attached:

I. An update of Defra's 2002 risk assessment on the use of composting and biogas treatment to dispose of catering waste containing meat – Dr Paul Gale *et al*, Veterinary Laboratories Agency (Annex 1),
II. A risk assessment for the use of source-segregated composts in UK agriculture – Cranfield University, ADAS, Macaulay Land Use Research Institute (Annex 2).

Please note that these reports are marked IN CONFIDENCE and are for Members' Use Only.

Action: Questions to the Committee

i. Do Members consider the approaches used in both risk assessments are appropriate and sufficiently rigorous to fully assess the microbiological safety risks associated with application of PAS 100 compliant composts to food producing land? In particular, do Members consider the risk ratio approach to be appropriate to assess microbiological risks?
ii. Do Members feel their recommendations for further development of the original catering waste risk assessment have been adequately addressed?
iii. Do Members agree with the conclusions derived for the assessed scenarios with regard to microbiological risks to the food chain?
iv. In relation to microbiological food safety, do Members agree with the overall conclusion that the risks associated with the use of PAS 100 compliant composts in agriculture are low?
v. Can Members identify any additional microbiological food safety scenarios not considered to date that should be brought to the attention of WRAP?
vi. Can Members identify any particular data gaps that should be prioritised in future research programmes in order to allow additional potential microbiological food safety risks associated with compost use to be more fully quantified?

Background

1. The Committee received an information paper in September 2009 which briefed members on risk assessment work being carried out under the WRAP 'Confidence in Compost' programme. This work aims to comprehensively establish the potential for harm to crops, animal and human health, and the environment, resulting from using PAS 100:2005 composts in agriculture and identify any residual risks that might be present.

2. These risk assessments provide the technical basis for developing sector-specific risk management guidance on source-segregated compost production and use. Guidance for the potato and combinable crops sectors is currently being developed and the ready-to-eat crops and livestock sectors are expected to start work on guidance later this year.

3. The Agency's general position to date has been that, based on the evidence that is currently available, the treatment and recovery of waste materials, including animal by-products and catering waste for application on agricultural land should not pose unacceptable risks to food safety providing such application and the composting or biogas treatment is carried out in accordance with regulatory requirements. The Agency is aware that stakeholders have food safety concerns connected with wider agricultural use of source segregated composts, particularly the use of animal by-product derived composts (including food waste). WRAP's current risk assessment programme provides an opportunity for the Agency to review its position in light of the updated scientific evidence base. Agency officials have provided technical and legislative input on relevant food safety matters to WRAP's Technical Steering Group (TSG), comprising WRAP, Defra, the EA, Sepa, FSA and key Industry stakeholders.

Peer review: involvement of independent advisory committees

4. WRAP and the Agency have recognised that, in addition to the peer reviews undertaken for WRAP (see Annex 3), additional scrutiny by the relevant independent Advisory Committees would provide greater stakeholder confidence in the results of these risk assessments. The Agency has agreed to facilitate this review process by consulting both the ACMSF and the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (CoT) on aspects of the work that have relevance to the microbiological and chemical safety of food. In addition, Defra intends to ask the Spongiform Encephalopathy Advisory Committee (SEAC) to review aspects of this work relating to the assessed TSE risks to animal health.

5. The CoT reviewed the relevant draft reports (which included the risk assessment for the use of source-segregated composts in UK agriculture but not the catering waste risk assessment) in February, and has made a number of technical comments and suggestions for amendments which will be incorporated by the project team once all comments from ACMSF and SEAC have been received. The CoT has asked to see final versions of the reports before giving its final view. WRAP intends to publish final versions of these reports once the peer review process is complete.

Relevant risk assessments previously reviewed by ACMSF

6. In 2003 the Committee peer reviewed Paul Gale's original catering waste risk assessment for Defra[1], as well as risk assessments for pathogens in sewage sludge (biosolids)[2] and animal manures[3] by the same author. Links to the relevant Committee papers are provided in Annex 4. A letter from the Secretariat detailing the Committee's comments in relation to the catering waste risk assessment which have been communicated to WRAP is attached at Annex 5.

7. Overall, the Committee considered that the general approach taken for these three risk assessments was sound, although data at the time were limited in a number of areas, particularly in relation to pathogen survival and dose-response. Despite the data gaps the committee accepted the conclusions of the risks assessors in relation to use of sewage sludge and catering waste, i.e. that the risk to human health from consuming root crops grown on land to which either sewage sludge or catering waste-derived compost/anaerobic digestate has been applied are very low. The Committee also accepted that the risk to a gardener from direct ingestion of compost was very low. In all cases the Committee stressed the importance of avoiding process 'by-pass' and complying with the controls on treatment and application to land detailed in the Safe Sludge Matrix and the relevant statutory Regulations. However, in relation to animal manures the Committee recommended further development of the risk assessment, as it considered the data gaps and uncertainties too large to draw any conclusion. Due to the lack of controls applied to animal manures the Committee felt that the microbiological risks would be higher than from sewage sludge. The Agency's current position on treatment and use of these waste materials in agriculture takes account of the Committee's previous views.

I. An update of Defra's 2002 risk assessment on the use of composting and biogas treatment to dispose of catering waste containing meat

Overview and general approach

8. Defra's original risk assessment evaluated the risk to grazing livestock in England and Wales from pathogens present in composted catering waste (arising from discarded uncooked meats) and made recommendations for risk

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[1] Risk assessment: use of composting and biogas treatment to dispose of catering waste containing meat - final report to Defra, (2002) http://www.defra.gov.uk/foodfarm/byproducts/wastefood/composting/comprisk.htm

[2] Pathogens in biosolids - microbiological risk assessment, UK Water Industry Research Limited (2002) http://www.defra.gov.uk/environment/quality/water/waterquality/sewage/documents/sludge-biosolids-report.pdf

[3] B17002: Assessment of the risks to food safety associated with the spreading of animal manure and abattoir waste on agricultural land, Paul Gale – WRC-NSF (2002) http://www.foodbase.org.uk/results.php?f_report_id=195

management measures regarding appropriate treatment parameters and use of composts/anaerobic digestates from catering wastes which were subsequently transposed into national legislation[4]. While this risk assessment primarily addressed risks to animal health, it also considered human health risks in relation to two scenarios; consumption of raw, unwashed root crops grown on compost-amended soil and direct ingestion of compost. An updated risk assessment was commissioned by WRAP in 2008 to review the assumptions used previously and take account of new data and published information.

9. The original risk assessment adopted a source-pathway-receptor approach and the model developed considers information in seven areas; the prevalence of pathogen occurrence in cattle, sheep, pork and poultry food products in the UK, the pathogen loading in different tissues of infected animals, the fate of individual animal tissues at abattoirs, the fate of individual tissues in catering outlets and domestic kitchens (as catering waste and municipal waste respectively), the fate of pathogens during composting and anaerobic digestion, the decay of pathogens in soil and receptor dose-response. Key new data sources used for the updated risk assessment include 'The Food We waste' (WRAP 2008) which gives better estimates of the amount of food (including meat) discarded by households in the UK and estimates for the amounts of infected-meat illegally imported into Great Britain (Hartnett *et al* 2004). Full details of the new information sources used in the updated risk assessment are given in table 2 (pages 12-13) and a comparison of new versus original parameter values is given in table 24 (pages 31-32) of the draft final report. Four additional pathogens relevant to animal health are also included[5].

10. The updated risk assessment considers the implications for human health from consumption of vegetable crops grown on land treated with food-waste compost in a previous rotation. This specific scenario was not directly addressed in the original risk assessment and a formal risk assessment is not within the remit of the revised risk assessment. Instead, the approach taken is to demonstrate that the loadings of faecal bacteria in treated composts are small in comparison with stored animal manures and conventionally-treated sewage sludge. The assessed doses to individuals from consuming root vegetables grown on compost amended soil or from direct ingestion of compost presented in the original have not been recalculated.

Risks to human health from faecal bacterial pathogens (Section 18, pages 53-57; summary, page 4)

11. The updated risk assessment summarises data published since 2002 on destruction of faecal bacteria and affects on genetic properties during composting. It also includes data on re-growth of *E.coli* O157 and *Salmonella* in compost (not factored into the original) and notes that Campylobacter re-growth in composts or the environment has not been demonstrated. The predicted *E.coli* O157 concentrations in composted catering waste, stored animal manures and conventionally-treated sewage sludge calculated in the original have been revised and are presented in Table 71 (page 56).

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[4] Animal By-Products Regulation (2003), SI 1482.

[5] Avian influenza virus (AIV), porcine circoviruses, porcine parvoviruses and methicillin-resistant *Staphylococcus aureus* (MRSA).

12. For ***E. coli* O157** the revised assessment predicts a slightly increased total loading in composted catering waste of 8.0 x 10^9 (previously 2.5 x 10^9) due to the higher percentage of meat assumed to be composted. This is shown to be 1,600-fold lower than predicted for stored manures and 13-fold lower than for conventionally-treated sewage sludge (values for manures and sludge have not been updated from the previous risk assessments[1,2,3]). The revised *E.coli* O157 concentration in compost is predicted to be 8-fold lower than the original assessment due to dilution within a larger total amount of compost, i.e. 3,913,200 tonnes compared to 500,000 tonnes (dry weight). Allowing for re-growth in compost of up to 3-log (based on data for *Salmonella*), it is concluded that the risks will not exceed that from stored manures. Some evidence is presented showing that *E. coli* O157 can grow in cattle faeces applied to soils. It is suggested that growth may also occur in manures after application to soils although no published papers addressing this were found. For human pathogens, such as *E.coli* O157, *Salmonella* and *Campylobacter* which are considered to decay relatively rapidly in soil, it is suggested that risks through consumption of crops grown on compost-amended soil and harvested 12 months after application would be negligible.

13. Pathogens which decay slowly in soils treated with ABP-derived composts are further considered. In the context of this risk assessment this applies to ***Clostridium botulinum***. A formal quantitative risk assessment for the additional *C.botulinum* spore-loading in soil from application of composts has not been carried out due to lack of data. However, it is noted that growing conditions for fresh vegetables make it unlikely that *C. botulinum* spores will germinate and grow and it is concluded that the risk to humans from spores of *C.botulinum* on fresh vegetables from soil or compost-amended soil would be low. Subsequent risks from canning of vegetables are not considered, as HACCP-approaches are applied in the food industry to protect against spores already in the soil.

14. The risk of infant botulism to an infant consuming 1g of compost was considered in the original risk assessment. This is not reconsidered because no information on re-growth of *C. botulinum* in mature compost or on dose-response has been identified.

II. Risk assessment for the use of source-segregated composts in UK agriculture

Overview and general approach

15. This project employed a generic risk assessment and hazard analysis approach to compare the risks to humans, animals, crops and the environment associated with different source-segregated compost feedstocks applied in a range of agricultural and horticultural end-uses. All analyses were undertaken on the basis that compost end-product was produced and applied in accordance with the relevant legislative requirements and PAS 100 standards.

16. The first stage in the risk assessment process involved a semi-quantitative exposure assessment to compare the extent to which the chemical,

microbiological and physical hazards associated with seventeen different types of compost feedstocks may be present after the composting process, and the risks of exposure to these hazards via seven different categories of agricultural and field horticultural end uses. This involved analysis of almost 40 million different feedstock/hazard/use combinations. This initial analysis was used to generate a semi-quantitative, ranked list of compost feedstock/end use scenarios which allowed exposure pathways with the fewest barriers to receptors (humans, animals, crops and environment) to be identified. This provided a framework from which the research team and stakeholders could prioritise scenarios of particular concern for subsequent quantitative analysis.

17. In collaboration with WRAP's TSG, the research team prioritised 20 compost feedstock/end use scenarios for fully quantitative risk assessment. Each scenario specified a source (e.g. green wastes, wood, animal by-product derived composts etc.) and certain specified hazards (physical, chemical and microbiological) that may be associated with that feedstock; an end use (such as ready to eat salad crops) which was used to describe the exposure pathway for the specified hazards; and a receptor (human, animal, crop or environment). Three scenarios with relevance to microbiological food safety were selected for quantitative risk assessment. These are summarised in Table 1.

Table 1: Scenarios prioritised for quantitative risk assessment with relevance to microbiological food safety.

Scenario	Waste Type	Hazard	End-Use	Receptor
S1	ABP Food Waste	*E.coli* O157, Salmonella, Campylobacter, *Listeria sp.*	Ready to Eat Crops	Human
S7a	ABP Food Waste	*Clostridium botulinum*	Grass Silage	Animal
S7b	ABP Food Waste	*E.coli* O157 *Clostridium botulinum*	Oats	Human

18. Information derived from peer-reviewed literature was used as the primary source material for all of the risk assessments. However it was necessary to use some grey literature where relevant information was limited and the applicability, relevance and quality of this was judged by the project team before use. This included published data on; the levels of pathogens detected in compost, the survival of pathogens in manures and soil, the uptake and transfer of pathogens to crops, the survival of pathogens during processing, consumption levels of crops by humans and animals and the infectious doses of different pathogens for humans and animals.

19. When determining the potential for harm, a conservative approach was taken for every scenario considered, allowing an over-estimation of any potential risk. This meant that where a range of values were available for a specific parameter, the extreme of the distribution was selected. For example, exposure was estimated for a person who was the 95th percentile consumer of

ready to eat crops, rather than for the average consumer. Calculations were also based on the assumption that 100% of the receptor's intake of crop was produced using compost at a maximum permitted application rate.
For each scenario, risk was defined as a risk ratio which was derived by comparing the estimated daily dose of a specified hazard to the reference 'safe' daily dose published in the literature. In the case of human receptors, the risk ratios for each scenario were determined for three population subgroups; the average person (age=39.5, weight=74 kg bw), the 95th percentile vulnerable (elderly) person (age=70, weight=55 kg), and the highly exposed infant (age=5, weight=13 kg). For animal receptors, two population sub-groups were assessed; beef calf (weight=130 kg; consumption=7 kg dry matter per day), and dairy cow (weight=450 kg; consumption=12.5 kg dry matter per day).

20. In line with peer reviewed risk assessment approaches, risk was characterised on the basis of 'tolerability'. Where the risk ratio was calculated as less than 1, the estimated dose was below the published 'safe' daily dose and therefore considered to present a negligible risk to the receptor. As the 'safe' daily doses used in the study had an in-built 100-fold margin of safety, a risk ratio of >1 but <100 was considered to be 'As Low as Reasonably Possible' (ALARP). These estimates provide an indicator of the magnitude rather than an exact prediction of the potential for harm. Detailed results for all of the scenarios assessed are provided in Appendix XIII of the draft report (pages 74-111). The microbiological scenarios for which risk ratios of 1 or above were calculated were S1 (human exposure to pathogens from composted ABP food waste applied to ready to eat crops), and S7a (animal exposure to *C. botulinum* from composted ABP food waste applied to silage crops).

21. Scenario S1 used *E.coli* O157 and assumed a starting density of 1000 cfu/g of *E.coli* in compost, of which 0.01 cfu/g was *E.coli* O157. Based on published data on the survival of pathogens following land spreading of livestock manures, it was further assumed that pathogen levels would decrease by one order of magnitude 39 days after compost was spread to land. The calculations also factored in a low likelihood of pathogens being transferred from the soil into crops, and no re-growth within the plant itself. The washing of ready-to-eat crops was also taken into account, assuming a 0.5 log reduction which was considered achievable by commercial washing practices. Finally, an infectious dose of 1 organism was applied to reflect the nature of the risk to the human receptor. A risk ratio of 10 was calculated for the highly exposed infant compared to a risk ratio of 1 calculated for the average person and the elderly person.

22. Scenario S7a assumed a starting density of 88,600 *C.botulinum* spores per tonne of compost. As there was a lack of data on growth and decay of *C.botulinum* during ensilement, it was assumed that these numbers remained the same following this process. It was also assumed that animals were fed silage for 60% of the year. An infectious dose of 10 organisms was used for *C.botulinum*, a conservative estimate based on published data. Risk ratios of 1 were calculated for both the dairy cow and beef calf population sub-groups.

23. Although the findings suggest that exposure via these routes could present a risk to the final receptor, the researchers concluded that, taking into account the margin of safety used when estimating ‘safe’ doses, these risks were not intolerable. However, it was recognised that these findings did not negate the need for risk management for the use of source segregated composts. It is intended to use the outputs of this risk assessment in the development of specific guidance for different agricultural sectors (arable crops, potatoes, ready-to-eat crops and livestock) which WRAP aims to take forward in partnership with Industry during 2010.

Annex 1

An update of Defra's 2002 risk assessment on the use of composting and biogas treatment to dispose of catering waste containing meat – Dr Paul Gale *et al*, Veterinary Laboratories Agency

Draft report attached. Circulated to Members IN CONFIDENCE – for ACMSF Members' Use Only

Annex 2

A risk assessment for the use of source-segregated composts in UK agriculture – Cranfield University, ADAS, Macaulay Land Use Research Institute

Draft report attached. Circulated to Members IN CONFIDENCE – for ACMSF Members' Use Only

Annex 3

Circulated to Members IN CONFIDENCE – for ACMSF Members' Use Only

Independent peer review comments – November 2009.

Annex 4

Relevant microbiological risk assessments previously reviewed by ACMSF

ACM/623 and **ACM/643** detail the Committee's views on Dr Paul Gale's 'Pathogens in biosolids' risk assessment (2002).
http://www.food.gov.uk/multimedia/pdfs/acm623.pdf
http://www.food.gov.uk/multimedia/pdfs/Acm643.pdf

ACM/637 details the Committee's views on Dr Paul Gale's original 'Catering waste risk assessment' for Defra (2002).
http://www.food.gov.uk/multimedia/pdfs/Acm637.pdf

ACM/638 details the Committee's views on Paul Gale's 'Pathogens in animal manures risk assessment' (2002).
http://www.food.gov.uk/multimedia/pdfs/Acm638.pdf

ACM/MIN/48 Minutes of the 48th ACMSF meeting provide additional details in relation to the Committee's views on the catering waste and animal manures risk assessments.
http://acmsf.food.gov.uk/acmsfmeets/acmsfmeet2003/123357/minutes26jun03

Annex 5

Letter from the Committee Secretariat dated 8 July 2003 detailing the Committee's comments in relation to Defra's original 2002 catering waste risk assessment.

Advisory Committee on the Microbiological Safety of Food

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8 July 2003

Dear Geraldine

RISK ASSESSMENT : USE OF COMPOSTING AND BIOGAS TREATMENT TO DISPOSE OF CATERING WASTE CONTAINING MEAT

1. You asked me in April to arrange for the ACMSF to give its views on this risk assessment. Following preliminary consideration by the *Ad Hoc* Group on Sewage Sludge, the full Committee considered the risk assessment on 26 June and endorsed the *Ad Hoc* Group's views. I am therefore writing to convey the Committee's comments.

2. The ACMSF regards as sound the approach adopted for the risk assessment. The Committee also regards as acceptable the conclusion drawn that, if the conditions specified for composting and biogas treatment are complied with, then the risks to human health either from root crops grown on land to which compost or biogas product has been applied, or through the ingestion of compost by gardeners, are very low.

3. However, the Committee has a number of detailed observations which it recommends should be drawn to the attention of DEFRA, namely :-

   - no value is included for die off of pathogens after application of catering waste to agricultural land, although values are given for the decay of pathogens in sewage sludge-treated soil (section 4.3). This should be assessed;

- there should be an event tree for each pathogen;

- a two barrier composting system is recommended for the meat fraction for each composting barrier (section 25). It is proposed that the catering waste should reach a temperature of 60°C for 2 days during composting, with the composting process being continued for at least 14 days. The important factor is the microbial load at the end of composting and there should be no barrier to shorter holding times where these are seen to achieve desired levels of pathogen reduction. A preferable approach might therefore be to state that other composting processes would be regarded as acceptable provided equivalent efficacy against the hazards detailed in the risk assessment could be demonstrated. This would provide opportunities for the development of alternative approaches and would be consistent with the approach adopted in the Safe Sludge Matrix and draft sewage sludge regulations;

- however, the heat treatment assumption used for the recommended composting process (60°C for 2 days) gives a worst case centre temperature in a particle of 40cm diameter of 56°C. This is said to be sufficient to give the appropriate destruction in respect of FMD-infected pig meat (ie. a bone-in leg of pork), and the assumption is made that 60°C for 2 days will also be sufficient to deactivate other pathogens present in meat tissue. It needs to be considered whether this holds true for, eg. parasites (which occur in pork tissue) or for invasive *Salmonella* strains. The same question arises in relation to the biogas assumption (5 cm sphere to reach 56°C in a biogas treatment plant held at 57°C for 5 hours);

- the risk assessment, while comprehensive, is restricted to conventional pathogens. Consideration needs to be given to possible new issues which might arise as a consequence of new disposal practices. For example, could application of composted animal tissue to agricultural land provide a human exposure pathway for an opportunistic pathogen or for other toxigenic microorganisms such as fungi, *Staphylococcus aureus* or *Clostridium perfringens*, all of which will occur on meat and some of which can produce heat-stable toxins ?;

- no assessment has been made for the risks from tapeworm (Taenia), an obvious hazard in relation to beef and pork, although it is recognised that properly-applied statutory meat inspection procedures should provide a safeguard;

- the risk assessment for *Clostridium botulinum* (section 22) appears to be based on bacon, but seems not to have been extrapolated to pork and other meats where the organism is likely to be equally prevalent. Indeed, the growth of the organism in bacon is likely to be inhibited by nitrite. This may not be the case for other meats which, in consequence, may present a greater risk and could substantially increase the calculated risk of infant botulism;

- no post-application restrictions, aimed at further reducing the risk of transmission through food chain exposure pathways, are applied to crops grown where catering waste has been spread. Post-application restrictions are an integral part of sewage sludge controls and, given several unknowns in the catering waste risk assessment, DEFRA should consider introducing this further level of protection. Consideration should, for example, be given to introducing a requirement for sub-surface injection/incorporation of the waste. In addition, DEFRA should consider, as a further safeguard, the option of precluding use of catering waste on ready-to-eat crops, or introducing a longer restriction between application and harvest;

- the risk assessment covers catering and consumer raw meat waste but does not include raw meat waste from other sources (eg. raw meat waste from retail outlets such as butchers and supermarkets). This clearly needs to be covered if DEFRA intends to extend the regulations to allow raw meat from these additional sources to be recycled to agricultural land;

- the definition of "animal" in the Animal By-Products Order includes "fish, reptiles and crustacea". "Fish" also features in the description of catering waste in the Order. However, fish and shellfish do not feature in the risk assessment. DEFRA should be asked to clarify its intentions regarding the disposal of catering waste comprising or containing such material;

against a background of farmers developing composting businesses, it seems impractical to expect that raw catering waste material will not be kept on livestock farms;

equally, it will be very difficult to prevent birds and small mammals gaining access to the raw material.

4. The Committee's principal concern relates to the question of process by-pass. It is estimated in the risk assessment that 1% by-pass would result in a 100-fold reduction in the effectiveness of the treatment process. The Committee therefore stresses the importance of eliminating any by-pass of the composting/biogas process.

Yours sincerely

COLIN MYLCHREEST
Administrative Secretary