

## Information Sheet No. 3-8

### Producing Quality Compost

#### Introduction to Australian Standard AS 4454 (2012) composts, soil conditioners and mulches

Information Sheet No. 3-8  
Fourth Edition 2012

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#### AS 4454 (2012) edition

The 4th edition of Australian Standard AS4454 *Composts, soil conditioners and mulches* was released on 29 Feb 2012.

The revisions are significant and affect the entire supply chain including compost manufacturers, distributors and specifiers, retailers, local government, and relevant state government agencies.

#### Purpose of the AS 4454 Australian Standard

The standard aims to:

- Protect human health, the environment, and food quality; and
- Encourage beneficial and sustainable use to recover valuable nutrients and organic matter

Composting is a recycling process. Biodegradable organic materials are reprocessed into a range of recycled organics products. The raw material inputs (feedstock) can include vegetation and crop residues, food and garden wastes, manures,

biosolids, and a range of highly putrescible organic materials. These feedstock materials can contain a range of biological, chemical and/or physical risks. Additional contamination and risk can be introduced in the collection process.

We ask a lot of the composting process to reliably manage risks embodied in the raw material feedstocks.

This requires the composting process to be systematically controlled to manage known risks and to manufacture products that are safe and beneficial for use.

The AS4454 standard provides a QA framework, and defines compost as:

*An organic product that has undergone **controlled aerobic and thermophilic biological transformation** through the composting process to achieve pasteurization (as defined); and to reduce [or decompose] **phytotoxic compounds**; and to achieve a specified level of maturity (as defined).*

**Figure 1.** Composted soil conditioner as defined in AS 4454 (2012) is a compost product suitable for incorporation or digging into the soil for a range of benefits.



## What's in the standard?

The standard defines both processing requirements and the physical, chemical and biological properties of composts, soil conditioners, mulches and vermicast. The goal is to facilitate the safe and beneficial recycling and use of biodegradable organic materials with minimal risk of adverse impact to environment and public health.

The standard provides a framework of definitions, product classifications, labelling and product characterisation test methods. In order to avoid general biosecurity and phytotoxicity risks associated with inappropriate product manufacture or product selection, the standard requires:

- Systematic process control for consistent product quality,
- Effective pasteurization to destroy pathogens and weeds,
- Compliance with associated regulations and guidelines for health and safety, and
  - related screening tests to manage health and biosecurity risks,
  - related screening tests to minimise chemical and physical contaminant risk,
- The correct characterization and mandatory labelling of compost products to support informed product selection and purchasing decisions
- Labelling and MSDS to inform safe handling
- Guidance for product use

### Benefits of compliance: management of commercial risk

The underpinning principle of the standard is “do no harm”, the second principle is correct characterisation and labelling for informed product selection and use by customers.

For compost manufacturers and distributors, the best protection from commercial product liability risk is realized by compliance with the risk management provisions in the standard, including the requirements for manufacturing process control (and associated records), product testing, labelling and the provision of MSDS and product use information.

For compost manufacturers, the standard is a fundamental quality assurance tool. However, any claim of compliance must be verifiable; this requires both process records and product test results.

Note that the specifications within the standard are significantly broad to enable a wide range of products for a wide range of applications to comply. Products must be consistently characterised via standard test methods, and specified characteristics must be reported to enable informed product selection.

### Major changes for 2012

- Scope and management of risks embodied in raw materials (biological, chemical, physical)
- Test methods revised for consistent product characterization
- Maturity index introduced for accurate assessment of maturity and to support the development of performance based product specifications
- Product classification system revised, with additional product categories introduced
- Labelling and product information requirements revised and additional product information requirements introduced
- Requirements for claiming compliance are more clearly identified, including production process requirements that are not demonstrated via a lab test report for a product sample.

## Definitions

### Pasteurization

A process whereby all organic materials are subjected to sufficiently high temperature for a sufficient duration to destroy plant and animal pathogens and plant propagules.

The standard requires appropriate turning of outer material to the inside of the compost pile so the whole mass is subjected to a minimum of three turns with the internal temperature reaching a minimum of 55°C for three consecutive days before each turn

Where higher risk materials are included in the compost feedstock (including manures, animal waste, food or grease trap wastes), a longer time at 55°C or higher and more turns may be necessary in order to counter risk of re-infection from the outside of the pile when turned. For these higher risk materials the core temperature of the compost mass shall be maintained at 55°C or higher for 15 days or longer, during this period the windrow shall be turned a minimum of five times (consistent with US EPA 503 Rule).

Where compost piles are contained in an insulated vessel, guidance is provided for alternative means of pasteurization that **guarantees** the same level of pathogen reduction. Pasteurization shall be confirmed by testing for indicator pathogens, and for the elimination of viable plant propagules.

### Pasteurized product

An organic product that has undergone pasteurization (as defined), but is relatively immature and lacking in biological stability.

### Compost product

An organic product that has undergone controlled aerobic and thermophilic biological transformation through the composting process to achieve pasteurization (as defined) and has achieved a specified level of maturity (defined in Appendix N – Maturity Index).

### Mature Compost product

Compost that exhibits a higher degree of biological stability and demonstrates a relative absence of phytotoxicity via plant growth bioassay (defined in Appendix N - Maturity Index).

*Continued on Page 3*

## Scope and risk management

The standard requires that all products shall fully comply with the chemical, physical, and pathogen contaminant provisions specified for products suitable for **unrestricted use** as expressed in applicable government guidelines. This provides assurance that AS4454 compliant products are suitable for home gardens and lawns, as well as broader landscaping and agricultural use.

Chemical contamination threshold limits are now directly specified within the standard, which apply nationally except where government guidelines specify more stringent requirements.

Regarding heavy metal threshold limits, note that the limit for Copper is now 150 mg/kg, and for Zinc is now 300 mg/kg, however additional labelling requirements apply.

Pasteurization requirements have been clarified and more tightly specified. Note that a minimum of 5 turns is now required where compost feedstock contains higher risk materials (including manures, animal waste, food or grease trap wastes). Alternative processes that guarantee the same level of pathogen reduction are now more clearly defined.

Physical contamination method: the method and threshold limits remain unchanged, however:

- A significantly larger sample quantity is specified for test, drying temperature is lower and a much more accurate balance is required.
- For products derived from the processing of mixed solid waste a variation on the method is specified and physical contaminants are counted in the entire sample.

## Test methods revised for consistent characterization

Whilst the standard now unambiguously targets products for unrestricted application, the standard also provides a much improved framework of consistent characterization methods and labelling to support the development of products for a broader range of applications (including agriculture), and to support informed product selection by consumers.

Inconsistencies within and between test methods have been resolved.

Note particular method changes:

- Check the drying temperature and sample preparation requirements for the tests you conduct on-site.
- Check the applicable particle size fraction which has been revised for some tests (eg. wettability).
- Test quantity can now depend on particle size grade of the product.
- Significant method changes for EC and pH, and the AS4454 bioassay (Appendix F).

The 7.5 upper limit for pH has been removed, however pH must be reported and labelled.

Total organic carbon levels, C:N ratio, and compost maturity must be analysed, reported and labelled.

The standard now includes a bulk density method for bulk product, providing a verifiable method for converting weighed mass of product into cubic metre equivalent.

Alternative test methods have been included for characterization for agronomic value to better support product and market development for agricultural applications.

These changes support correct and consistent characterization of products, and in conjunction with labelling requirements support informed product comparison, selection and use by customers.

*Continued from Page 2*

### **Composting**

*The process whereby organic materials are microbiologically transformed under [generally] aerobic conditions to achieve pasteurization and a specified level of maturity (see Appendix N: Maturity Index).*

#### **Turned Pile (also called “static pile”)**

Forming compost into piles and periodically turning these piles of organic matter with mechanical equipment (e.g. front-end loaders or specialised windrow turners). Turning assists in: breaking up and mixing materials and moisture, aeration and oxygen re-supply; reducing the density of the material to better allow aeration via diffusion and convection, thereby reducing odour generation and supporting more even decomposition.

#### **ASP - Aerated Static Pile**

Forced aeration method of composting in which a compost pile is aerated by a blower that pushes air through the pile via perforated pipes located beneath the pile.

#### **Windrow with or Without Aeration**

A compost windrow is simply a compost pile that extends horizontally in one direction to form an elongated pile. Such piles can be formed into orderly rows for ease of management and turned by a front-end loader, a windrow turner, or an excavator. The height and width of piles depends on the materials and the turning equipment, and length is limited by the size of the composting area. As for turned piles, aeration is commonly achieved by mechanical turning.

#### **In-vessel and tunnel composting**

A wide variety of “enclosed” composting chambers which contain the composting biomass. Containers allow an increased degree of automated process control, and aim to better contain and manage potential odour generation. In-vessel systems are often required by authorities in high population areas for the treatment of putrescible organics to minimise risk of negative impact on surrounding neighbours and environment.

Biological stability is relevant for regulation of organics processing facilities as a measure of the potential of material to generate odour and/or attract pests. The achievement of a specified level of biological stability can signal that the material is no longer putrescible, and in-vessel processing is no longer reasonably required.

## Accurate assessment of compost maturity

A [maturity index](#) has been introduced as a fundamental change to the standard. Compost maturity is determined by assessing two complementary characteristics.

- **Biological stability** (Group A tests), assessing the degree to which a material has been composted, or biologically stabilized, and
- **Plant growth response** (Group B tests), assessing the absence of phytotoxicity risk. Compounds that are toxic to plants can be present in the raw material feedstocks, or can form in the early stages of decomposition. Such phytotoxic compounds are commonly broken down as compost matures.

Quantitative and semi quantitative test methods and associated threshold limits are specified for composts.

Products classified as “**Compost**” must meet the specified level for three tests, including at least one from Group A and one from Group B

Products classified as “**Mature Compost**” must meet the higher level specified in four tests, including at least two from Group A and two from Group B, one of which must be a plant growth test (bioassay).

How mature does compost need to be? That depends on the intended use. Compost products are suitable for general landscaping applications. Mature composted soil conditioner may be more suitable for sensitive applications where any short term nitrogen immobilisation can cause problems, such as seedling mixes or immediately prior to planting in intensive vegetable cropping.

The maturity index initially appears complex; however it provides different test options that are relevant to products derived from different materials, and for different uses.

The AS4454 standard now offers:

- Relatively simple, affordable and fast QA tests for use on-site for interim release of product for sale
- Quantitative analytical methods for research, product development

This provides a framework for the development of performance based products, and for the more accurate quantitative assessment of product performance in the field.

Note that elevated levels of volatile ammonia (Group B test) can inhibit biological activity, and is recommended to avoid false positive results in biological stability tests.

Note that biological activity in a sample and the assessment of biological stability is highly sensitive to temperature and moisture. Sample handling and management requirements for valid assessment of biological stability are specific, and apply to all Group A test methods. Requirements are detailed the maturity index (Appendix N).

Both the simple tests and quantitative analytical tests can be implemented by laboratories for full characterization analysis to assess compliance with AS4454 specifications.

This provides compost manufacturers with an opportunity for evaluation of sample handling and management during transport and in the laboratory by comparing laboratory results with results from on-site testing prior to sample dispatch.

The minimum 6 week processing requirement has been deleted due to the inclusion of the performance based maturity index.

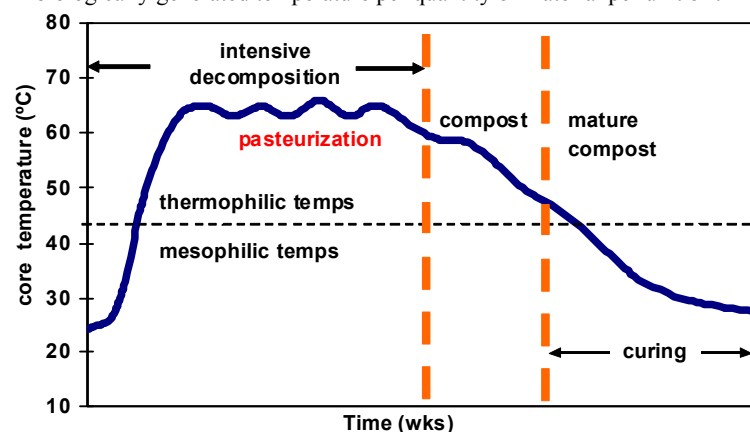
## Dehydration vs composting

Some technologies, whilst marketed as “composting” units, use external energy to heat and rapidly air dry food wastes. These are dehydration systems. Like dried fruit, stability persists only whilst the material is dry. The materials have not been biologically stabilised and if rewet can again become putrescible.

Pasteurization requirements are very different for dehydrators, requiring particles to be heated to  $>80^{\circ}\text{C}$  for sufficient time to achieve a final solids content of at least 90% by weight ( $<10\%$  moisture).

The output product has not been biologically transformed or stabilised and cannot be classified as compost under the AS4454 standard.

**Figure 2.** Biological stability is the extent to which biodegradable organic material has been decomposed. Under conditions of favourable moisture and temperature, material is considered unstable if it can sustain high levels of bacterial activity as this indicates the presence of readily biodegradable materials. If the material contains mainly recalcitrant or humus-like matter, it is not able to sustain high levels of microbial activity and is considered biologically stable. Respiration methods measure biological activity under specified moisture and temperature conditions by quantifying microbial  $\text{O}_2$  consumption or  $\text{CO}_2$  respiration, or the biologically generated temperature per quantity of material per unit of time.



## What products are covered in AS 4454?

AS4454 classifies products into general product categories by maturity (or lack thereof), and then into subsequent particle size grades.

This twofold classification assists specifiers, retailers and customers to identify the general product type that best meets their requirements

Processing requirements and product characteristics are specified for the three major product classifications:

- **Pasteurized products** have been processed by controlled aerobic and thermophilic biological transformation to achieve pasteurization, but are still immature and relatively unstable.
- **Compost products** have been processed more thoroughly for a greater time and effort to achieve both pasteurization a specified level of maturity.
- **Mature compost products** have been processed more thoroughly again to achieve both pasteurization a higher specified level of maturity, Mature composts exhibit greater

biological stability and demonstrating a relative absence of phytotoxicity via a mandatory plant growth bioassay.

Biodegradable organic materials may contain biological hazards and should be *pasteurized* to kill any harmful human or plant pathogens. The pasteurization process — achieved through subjecting all materials to a minimum of 55°C for at least three consecutive days — will also destroy or reduce the viability of weed seeds.

Pasteurization can be achieved over a short period of processing. Pasteurized products can therefore still be unstable and are commonly considered as lower quality of product than composts. However, pasteurized products do not have the risk of distributing animal and plant disease organisms or weeds and in this regard are superior to non-pasteurized products such as raw leaf mulch and fresh or aged manures.

Composted products are processed for significantly longer periods under generally aerobic and thermophilic (hot >55°C) conditions until the compost is adequately mature for general use.

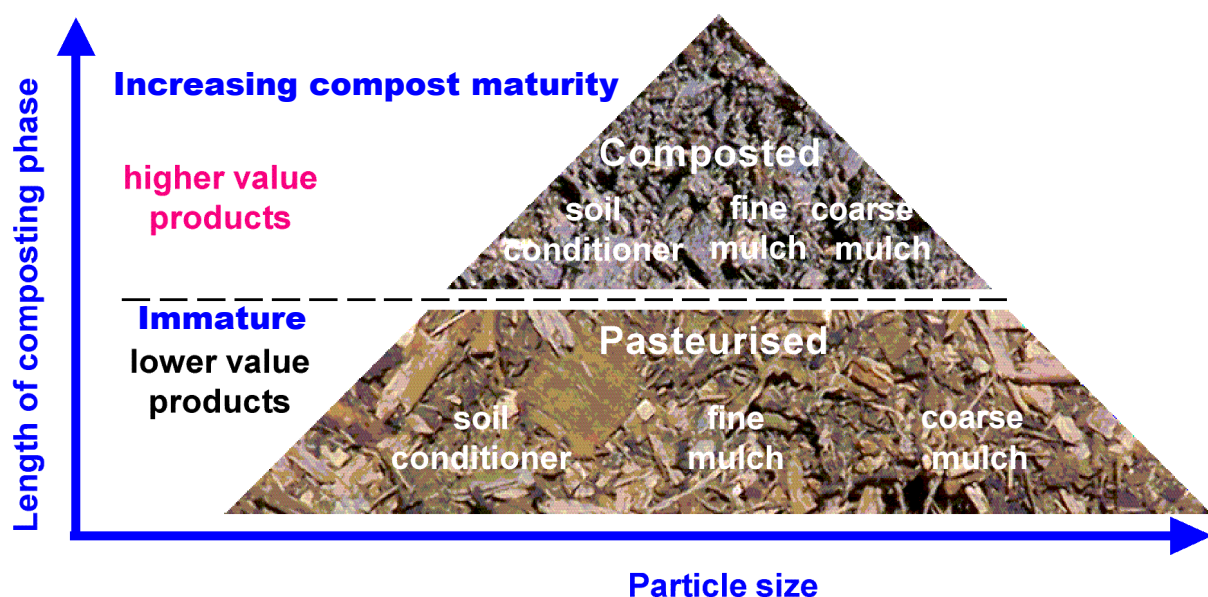
This commonly involves regular turning of compost piles to mix and aerate, moistening as required. *In-vessel* and *ASP* composting technologies provide additional means of aerating and/or turning.

As with pasteurized products, composted products are initially pasteurized to destroy pathogens and plant propagules (weeds). *Compost products* can be applied at greater rates and with low risk to established gardens. Biological oxygen demand has peaked, phytotoxic compounds are broken down, and composts are sufficiently stabilised to provide many benefits for plant growth.

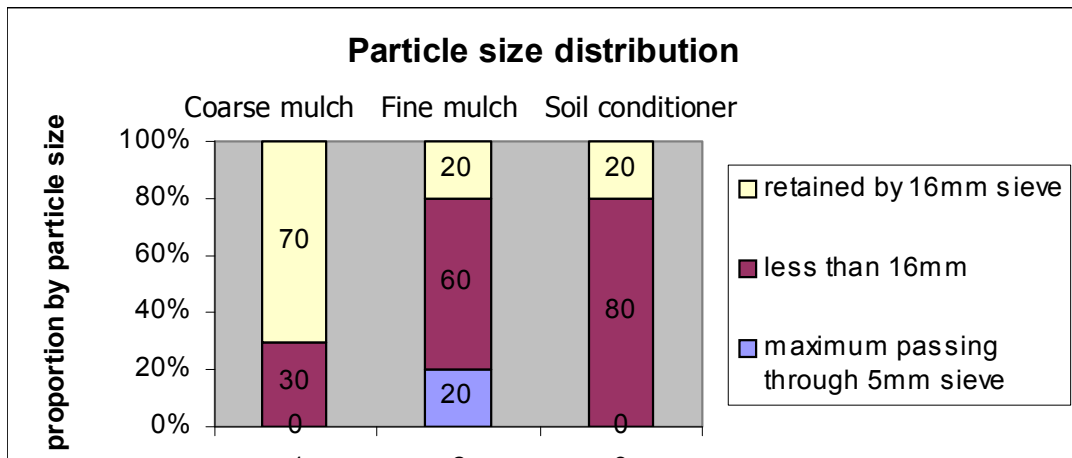
*Mature compost products* may be more suitable for sensitive applications that will be immediately planted out and cannot withstand any risk of short term nitrogen immobilisation. This might include use in seedling mixes or immediately prior to planting in intensive vegetable crops.

Once the preferred maturity requirement is selected, the correct particle size grade of that product is selected, depending on intended use.

**Figure 3.** The AS4454 standard classifies products by maturity (or absence of) and by particle size. Pasteurized products have been sufficiently processed to sanitise the materials by heat from the composting process, but are still immature and biologically unstable. Compost products have been processed beyond the achievement of pasteurization to also achieve a measurable level of maturity. The different particle size grades of either product are classified as coarse mulch, fine mulch and soil conditioner



**Figure 4.** Just as compost facilities screen compost piles into different grades, the AS4454 standard uses square aperture sieves to separate products into different particle size grades. Finer soil conditioner grades are suitable for digging into the soil, commonly exhibiting lower C:N ratio and higher nutrient content than the larger particle mulch grades, which are commonly woodier. Mulch grades are for application to the soil surface, commonly with higher C:N ratio, representing the larger, woodier fraction which is ideal as a long lasting surface blanket that is porous, allowing air, irrigation and rain to pass through the mulch layer to reach the soil.



### Soil conditioner, fine mulch and coarse mulch

*Pasteurized products, compost products and mature compost products* are further divided into sub classification based on particle size grading. Particle size grade is relevant to use as soil conditioners (for incorporation into soil); or fine mulch and coarse mulch (both for surface application).

Products are tested and specified on the basis of their combined classification.

Ten products are defined and specified in this standard, including:

- pasteurized soil conditioner
- pasteurized fine mulch
- pasteurized coarse mulch
- pasteurized vermicast
- composted soil conditioner
- composted fine mulch
- composted coarse mulch
- Mature composted soil conditioner
- Mature composted fine mulch
- Mature composted coarse mulch

Buyers should specify the combined classification by maturity and then by particle size when selecting the preferred product type.

A buyer might specify an “*AS5545 compliant Composted soil conditioner*”.

Some of the specifications in AS4454 are broad, and compliance with the standard essentially requires reporting of the attribute to support informed customer choice (eg. C:N ratio, pH, EC and nutrient levels).

AS4454 compliance alone therefore does not necessarily ensure that a product is ideally suited to optimize performance for a particular use.

Customers may choose to specify compliance with the standard with a tighter specification on particular characteristics (eg. pH and EC).

In this instance a buyer might specify an “*AS5545 compliant Composted soil conditioner with a pH between 6 and 7 and a maximum C:N of 20:1*”.

### What products are excluded from AS 4454?

Shredded garden organics (sometimes referred to as leaf mulch or shredded garden waste) are excluded from the standard, unless they have been subjected to a pasteurization or composting process. This is because these raw materials have a high probability of containing plant propagules and pathogens.

### Requirements for claiming compliance

A principle of the standard is that claims must be verified. The 2012 edition of AS4454 is more specific in the defining the requirements for claiming compliance, which include:

- Processing requirements and process control records
- Sampling and analysis of characteristics relevant to the defined product classification
- Product labelling (or equivalent information sheet for bulk products), including warning labels
- Product use information
- MSDS – material safety data sheet

The key message is that a laboratory test report does not and cannot demonstrate full compliance with the AS4454 standard.

Standards drafting rules did not allow the compliance requirements specified throughout the standard to be duplicated in a list within the standard.

Consequently the ROU has documented a concise, [AS4454 compliance requirements checklist](http://www.recycledorganics.com) on the ROU website.

This compliance checklist can be used by compost manufacturers to transition to the new standard.

## Sampling compost piles

Sampling advice is now included in the standard, but not in the form of an operational procedure. The ROU has documented AS4454 compliant sampling procedures in the free access ROU [Producing Quality Composts](#) package. See:

*Information sheet 3-11 Sampling and Sample Management for Consistent*

*Analysis of Products and Raw Materials.*

## Tools and procedures for implementation

Resources are under developed to assist compost manufacturers and councils to implement the revised AS4454 (2012) compost standard.

The ROU has established an [AS4454 support web-page](#) to provide:

- Complementary documents referred to in the AS4454 standard

- Test methods and materials with links to relevant suppliers
- Laboratory service providers
- Operational procedures and *how to* guidance manuals
- Training service providers
- Relevant notices and updates (including the May 2012 correction amendment #1 issued by Standards Australia).
- Subscribe to receive notices.



## Recycled Organics Unit - resources and services

The ROU website provides free access information resources that are used around the world for the safe recovery and management of biodegradable organic materials, and the manufacture and beneficial use of recycled organics products. The ROU also offers direct services for government and commercial projects.

**Need assistance to establish a facility? To improve compost production capabilities and quality?**

ROU has over 20 years direct experience design, development and operation of food/garden/manure organics collection and processing systems, including operator training, procedures and quality manuals.

**Are you carbon price ready? Are you clear on your greenhouse risk & opportunity?**

ROU has over 10 years experience in corporate greenhouse accounting and management, and in carbon credit offset projects in Australia and internationally via the Kyoto *Clean Development Mechanism*.

To discuss your needs, online contacts at [www.recycledorganics.com](http://www.recycledorganics.com) or email [rou@recycledorganics.com](mailto:rou@recycledorganics.com)

<ul style="list-style-type: none"> <li>• Operator training and operating procedures</li> <li>• Compost facility design and arrangement</li> <li>• Production and QA systems: manuals, training, and associated services for certification</li> <li>• Independent verification of standards compliance</li> <li>• Development of compost recipe formulations, products and specifications for target markets</li> </ul>	<ul style="list-style-type: none"> <li>• Performance assessment of processing technologies (large scale and on-site)</li> <li>• Corporate sustainability strategy</li> <li>• Practical action plans for resource recovery including food waste and compliance solutions</li> <li>• Greenhouse impact assessment and emissions management (CDM and CFI offset projects)</li> </ul>
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