The Open University

WR0510 Defra Waste & Resources Evidence Programme

Attitudes to the use of organic waste resources to land

Annex 1

Literature Review

The Open University

February 2008

Authors
This report was written by Frank Schiller and Christine Thomas (Open University)

Acknowledgements
We would like to recognise the contributions to this report from:

- Mark Yoxon, Sue Oreszczyn and Andy Lane (Open University) for their comments and editing.
- Stephen Nortcliff (Reading University) and Jon Pickering (Organic Resources Agency) and Kiara Zennaro (The Composting Association) for their expert advice.
- Other members of the project Advisory Panel for comments and feedback.

Contact details:
Dr. Christine Thomas (Project Manager)
Integrated Waste Systems
Faculty of Maths, Computing and Technology
Open University
Walton Hall
Milton Keynes, MK7 6AA

Tel: 01908 653460
Email: c.i.thomas@open.ac.uk
Web: http://technology.open.ac.uk/iws

Contents:

1 Introduction

A range of materials derived from processed and unprocessed organic wastes are currently being spread on land in varying quantities. It is highly likely that there will be increased pressure for this to expand, resulting from the implementation of a range of EU and UK legislative drivers aimed in part at diverting organic wastes from landfill. As a consequence of both this potential increased activity and environmental controls it is expected that in future, organic waste-derived resource applications to land will come under increasingly rigorous scrutiny. Recycling organic wastes in these ways can benefit the environment and help meet sustainability goals. Added to the land these resources can also improve soil quality. However, there could be risks involved and these need to be identified and managed.

Issues of sustainability, like climate change, and land availability have led to pressure to reduce the amount of biodegradable waste going to landfill to substantially lower the carbon and methane emissions associated with this current, unsustainable waste disposal route. Other environmental sustainability issues regarding resource and energy use have led to pressure to move waste treatment up the 'Waste Hierarchy' to encourage more waste avoidance, reuse and recycling. These changes in the way wastes are managed has the potential to decrease resource and energy use and even to contribute to the production of energy, for example by the production of biogas by the anaerobic digestion of biodegradable waste.

Besides the regulatory pressure from waste management policy, there are other reasons for applying more organic waste-derived resources to land. Agricultural and environmental research has emphasised issues of nutrient balance and soil quality, as highlighted by the following quote: *"There is a risk, given the complexity and scale of the climate challenge, that another cycle of great significance will be neglected: this is the nutrient cycle — made up of two great geochemical fluxes, those of nitrogen and phosphorous. […] As with the carbon cycle, we have overloaded natural systems in a short span of time as we have industrialised, and in particular as we have developed and applied synthetic fertilisers."* (Hislop 2007: 2).

Balanced against this are issues concerning potential contamination and pollution from recycled organic waste-derived resources applied to land. Like all wastes, organic wastes arise as inevitable by-products of production and at the end of a product's life-time and may become intermingled with other materials during the waste collection and recycling process. Understanding and mediating possible threats to the environment and/or human health is therefore an important issue.

People are likely to hold a range of perceptions of these issues. However, the perceived importance of particular aspects will be different for different people and consequently the overall situation is complex. This is increased by the fact that industrial processes have grown in complexity and modern supply chains have become so long and dense that it is often challenging to consider all their facets. In order to get as close as possible to the relevant issues for future policies this project addresses attitudes against a background of supply chains associated with the use of organic waste-derived resources on land. It will consider the perceptions and attitudes along the whole chain of stakeholders from waste producers, to land managers, to waste processors, to buyers and

consumers. These all play a role and are crucial to whether social, market and policy activities can increase and how they might work in practice.

Capacity to spread organic waste-derived resources to land will be determined by both technical issues of environmental impact and social issues of passive acceptance and active support of these practices. On many occasions passive acceptance may suffice. Yet, the Scottish Environmental Protection Agency's (SEPA) review of organic waste resources spread to land (SEPA 1998) concluded, "*[t]here is a lack of public confidence in the practice which threatens what is basically an activity which can have environmental benefits*" (ibid: 53). Furthermore, passive acceptance will not suffice to increase the diversion of biodegradable waste from landfill. Households as collectors of organic waste, waste businesses, farmers, and purchasers of farm produce must all give their active support in order to divert and recycle organic waste.

If this perception exists, it is crucial to understand why and where it is held. The paucity of research into attitudes to spreading organic waste-derived materials to land hampers attempts to effectively communicate its benefits and to plan waste processing facilities, as investment needs reassurance of end-use markets. Against a background of media articles questioning the safety of organic waste-derived resources spread on land understanding the social context around the supply chain has become an urgent requirement for policy formulation.

In order to appreciate the attitudes driving social action on organic wastes this project has begun to explore the field by conducting semi-structured, qualitative telephone interviews with selected individuals representative of the range of stakeholders involved in organic waste management and throughout the supply chain. Together with the findings of this literature review this has helped to illuminate and focus areas of questioning for the quantitative surveys in the next stages of the project. The insights gained have both informed this review and been informed by it.

The quantitative surveys will study the attitudes of farmers and the general public drawing on a representative sample and exploring socio-demographic factors, which may influence attitudes. It will explore issues where contentious views may be held, and where there may be a lack consensus. Building on this information the key issues, attitudes and potential opportunities as they are perceived by:

- organic waste resource suppliers (i.e. those involved in generating wastes and in waste treatment),
- organic waste-derived resource users (including farmers, local authorities, the horticultural trade and other non-food users),
- those affected by the use of organic waste-derived resources on land (i.e. food purchasers, consumers, rural dwellers), and
- key opinion formers (including NGOs)

will then be explored through a series of in-depth interactive workshops.

This qualitative research stage will thus further develop understanding of attitudes and perceptions, in particular any contentious aspects around health, safety and environmental impacts. There is a need to understand and develop a more complete picture of attitudes and related behavioural intentions before any appropriate mechanisms to facilitate change can be identified.

1.1 What is covered in the review

This literature review assesses existing evidence, information and experiences relevant to spreading organic waste-derived material to land including literature on surveys, attitudes and key experiences inside and outside the UK. Existing research on public attitudes in related areas include attitudes to waste recycling and processing carried out by local authorities, water companies and others, and attitudes to the use of sewage sludge and compost in agriculture. These are all reviewed. Attitudinal and relevant technical issues related to different types of organic materials, which may be applied to land are explored. The review seeks to identify evidence and to indicate where the evidence base is partial or incomplete.

The following sections draw on the literature and data available to set the context of what, and how much organic waste-derived materials are currently used on land, as well as the quantities potentially available, the treatment processes involved and the types of land application. It then describes the drivers and constraints for their use, focusing on the main organic wastes and products derived from them. The review brings together the views held amongst key stakeholders and it concludes with an exploration of social research on risks, sustainable behaviour and attitudes to waste recycling and minimisation in order to gain a deeper understanding of the issues, which contextualise putting organic resources to land and their relevance to this policy area.

1.2 How the review was carried out

The literature survey has utilised several research databases (see Appendix 1 for details of sources used). The results have been further refined according to the general research question, which explores peoples' attitudes and perceptions towards using organic resources on land. The outcome strongly reinforces the initial impression, that there exists little research directly linking to attitudes on the use of organic waste-derived resources to land. The one exception was the application of sewage sludge which has been accompanied by social research in several countries in Europe and around the world. In addition, some of the academic literature on risk perception, sustainable consumption and behavioural change, touches on the topic.

This review has also supplemented the body of academic literature with other sources, e.g. publications from NGOs, scoping papers, literature reviews and reports from consultant agencies and public bodies. Given the general deficit of academic literature on the use of organic waste-derived resources on land, this grey literature has been particularly valuable in shedding light on the key issues and the concerns of different stakeholders.

2 Organic resources to land – what are they?

Although organic resources have been used for land application since the first agricultural societies, it is an activity that has received little attention from waste regulation in the past and it is only with the increasing use of organic waste-derived products generated outside agriculture that the application of organic materials to land has recently become a waste policy issue in the UK.

The public may perceive waste to land as a single issue whereas organic waste resources covers a wide range of different materials that can include sewage sludges, composts, digestates, food and plant residues, animal residues and manures; and these may be applied to a range of end-uses including land remediation, land restoration, habitat establishment, soil formation, and spreading on arable farm land or for amenity uses.

2.1 Amounts, types and disposal routes for organic wastes

The range of wastes and by-products from agriculture, industry, commerce and the public that is being applied to land across the UK and the European Union is extensive. A review carried out on behalf of SEPA (1998) included the following materials within its scope of organic wastes used on land:

- sewage sludge, composted waste, industrial wastes which are exempt from licensing (exempt wastes), agricultural wastes and fallen stock.

Another survey carried out for the European Commission gave a more detailed breakdown of exempt industrial wastes and other organic waste materials used on land (European Commission 2001):

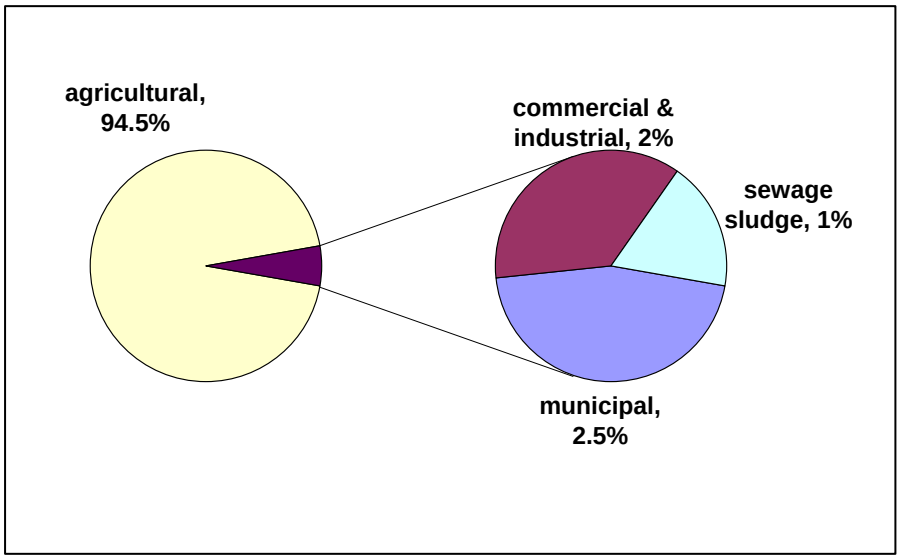
- animal manures;
- waste from food and drinks preparation (sugar beet processing, meat and fish processing, dairies, vegetable processing, breweries, etc);
- blood and gut contents from abattoir;
- waste lime from cement manufacture or gas processing;
- waste from basic organic chemical and pharmaceutical companies;
- waste wood, bark and other plant material;
- paper waste sludge, waste paper and de-inked paper pulp;
- sludge from potable water production;
- decarbonation sludge from industries;
- dredgings;
- textile waste;
- waste from the leather and tannery industry; and
- slag from steel industry.

However, this study did not consider sewage sludge or biosolids and compost, which are the second and third most commonly spread organic wastes after agricultural wastes. A more detailed account of these waste types is given in Insert 1 (page 15).

Even though such a wide range of organic waste-derived resources are being applied to land in the UK, in terms of the amounts applied there are wide variations and although

available data on quantities is generally rather poor, it is clear that the following types dominate: manures and slurries from agriculture, sewage sludge, and composted plant material or garden waste (from municipal, commercial, industrial and agricultural sources) together with composted food or kitchen wastes (from municipal, commercial and industrial sources). In Scotland, for instance, agricultural manures and slurries alone make up about 95% of all organic waste spread to land followed by sewage sludge/ biosolids (1%) and compost (<1%). The situation is fairly similar in England, Wales and Northern Ireland. Figure 1 shows that of the 95million tonnes of organic resources currently used on land each year in the UK, around 89 million tonnes are agricultural manures and slurries. Of the rest around half is composted material mostly from municipal sources together with some commercial waste; and the other half mostly from industrial wastes (such as paper industry sludges and food processing wastes) and sewage sludge.

Figure 1: Sources of organic waste currently applied to land in the UK



Sources: ERM & Golder Associates (2006) and Defra (2007c)

Agricultural manures and slurries are currently predominantly used on land. It is estimated that in the UK over 99% are spread on land, with the remaining less than 1% anaerobically digested prior to land application. Although these are an important organic resource in agriculture, they do not though offer opportunities for increased use. Whether their future use will be affected by changes in waste management legislation is not an issue covered in this review.

This review focuses on organic resources which offer opportunities for increased use on land. From the data described below it can be seen that of those materials currently used in significant quantities this includes composted wastes, some industrial wastes and to a lesser extent sewage sludge. With regard to future developments, however, the scope needs to be widened to include the potential increasing use of other organic waste-derived resources including anaerobic digestates, compost-like outputs (from mechanical-biological treatment) and other organic commercial and industrial wastes.

Estimating the total amount of organic wastes produced that potentially could be used on land is a challenging task. It is dependent on both the assumptions made about which materials may be appropriate and the data used as different sources vary in their

estimates. The data used here on the amounts and types of organic waste produced and treated in the UK is taken from the ERM and Golder Associates report (2006) produced for Defra and the data appendix to the 2007 Waste Strategy for England (DEFRA 2007c). Table 1 and Figure 2 below show the estimated quantities and sources of those organic wastes that are or could be used on land that are produced in the UK. The data used was taken from different sources and hence did not all apply to exactly the same time periods; however it refers to annual amounts in recent years, mostly for 2005.

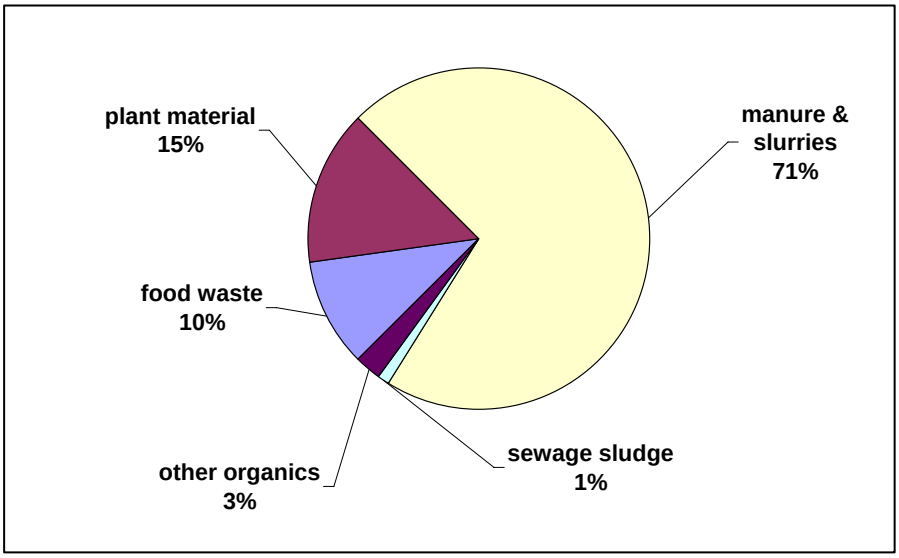
Table 1 Quantities of organic waste resources that could be applied to land by source

material type	waste source (000tonnes)					Total
	MSW	commercial	industrial	agricultural	sewage sludge	
food waste	6,100	3,564	2,324			**11,988**
plant/garden waste	6,400	3,207	929	6,560		**17,096**
manure & slurries				82,880		**82,880**
other organics (industrial process waste, crop waste)		535	2,324	197		**3,056**
sewage sludge					1,300	**1,300**
Total for main organic wastes that could be applied to land	**12,500**	**7,306**	**5,577**	**89,637**	**1,300**	**116,320**

Notes:
A variety of data sources were used in the original reports and hence it is not possible to give an exact year for this data
Sewage sludge data is for dry weight equivalent - the wet weight of the sludge will be much greater

Sources: ERM & Golder Associates (2006); Defra (2007)

Figure 2: Main organic waste resources potentially available to be treated and applied to land by material type

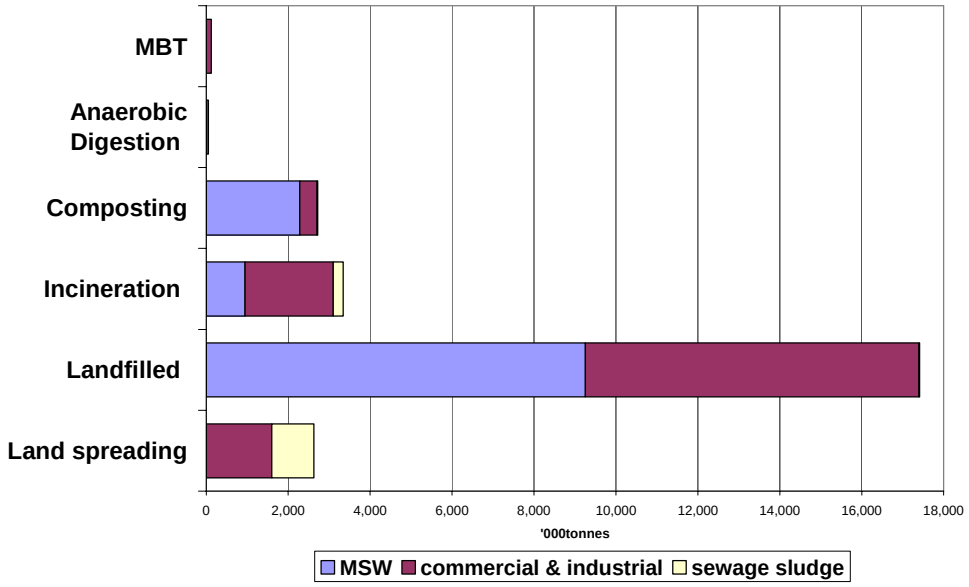


Sources: ERM & Golder Associates (2006) and Defra (2007c)

Current practices for dealing with these waste resources include spreading on or injection into land without treatment (manure, slurries) and a number of waste treatment

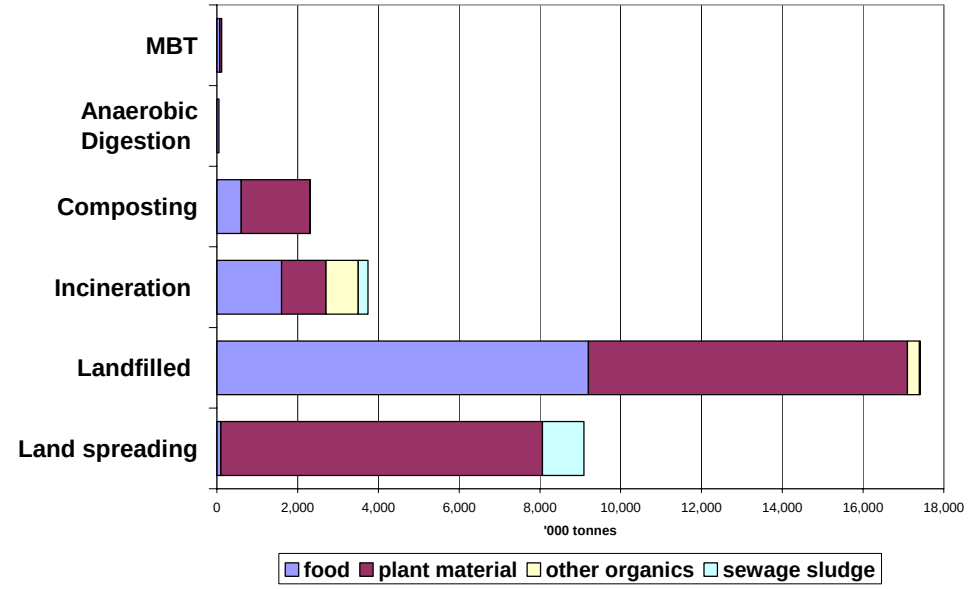
processes including composting, anaerobic digestion, biosolids production, incineration, landfill, and mechanical and biological treatment (MBT) processes. The disposal or recycling routes currently used for the main organic waste resources other than agricultural wastes are shown in Figure 3 according to the source of the material. Figure 4 shows the waste management routes used for different types of material.

Figure 3: Waste management routes for organic wastes (excluding agricultural wastes)[1]



Sources: ERM & Golder Associates (2006) and Defra (2007c)

Figure 4: Waste management routes by material type (excluding agricultural manures and slurries)

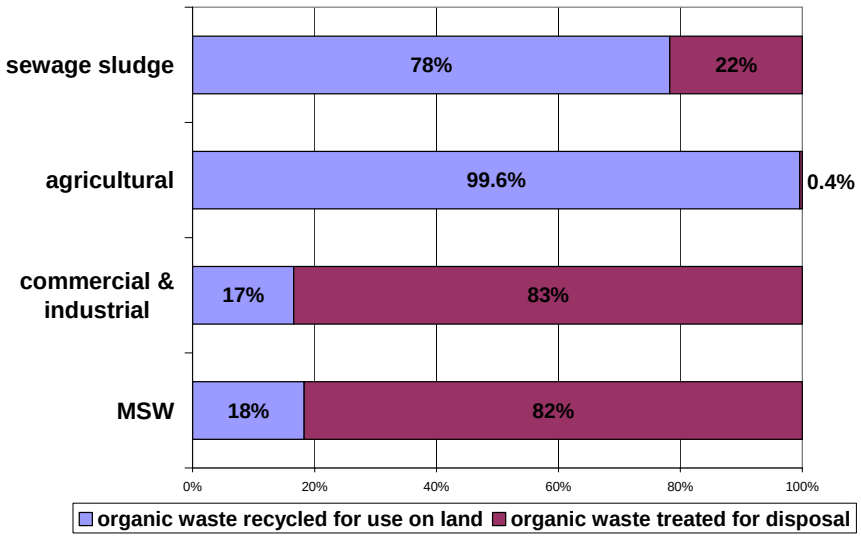


Sources: ERM & Golder Associates (2006) and Defra (2007c)

[1] Note that land spreading does not include compost, AD or MBT outputs that are subsequently used on land

As Figure 3 and Figure 4 show there are currently large amounts of kitchen and garden waste going to landfill. These offer great potential for diversion from current waste streams and increasing the amount of composts or AD digestates currently spread to land. Figure 5 shows the percentage of each source of organic waste material that is currently used on land and that which is treated for disposal.

Figure 5: Current proportions of available organic wastes that are recycled for application on land or treated for disposal



Sources: ERM & Golder Associates (2006) and Defra (2007c)

Regarding these different organic waste streams, there are several technical processing options available and these are linked to different social choices. Ultimately, all technical innovations have to be considered within a social, economic, legal and environmental context. This should reflect that waste streams arise as inevitable by-products of agricultural and industrial production (Baumgärtner 2001). The choices society faces will thus have to balance health, environment, economic and other considerations. As a consequence of that, all likely socio-technical options have to be explored in regard to the attitudes people hold towards them.

2.2 Bioprocessed organic wastes applied to land

Section 2.1 provided a quantitative review of organic waste arisings; this section considers the technical options for the treatment of organic waste and provides more detail on processed organic materials or final products. The term bioprocessed highlights that active processing is taking place, transforming an organic waste input into an output potentially fit to go to land. For the purpose of this study, bioprocessing is divided into four categories: composting, sewage sludge treatment, anaerobic digestion, mechanical-biological treatment (DEFRA 2004). The subsequent outputs are: compost, biosolids, digestates and compost-like outputs. There are also many variations and combinations of bioprocesses but these will not be covered in any detail here because their outputs fall into one of these four categories.

2.2.1 Composting

The recycling of organic matter occurs as a natural process in the environment: different microorganisms, including bacteria and fungi, break down biodegradable material into simpler substances. Composting is a process where this natural recycling process is controlled and optimised and raw organic matter converted into biologically stabilised compost under aerobic conditions at elevated temperatures in the presence of adequate moisture and oxygen.

The effectiveness of a composting system is dependent upon the operating conditions and how these influence oxygen levels, temperature, moisture, material disturbance, organic matter and the size and activity of microbial populations. Essential elements for the flourishing of the microorganisms are carbon, nitrogen, oxygen and water. Composting carried out at near optimal conditions will convert organic matter into stable compost (humus) that is odour and pathogen free. In addition, it will significantly reduce the volume and weight of biowaste as the composting process converts much of the biodegradable fraction to carbon dioxide and water vapour. Food and farm waste, green waste such as leaves and grass cuttings, wood, and paper can be turned into compost which when returned to the soil compost improve soil structure, moisture level and nutrient dynamics.

Since approximately 68% of municipal solid waste stream is biodegradable, composting could have a significant role to play in diverting biodegradable waste from landfills. This is already apparent in the steady growth of compost produced in the UK: "*Between 2003/04 and 2004/05 the estimated amount of composted waste in the UK increased by 35%, growing from 1.97 million tonnes (Mt) in 2003/04 to 2.67 Mt in 2004/05.*" (TCA 2006: 13). These amounts have kept growing reaching 3.4 million tonnes of compost produced in 2005/06 of which 2.9 million tonnes (85%) were from source segregated municipal organic waste (TCA 2008: 10).

Composting processes are often divided into two broad categories: windrow composting for green or garden biowaste and contained in-vessel composting for all types of biowaste (including food biowaste). Composting is regulated by Waste Management Licensing and for certain operations by the Animal By-Products regulations. A voluntary standard for compost, called a Quality Protocol, has been developed and implemented by the Environmental Agency and other bodies. The principal objectives of the protocol are to clarify the point at which waste ceases to be waste (and becomes a new product) and to provide an approved standard that protects the environment and human health. The Quality Protocol builds on the earlier Publicly Available Specification for Composted Materials (PAS 100) by the British Standard Institute, which offers a voluntary compost specification for composters. To conform to the requirements of PAS 100 input and process control as well as output monitoring must be provided based on a comprehensive set of parameters and requirements. These include: the need to undertake a Hazard and Critical Control Points (HACCP) analysis; to develop a set of Standard Operating Procedures (SOPs) covering quality management, frequent sampling and testing, limits for human pathogens (indicator species), potentially toxic elements, physical contaminants and stability. Only source-segregated biodegradable material qualifies as appropriate input for PAS 100-compost. Due to the recognised potential risks to animal and human health from the transfer of diseases from meat wastes, there are strict controls on the processing of kitchen type wastes. Only certain approved treatment routes, specified by the 2005 Animal By-

Products Regulations, can be used for this purpose. Kitchen wastes, for instance, is only permitted to be composted in an in-vessel composting system that has been approved by the State Veterinary Service.

2.2.2 Sewage sludge treatment (biosolids production)

Sewage sludge is an inevitable by-product of waste water treatment. It emanates from the removal of solids from wastewater discharged from households, industry, and collected as drainage from the streets. The most important constituents of sewage sludge are biodegradable organic matter and reduced forms of inorganic molecules (e.g. ammonia). Besides these materials, traces of heavy metals, organic pollutants and other chemical substances can be found in sewage sludge.

Sewage sludge exists in two basic forms: raw or primary sludge and secondary sludge. The former refers to sludge after excessive water has been taken out and before a treatment process has started. The later is basically a living 'culture' of organisms used in an active process such as anaerobic digestion. During final treatment the micro-organisms oxidise the biodegradable constituents and nitrify the inorganic ammonia to nitrate. The sludge can be transformed further using processes such as thickening, dewatering, drying, and lime stabilisation. These additional methods are applied for precautionary reasons for instance to reduce the number of pathogens in the final biosolids.

The spreading of biosolids on land began with the construction of wastewater treatment plants in the wake of the water policies of the 1960s. Prior to this most of the sewage sludge in the UK was disposed of to sea. Only later did EU regulation prohibit the dumping of sewage sludge in the sea leading to an increased diversion of this type of waste to agricultural systems. The amount of sewage disposed of at sea decreased by 41 % between 1997/98 and 1998/99 and disposal of sewage at sea ceased at the end of 1998. Incineration is now the second largest disposal route. Quantities going to land have increased over time until, in 2004, 62 % of the UK's sewage sludge went to agricultural land, while 19 % was incinerated, 11% used for land reclamation, 7% for composting and industrial crops and 1% went to landfill (Water UK 2006a: 9). This puts the UK at the top of European countries reusing sewage sludge.

Even so, sewage sludge makes up less than 5% of total organic material applied to land. It is thus of lesser relevance for farmers and greater importance for water companies who are responsible for the recycling, recovery, and disposal of the sludge. Putting sewage sludge to land has in many countries been a contested issue with strong public resistance at times. Although enhanced treatment methods can kill almost all organisms, the effects of other polluting materials on the environment and health are difficult to predict since they have different rates of decomposition in the natural environment and particularly in the soil. Some risks are well understood and controlled — like those associated with heavy metals. Others, like persistent organic pollutants (POP), are not subject of sewage regulation but they are covered by other EU and international environmental law. Given the agricultural value of organic matter, regulation has turned sewage sludge into a highly processed product, which is continuously analysed even though it only contains a limited number of pollutants. Biosolids are subject to microbiological standards, formal record keeping and hazard analysis and critical control point procedures (HACCP) to ensure improved quality control. All regulations are enforced by the UK Environment Agencies.

Since biosolids contain about 50% organic matter they fall under the regulation of the EU Waste Directive which restricts their disposal in landfill. Other treatment methods include biogas generation (anaerobic digestion) and thermal treatment.

2.2.3 Anaerobic Digestion

Anaerobic digestion (AD) is a biochemical process based, like composting, on the decomposition of organic matter by microorganisms. It is dissimilar to composting, however, as the process takes place in the absence of oxygen. Anaerobic digestion converts garden and kitchen biowaste into a digestate. Some mechanical processing to support the bacterial activity is common for most AD systems.

In the digestion process, a fibrous material, a nutrient rich liquid residue, and biogas are produced. There are a number of different types of digestion systems. The most common are batch and continuous flow systems. In the former the digester vessel is filled, the input allowed to digest and then the content emptied. In the continuous flow system the digester vessel is constantly filled and the digestate and liquor continuously removed. The digestion process needs constant mixing (either by mechanical stirring or pumping) and heat (which is typically provided with the biogas generated).

The composition of biogas varies depending upon the anaerobic digestion process and its feedstock. The principal outputs are methane gas (CH_4) and carbon dioxide (CO_2) dominate (CH_4 50 - 75% / CO_2 25 - 50%). Most AD plants aim to optimise the production of methane, which is used to generate energy. If sufficiently cleaned, the gas has the same characteristics as natural gas and can be stored and sold.[2] The solid and liquid residues can sometimes be fed back into the process again to improve efficiency. After dewatering the digestate the volume of the organic waste-derived materials will be reduced. Pre-processing biowaste by digestion prior to composting can significantly reduce the storage space required at composting facilities.

Feedstock can comprise mixed or segregated wastes which might include biodegradable municipal solid waste (BMSW), agricultural wastes, kitchen or food wastes and sewage sludge. There are issues around feedstock uniformity and inconsistent feedstocks can lead to technical problems stopping the entire digestion process. The digestates may be applied to land depending on the input and the particular process applied. If the process uses only source-segregated organic waste the digestate can be composted and put to land[3]. This is not allowed for digestates derived from mixed waste inputs even if these have undergone mechanical sorting.

According to data from the Renewable Energy Association (2008) currently 10 digesters operate in the UK — one third of these for research and testing purposes. Since anaerobic digestion produces a beneficial digestate it qualifies as 'recycling' under local authority Best Value Performance Indicators (BVPI). In addition the process can recover energy from biogas. Therefore anaerobic digestion can be counted both as recycling and recovery. However, the incentive provided by the Renewables Obligation Scheme set up in 2000 has had little impact in comparison to the renewable energy

[2] In Sweden and Germany purified biogas is already added into the gas distribution networks.

[3] The Animal By-Products Regulations 2003 requires that if catering wastes are treated in a biogas plant, they be treated for 5 hours at either 57 °C with a particle size of 5 cm. or; for 1 hour at 70 °C with a particle size of 6 cm.

schemes set up in other European countries. The situation in the UK contrasts, for instance, sharply with more than 3700 plants in Germany where a boom in biogas started after the Renewable Energy Act had been introduced in 2001. As a result, biogas has by now become the most important renewable energy source in Germany with 70% of all biogas generated from farm wastes or agricultural by-products (Kaltschmitt et al 2007). This, however, does not immediately add to diverting biodegradable waste from land since the dominating feedstock are agricultural biomass or biowaste but apart from this the use of mixed waste as an input for digestion has remained constant at about 2% (ibid.). Comparable expansions of biogas plants took place in other European countries (e.g. Austria > 270 plants, Sweden >200, Denmark >55).

2.2.4 Mechanical Biological Waste Treatment

Mechanical biological waste treatment (MBT) generates several different recyclates. The organic output derived from non-segregated biodegradable municipal wastes compost-like outputs (CLO). Mechanical biological waste treatment combines the mechanical segregation of municipal solid waste with the composting or digestion of the biodegradable fraction of the feedstock. This means that the degradation of the organic fraction of the municipal solid waste can take place under aerobic or anaerobic conditions. Since the feedstock is not biowaste but mixed waste, the MBT-output may contain some plastics, glass and, in general, more visible or invisible contaminants than composts or digestates produced from source-segregated waste streams like garden or food wastes. However, the quality of the MBT-output can be influenced through the processes involved. Some of the output may possess compost-like qualities in that they are stabilised and contain nutrients much like compost. This is why they are sometimes — though incorrectly from a regulatory point of view — called lower-grade composts.

Compost-like outputs are clearly distinguished from compost by current waste regulation and standards. The clear-cut distinction in which composts are defined by the Compost Quality Protocol, and PAS 100 is based on the fact that the wastes fed into the processes producing CLOs have not been source-segregated. However, during a consultation held by Defra and the Welsh Assembly (DEFRA/ Welsh Assembly Government 2006) on the source-segregation requirement of the Waste Management Licensing Regulations 1994 some respondents called for an output-based standard and the suspension of the current constraint to biowaste. Echoing this some scientists have pushed forward the idea of a safe compost matrix to cover CLOs and their potential use on agricultural land (Bardos 2007). This impression seems to be endorsed by the fact that from the 100,000 tonnes of organic waste from MBT in 2005/06 only 1% was actually sold whereas 99% was used on site (TCA 2008: 18).

Yet, their application to non-agricultural/non-forest land such as Brownfield sites and reclamation projects is allowed in England provided that it has an ecological benefit. Given the environmental state of these sites CLOs may render possible the build up of soil and the growth of vegetation.

Inset 1: Agricultural and industrial organic wastes which may be directly spread to land:

Agricultural wastes

In the last 50 years, intensive livestock production has significantly increased in the U.K. Livestock rearing units have grown in size, and with them the quantities of farm yard manure and slurry produced. Waste from and around livestock production is biodegradable and its application to land is controlled as in large quantities untreated slurry and liquid manure could cause environmental problems (e.g. eutrophication). Intensive livestock units have often become separated from the land where feed and food is produced and where the manure and slurries could be recycled.

Manure is associated with the microbiological production of a variety of odorous chemicals including ammonia, organic acids and alcohols, and sulphides. In addition toxic bacteria like Salmonella spp, Escherichia coli, etc. have been found in manure. Scotland, in particular, has exhibited some of the highest rates of E. coli O157:H7 infections in the world (Reilly 2001). DEFRA has commissioned research on the implication of measures to control pathogens in manure management (project WA0656). Still, little is known about the micro organisms present in manure and their survival rates on land.

In some EU countries such as Denmark and Sweden ~5% of the farm wastes are anaerobically digested or composted before being recycled. In the U.K., however, these wastes are generally not treated before being recycled to land.

Fallen stock is legally considered an **animal by-product (ABP)**, which includes, besides animal carcases and parts of carcases, all products of animal origin not intended for human consumption. This comprises catering waste, used cooking oil, former foodstuffs, butcher and slaughterhouse waste, blood, feathers, wool, hides and skins, pet animals, zoo and circus animals, hunt trophies, manure, ova, embryos and semen.

Industrial Wastes

When the new waste management licensing regime was introduced in 1994, it established a list of "exemptions" from licensing for activities deemed to pose minimal risk to the environment or human health. This eased the disposal of several major industrial waste streams to agricultural land although a registration system was introduced under which pre-notification of such operations needed to be made to waste regulation authorities. However, no central records were kept of the effects of this deregulatory measure.

According to an ENDS report (1998) an unpublished official study (by WRc and ADAS) concluded that 2.78 million tonnes of waste a year were being applied to land by that time. "*Disposal of paper industry sludge to land has been rising particularly rapidly. Other sectors using this outlet are abattoirs and food and drinks plants*."

The exemptions for land spreading of industrial waste have been criticised. In its 1996 report on soil protection, the Royal Commission on Environmental Pollution disapproved the exemptions (Royal Commission on Environmental Pollution 1996). In addition regulators and the water industry were concerned by the pollution potential of this practice. Finally, the exemptions led to different levels of control for bioprocessed and non-bioprocessed organic wastes to farmland, which indicated regulatory inconsistency.

According to the data available the spreading of non-bioprocessed materials has remained constant of the past 10 years or so; but even with the growing application of compost today industrial wastes still outnumber the amount of compost applied to land by ~ 2.7 times. The practice is thus still unbowed even though exemptions are more rigid after the Waste Management Licensing Regulations 2005.

Abattoirs produce wastes, which include blood, bones, feathers, stomach and bowel contents, manure, wash waters and sludge from dissolved air flotation treatment where this process has been used to separate solids from liquid waste materials of the abattoir.

About 21% of a slaughtered animal remain waste. Between 80 and 90% of it is re-used or recycled mainly in the feeding industry. Some is treated in rendering plants. Hoof parts and bone meal are recycled in other industries (to produce e.g. fertiliser and glue). Between 5 to 10 % are spread to land either with or without treatment (composting). This is mainly the content of guts which consist predominantly of partly digested feed or vegetable matter. A study for the European Commission (EU 2001) estimates that 6000 t stomach content are recycled to land in the United Kingdom.

In the **fruit and vegetable processing industry** much waste is connected to the large volumes of water used, mostly for washing. The effluent generated is either spread directly on agricultural land or treated in an on-site or municipal (domestic/industrial) wastewater treatment plant. For instance, **sugar beet production** creates large quantities of dirty water containing soil and sugar. This effluent can be land spread directly during the harvesting season, which takes place from September to December. Otherwise it can be stored in sedimentation lagoons. The water of the sedimentation lagoon is recycled and the odorous sludge collected from its bottom is either spread on land or used as landfill cover or soil material in land reclamation projects.

In the actual production process the pulp, left over from the sugar extraction, can be dried and sold as a fodder. The sugar juice is clarified by adding a lime solution. The lime sludge generated in this process is not considered a waste and is used as fertiliser. In the further process vinasse is produced, which can be recycled to land or used as animal feed. Another by-product is potassium sulphate which can be applied as a fertiliser. The data provided by the EU (2001) suggests that almost all sludges from these processes are recycled to land.

Wastes generated by **vegetable and fruit industries** such as jam, fruit juice production may contain soil residuals and fruit pulp, stalks, peels/skins, leaves, etc. If wastewater is treated on site, sludge produced from treatment of wastewater and soil can be spread in agriculture and the other waste re-used as animal feed. Since a lot of fruit and vegetables are imported as semi-processed products they generate less waste at the processing plant.

There are other sectors such as **dairy, fish processing, breweries and distilleries and soft drinks** that produce quite large amounts of organic wastes. Most of it is re-processed or sold as a raw material substitution in animal feed or road construction, etc. In this way the majority of waste products generated by the food sectors are recycled.

Wastes arising from **milk production** include whey (liquid phase), wash water and a solid phase. About 90% of milk used for cheese-making ends up as whey. Effluents are often treated and the sludge spread to land. It is quite unclear what amount actually goes to land. The EU study estimates that 1% may be put to land.

Breweries and distilleries generate much larger proportions of waste than all other non-bioprocesses together. However, the by-products of their production, grain husks and yeast, can be reused as animal feed. Estimations based on data from Denmark (EU 2001) assume that less than 15% are land spread. However, the *Soil Quality Report* published by SEPA (2001), says that "*distillery waste is of concern because it can contain high levels of copper as well as other prescribed substances and current regulations do not control the build up of these substances in soil*." (ibid: 53) SEPA is therefore working on a National Waste Protocol with distillers. For the time being SEPA suggests applying copper rich distillery sludge to regions with copper deficient soils (e.g. Speyside and other areas in NE Scotland).

Tanning is a process by which the tanning agent fixes the principal protein of the skin (collagen), thus stopping putrefaction and creating leather. Leather manufacturing generates liquid and solid wastes. In the preparation of the hides the hair is taken off. These can be composted if they are pre-degraded in the process. A second waste is a liquid effluent rich in organic matter and suspended solids which produces a sludge

rich in nitrogen if it is treated. Other by-products such as glue and gelatine are also generated from wastes that accrue before tanning. Collagens can be used in food and cosmetics industry. Sludge can be anaerobically digested with other tanning wastes before being spread to land or can be land filled if their chromium content is too high. Around 90% of the industry use chromium salts in the tanning process of which up to 50% can be lost in effluent and thus contaminates sludge. There are other problematic substances such as halogenated compounds for degreasing animal skins. In the UK 10% of the 30,000 t of tanning wastes are being recycled to land (EU 2001: 31).

Finally, there are organic wastes arising from **textile industry**, which is sub-divided into sectors such as shearing, washing and combing of wool, spinning and textile processing. Textile processing requires up to ten successive treatments. Wool washing (with subsequent bleaching, dying, soaping, rinsing) and textile processing activities consume large volumes of water. These can vary from 10 to 30 l/kg of wool for wool washing and 150 l per kg for textile processing. Wastes arising from wool washing and combing activities are:

- Natural grease that is re-used by the cosmetics and soap industry for lanolin;
- Wool dust which is either land spread or incinerated;
- Sludge from treated effluent which can be either composted and spread to land or incinerated.
- Ash from incinerated sludge and wool dust can be used as a potassium soil amendment.

The amount of sludge arising in textile processing has been estimated to be 1/5 of the final product with an average of 13% of dry solids. The composition of the sludge depends on the process. While they contain large organic matter they may also hold bleaching agents, heavy metals from dyes. Overall the quantities of sludge generated by the textile industry are said to be rather small (although no detailed figures were available). This will further decrease due to programmes of the industry to reduce water consumption and closing down of this sector.

In the **paper industry** two types of manufacturing processes are being applied:

- Pulp production (chemical or mechanical); and
- Paper and cardboard production using virgin fibre and/or recycled fibre.

Both need large quantities of water. Most paper mills have primary treatment of effluents and in some cases a secondary treatment generating sludge. If the paper production relies mainly on virgin wood fibre, the liquid effluent and the sludge are predominantly composed of lignin and cellulose. The production of fibre from recycled paper generates larger amounts of sludge. The EU-study is not entirely clear on this. It states: "In the UK, it has been reported that virgin fibre generates 65% on wet weight basis of sludge while recycled fibre generates 80% sludge. However, calculation seems to indicate that 590 kg of paper sludge are generated per tonne of virgin fibre processed and 340 kg of sludge per tonne of recycled fibre." (EU 2001: 20) De-inking and bleaching might be required, which can build up colour, chemical and bleaching residues in the sludge and might impair its re-use on land. This, however, depends on the particularities of each production process.

Other sectors generating organic waste are **wood processing, basic organic chemical industry and pharmaceutical industry**. Their wastes are applied to land on a case by case basis. Mineral waste is commonly recycled to land at an estimated rate of about 5% (EU 2001) of the total amount generated by different sectors. These are:

- Chemical industry: iron salts from Titanium dioxide production, ammonium sulphate, residual lime
- Energy production: residual lime from coal burning, ash from wood burning
- Clay and mineral exploitation: rock and soil, residual lime, waste gypsum
- Metal production and processing.
- Drinking water supply and industrial decarbonation: sludge
- Dredging: spoil.

3 Drivers and constraints

In considering future developments in waste policy and the use of organic waste-derived resources on land it is important to identify the drivers for change.

The main driver for increasing the amount of organic waste diverted from landfill is the EU Landfill Directive, which set targets for the reduction of biodegradable waste sent to landfill as:

- 75% of the 1995 level by 2010,
- 50% of the 1995 level by 2013 and
- 35% of the 1995 level by 2020.

The latest Waste Strategy for England 2007 (DEFRA 2007c) builds on the framework set out in the Waste Strategy 2000 to ensure the implementation of these targets. The Strategy recommends greater efforts to reduce waste, substantially increase re-use, recycling and composting and recover energy from waste where waste cannot be recycled. Local authorities in England were given the target:

- to recycle or compost at least 40% of household waste by 2010, 45% by 2015 and 50% by 2020,
- to recover at least 53% of household waste by 2010, 67% by 2015 and 75% by 2020.

Similarly, the administrations in Wales and Northern Ireland have set recycling targets in their own strategies. Northern Ireland's targets (EHSNI 2006) are:

- 25% of household waste must be recovered by 2005, and
- 40% by 2010, of which 25% has to be recycled or composted.

The Welsh Assembly has specified these targets (Welsh Assembly Government 2002):

- to achieve at least 15% recycling/composting of municipal waste with a minimum of 5% composting and 5% recycling by 2003/04;
- 25% recycling/composting of municipal waste with a minimum of 10% composting and 10% recycling by 2006/07; and
- 40% recycling/composting with a minimum 15% composting and 15% recycling by 2009/10 and beyond.

The Scottish National Waste Plan (SEPA 2003) sets interim targets of:

- 25% of municipal waste should be recycled/composted by 2006; and
- the quantity of BMW disposed of to landfill in 2006 should reduce to below 1.5 million tonnes (90% of the 1995 level).

The 2007 Waste Strategy for England (DEFRA 2007c) has also introduced targets for reducing the amount of household waste not reused, recycled or composted, and for reducing the amount of commercial and industrial waste going to landfill.

The amount of biodegradable waste going to landfill has not only been driven by targets but also by the incentives introduced by the Landfill Tax Escalator (1999) and the Landfill Allowance Trading Scheme (2004).

To meet these requirements a range of solutions drawing on different policy instruments and technologies are envisaged by Government. Again, these innovations in waste management must be seen as both technological and social innovations. Indeed, in many cases social innovations are preconditions for technological ones.

To reduce, for instance, the amount of household food and garden organic waste going to landfill these wastes can be separately collected in source-segregation schemes and then composted with the compost put to land. This, however, is a social innovation that requires proactive behaviour on part of consumers. In turn, the resulting recycling rate may determine what kind of waste treatment technology councils consider appropriate to fit their specific local requirements. In other cases, the waste treatment technology may determine the options chosen by councils to increase the collection and recycling of compostable materials. In either way, the final socio-technical solution will influence the quantity and quality of waste-derived products, which subsequently effects intermediate demand. Social innovations may, even be relevant for final demand, since in emerging (mass) markets consumers ultimately decide on the success or the failure of products. The food sector in particular has experienced the sensibilities of the market in recent years quite dramatically. In the food market this uncertainty is reflected by the strong position of the intermediate buyers who seem to matter more than in other sectors. According to the 'Report on the 2001 Farm Practices Survey (England)' (DEFRA 2001) 63% of specialist cattle farms and 88% of cattle farms with crops belong to a specific management system (e.g. produce assurance schemes, supermarket standards and protocols, buyers standards and protocols etc.) (ibid: 68).

From a regulatory perspective one could therefore conclude that progressing waste policy is not just a matter of implementing an EU directive (in a hierarchical way) but a question of (interdependent) governance of various stakeholders. This relies on proactive behaviour as well as benevolent attitudes all around to be successful. Thus, positive attitudes and reflected behaviour amongst a wide range of stakeholders will be crucial for progress in waste policy.

3.1 The regulatory framework

A wide range of wastes and by-products are being spread on agricultural, forest and reclamation land. Some organic wastes like manure and slurry have been used on land for centuries and are still part of traditional farming practices. Others have been added only with the rise of industrial society and some only in the past few decades, like, for instance sewage sludge which was previously disposed of in rivers and at sea. Finally, others have been put to land even more recently — sometimes experimentally in pilot projects such as compost-like outputs on reclamation land.

The use of organic waste derived resources is not consistently regulated and to some extent is dependent on the type of waste material and on whether the waste comes from agricultural or industrial processes. Surprisingly, the only regulation uniformly applying to all organic resources put on land are the 'Nitrate Vulnerable Zones (England and Wales) Regulations' of 1998 that, however, address only farmland within designated nitrate vulnerable zones. They do not apply to land outside these areas.

Besides this there are several regulations that influence the application of organic resources to land (e.g. by altering the input of bioprocessing) even though they were not necessarily intended to govern this subject area: water and chemical legislation are examples for this but cannot be dealt with here. Similarly, other indirect impacts, e.g. of the Renewables Obligation Certificates, are beyond the scope of this review even

though the EU agreement on renewable energy in 2007 will almost certainly have a large impact on the use of biomass (incl. organic waste) for energy production.

Organic agricultural wastes have long been an uncontrolled waste although agriculture has been an intensive subject of environmental law. With the rapidly changing agricultural structures after World War 2 the traditional use of manure and slurry had become a tremendous environmental problem and, subsequently, been regulated by environmental legislation. In the UK the 'Rivers Prevention of Pollution Acts' of 1951 and 1965, the 'Control of Pollution Act' (1974), the 'Water Act' (1989 and 2003) and the 'Water Resources Act' (1991) along with the 'Pollution Prevention and Control Act' (1999) established a 'Code of Good Agricultural Practice' that regulated amongst others the use of manure and slurry in agriculture. A 'Water, Air and Soil Code' in England and Wales and the 'PEPFA Code' in Scotland have been designed to provide practical guidance to farmers and growers in order to protect soil as their most valuable resource and to avoid pollution. The Codes are, however, outside the environmental regulations. They explain the main dangers of causing pollution from different agricultural and horticultural sources. Good agricultural practice implies minimisation of risks of pollution and protecting natural resources without endangering the economic success of farmers. Additional official recommendations that complete the Code of Good Agricultural Practice are mostly based on these official guidelines rather than the legislation itself.

This comprehensive body of legislation sets the legal frame for agricultural waste and it wasn't considered necessary to regulate this area, for instance, by waste law. This may have been endorsed by the very logic of waste regulation, since from this perspective the use of organic agricultural waste is conceived as recycling, which sits high up in the waste hierarchy and so has received little legislative attention. However, the recent incisive experience of BSE and Foot and Mouth disease have resulted in tight regulation on animal by-products, which in turn effect the spreading of organic wastes to land.

The 'UK Animal By-Products Order' (1999) was designed to prevent access of livestock or wild animals to waste which contained meat or products of animal origin. Fallen stock could no longer be buried or burnt in the open because of the risk of spreading disease. The 1999 regulations did, however, not only apply to fallen stock but also to animal by-products (ABPs) arising from catering, retail, wholesale, manufacturing and distribution premises, convenience stores, food markets and bakeries. Raw meat and fish, former foodstuff and catering waste became ABPs when no longer intended for human consumption. This ban applied whether or not the animal by-product wastes had been treated, which meant that they could not be composted or used in biogas treatment plants. It prohibited spreading these wastes to land.

This tight regulation, however, was revised three years later when the 'EU Animal By-Products Regulation' (EC1774/2002) came into force. The new regulation allowed the treatment of low-risk animal by-products and catering waste in approved composting and biogas facilities. The EU Animal By-Products Regulation thus permits the use of composting and biogas treatments for catering waste and Category 3 animal by-products. Animal by-products must be treated according to the EU standard, but the Member States were allowed to introduce their own national standards for premises handling only catering waste and no other animal by-products. 'The Animal By-Products Regulations' in England (2003 and 2005), implemented and specified the EU

Regulation. Similar regulations to those in England also apply in the devolved administrations of Scotland, Wales and Northern Ireland.

The 'Environmental Protection Act' (1990) Part 2 introduced waste management licences as a legal document permitting the treatment, keeping, carrying or disposal of controlled waste. The purpose of the licences is to ensure that authorised waste operations are carried out in a way which protects the environment and human health. The Waste Management Licensing Regulations (1994) and its amendments supplemented the licensing system and introduced exemptions for specific recovery and other activities. Waste management licences are issued by the Environment Agency. The amount of information required by the EA varies depending on the level of risk the activity poses. Some of the higher risk exemptions also require a charge to be submitted.

The Waste Management Licensing Regulations 2005 (WMLR, England and Wales) introduced further amendments to the licensing system. In particular, the 2005 Regulations inserted a new paragraph 7A on land treatment and paragraph 9A on reclamation or improvement of land into Schedule 3 of the Waste Management Licensing Regulations (1994). The 2005 Regulations clarified the wastes that can be spread to land under these exemptions. In relation to the aerobic and anaerobic treatment of wastes, one of the requirements now is that only composts, liquors and digestates derived from source segregated biodegradable waste can be spread under the terms of a paragraph 7A exemption (the source segregation requirement). The amendments to paragraph 9A imply that some outputs from treatment of non source segregated wastes can be spread to reclamation land.

In 2006 England and Wales carried out a consultation on the source segregation requirement. The Governments concluded "*that the source segregation requirement should remain in place as a temporary safeguard to protect the environment and human health against the landspreading of any sub-standard wastes to agricultural land. However, the Government views this as an interim measure, and is working to find a longer term, more sustainable solution that will encourage the development of technologies to produce high standard outputs which could be safely spread to land.*" (DEFRA 2006)

There is no legislation addressing compost in detail. The WMLR 1994 defined composting as any biological process that results in materials, which may be spread to land for the benefit of agriculture or ecological improvement. However, in 2000 the Composting Association delivered a standard for the production of composts, which in November 2002 was taken up by the British Standards Institute with the release of the Publicly Available Specification 100. PAS 100 sets out a voluntary standard for the process of composting source separated wastes and for the end product quality in terms of the content of potentially toxic elements, contaminants, human pathogens, weed seeds, and labelling. In October 2001 the Environment Agency also introduced the 'Technical Guidance on Composting Operations' (EA 2001). The objective of the guidance is to promote best practice in the operation and regulation of composting facilities. Finally and most recently the compost Quality Protocol was introduced which describes parameters for the full recovery of compost and implies that compost produced under managed conditions will no longer be considered a waste. There will

soon be an equivalent to the PAS 100 standard for digestates, complemented by a digestate Quality Protocol.

At the EU level there is currently no specific regulation on wastes applied to land with the only exception of sewage sludge, which is regulated by *Sewage Sludge Directive 86/278/EEC*. However, *Annex IIB of the Waste Framework Directive 75/442/EEC* [4] considers land spreading operations of wastes other than animal carcasses and animal manures as recovery as long as they are carried out without endangering human health and the environment. According to the Directive, companies can be exempted from a permit requirement if the competent authorities have adopted specific rules for these exemptions.

In the UK the 1986 EC Sludge Directive was implemented by the 'Sludge (Use in Agriculture) Regulations' of 1989 (SI 1989, No. 1263) covering Great Britain, and the Sludge (Use in Agriculture) Regulations (Northern Ireland) 1990 (SR 1990, No. 245). The Code of Practice for Agricultural Use of Sewage Sludge complemented these regulations later. The authorities in the UK consider spreading of sewage sludge on agricultural land as the best practicable environmental option (BPEO) in most circumstances usually also providing the most economic option where there is reasonable access to agricultural land.

Although the application of sewage sludge has been found not to adversely effect human health (Royal Commission 1996), debates about its use on land have not entirely stopped. In the 1990s concerns were raised about the biological risks involved in the application of sewage sludge in the UK. Whereas the risks related to heavy metals had been considered as well controlled from a scientific perspective, the debate about health risks emanating from biological contamination of sewage sludge with bacteria and pathogens ultimately led to the adoption of the Safe Sewage Sludge Matrix (the matrix). This voluntary measure drawn up and adopted by industry included process control and output standards. It was agreed upon in 1998 by the water industry, the British Retail Consortium (BRC), food industry, landowners, and farmers etc.

The matrix introduced controls of the microbiological quality of sewage sludge and procedures for the application of sewage sludge to agricultural land utilised to grow food crops. The provisions of the matrix went beyond the requirements of the Sludge (Use in) Agriculture Regulations as it stands today. The matrix included the adoption of HACCP (Hazard Analysis and Critical Control Point) measures for sludge processing by the Water Companies. HACCP procedures apply risk assessment and process control. They include formal record keeping and ongoing quality controls. Furthermore the agreement led to the phase-out of untreated sewage-sludge application to land in 2001.

Recent developments in waste regulation are seen in the Waste Protocols Project carried out in collaboration by the Welsh Assembly Government, the Environment Agency (England) and WRAP (DEFRA 2007c). This process is reviewing the scheme of exemptions from waste management licensing. The aim is a more risk based and proportionate approach to the regulation of waste recovery and disposal operations, complementing the proposed new environmental permitting regime.

[4] as amended by Directive 91/156/EEC(CEC 1991)

At the moment several protocols are in preparation. They are thought to reduce the regulatory burden for the production and use of waste-derived products. They include incinerator bottom ash (IBA) (from incineration of municipal solid waste), boiler ash (from combustion of paper sludge), gypsum (from waste plasterboard and manufacturing), uncontaminated topsoil (including manufactured soils), and anaerobic digestates. The aim is to define the point of full recovery of a waste back into a product and where exemptions from the need for a waste management licence do not apply. This is a crucial undertaking in regard to sustainability with immediate and long-term implications for stakeholders.

Of related importance for spreading organic resources is also the Communication 'Towards a Thematic Strategy for Soil Protection' adopted by the European Union in April 2002 (European Commission 2002). This identified a number of threats to soil quality across the EU. Two dangers directly correspond to the issues connected with spreading organic resources to land: these are the decline in organic matter and diffuse local contamination. In the UK the 'Welsh Strategy for Soils' (Welsh Assembly Government 2007), the 'Soil Protection Strategy for Scotland' (Adderley et al 2001) as well as the 'Soil Action Plan for England' (DEFRA 2004) respond to this challenge. Farm soil management schemes and Environmental Stewardship set guidelines for compost use on agricultural soils and endorse their use. In addition the EU cross-compliance scheme supports the application of organic matter to land. While there is some influence on organic waste regulation from this side no legal obligations for waste regulation are discernable.

In the telephone interviews a majority of the stakeholders shared the perception of waste regulation as an ongoing, dynamic process. They referred to the statutory side of regulation — in particular the setting and reviewing of standards and technical norms. This process is seen as evolving from strictly evidence-based scientific expertise, which assures high approval for these negotiation processes amongst the stakeholders. However, risk sociology and political science have shown that such processes may still be neglecting the wider social context.

3.2 Markets for organic waste-derived resources

The regulatory framework, in particular the EU Landfill Directive, has led towards an internalisation of external costs associated with environmental damages of cheap waste disposal. It established a market with business opportunities to profit from organic waste-derived products since, for instance, the price relation between organic recyclates made from secondary resources and fertilizers produced from primary resources (e.g. phosphorus) has started to shift. As a practical consequence for the waste sector new businesses emerged around processing biodegradable waste — most notably the compost industry. In addition, mechanical-biological treatment plants (MBT plants) and digesters, though much fewer in number, have started to develop an economic path of waste treatment technology, which is likely to impact in turn on future regulations (ENDS 2005). In this regard the arising market is strongly technology driven and these technologies create a 'demand for demand'. If demand for their outputs can not be provided the profitability might be hampered. It remains to be seen how councils and regulators will react to this situation. Like mass burn incinerators, MBT plants and

anaerobic digesters demand significant capital investments[5]. These investments represent sunk costs holding large financial stakes and long-term commitments for investors (Archer et al 2005). At the same time mass burn incinerators and MBT plants will establish regional or local natural monopolies which suspend by their specific economic properties competitive waste markets. The effects of these monopolies on the recyclates markets (for secondary resources) have not been well studied.

Generally speaking, the waste market in the UK is characterised by a few companies with none holding a dominant position. According to an AMA Research report (2006) on the waste market there has been considerable consolidation within the waste management industry over the last decade. This trend is continuing with larger companies buying smaller waste operators. The composting sector is more varied with, according to the most recent data from the Composting Association (2008), 41% of compost producers exclusively focused on composting; 22% relying on agriculture as their main source of income; and another 20% also operating as waste management companies. The financial size of the UK composting industry is growing with an estimated current total turnover of about £91 million.

Price relations are influenced by many factors amongst which final and intermediate demand is particularly important. In the composting sector the price relation between primary and secondary organic materials have been shifting: e.g. the price for ammonium nitrate has doubled from 2002 to 2005 (Evans 2006: 15) and peat prices have started to fluctuate as a result of shrinking supply and demand moving away from peat for environmental reasons (WRAP 2005). A WRAP report (2003) took a close look at the increasing demand for compost in the UK growing-media manufacturing sector, which produces growing media for gardening, horticulture etc. The report focused on this particular segment of the emerging market for organic resources and noted above all a strong spatial segregation of the supply side (compost manufactures) and the (intermediate) demand side (growing media manufacturers). Whereas the growing media manufacturing sites are predominantly located in Northern Ireland, the North West and North East of England and Somerset (reflecting historical peat availability), there are no significant growing media manufacturing sites in Scotland, Wales and the South East of England. In contrast to this, most compost producers (with more than 10.000 t/a green waste) are located around the densely populated areas in the South East of England and the Midlands that produce large amounts of food and kitchen waste. Given the importance of transport costs for a bulky product like compost, this spatial split challenges the establishment of a market-driven production chain for organic-waste derived products. The geographic mismatch thus represents a serious challenge to business. However, the general outlook for compost is improved by the shrinking supply of imported peat that shifts the price-ratio in favour to compost. In addition to that, there is also a high demand for growing media in the same areas with high organic wastes arising.

Other effects of shifting price-relations are observed by Evans (2006) who claims that administrative fees disadvantage digestates and paper mill sludges in relation to sewage sludges: farmers have to pay £546 to register an exemption (and a further £412 each

[5] The capital costs for an MBT plant is somewhere in the range from £12.6 million to £170.8 million depending on the input tonnage and more than a £0.74 million for an anaerobic digester.

year to renew the exemption) for the former materials while the latter is free[6]. In addition the exemption applies only to land of less than 50 ha, which disadvantages small farmers.

The situation is different for compost-like outputs or low-grade compost. These may arise around densely populated urban areas (Chapman & Bardos 2006) and may be applied to Brownfield sites and reclamation land if they are ecologically beneficial. However, a DEFRA report on mechanical biological treatment (MBT) and mechanical heat treatment (MHT) of municipal solid waste (2005: 9) says that "in the U.K., at present, the market for many of the outputs from MBT and MHT does not exist. Considerable effort is being undertaken by a number of organisations and individuals to change this situation. Plans being specified today will need to provide materials into an as yet undeveloped market." An important problem regarding demand is the lower quality of recyclables derived from the various MBT processes. These have a lower potential for high value markets than those from source separated household collection systems. This concerns papers and textiles as well as bio-stabilised or compost like outputs that could go to land. In fact, the report states that "these markets are traditionally low value and materials may be in competition with other more traditional soil improvers such as sewage sludge, poultry waste or source segregated at green waste derived compost." (ibid: 10) This is even true for the lower value application to Brownfield sites and reclamation land. At best demand for compost-like outputs is thus as big as the reclamation project itself.

Although these issues are common ground in economics they are hardly ever studied in regard to the attitudes of economic actors involved. There is of course a private body of market research studies as well as public research on sustainable consumption. Still, no specific studies on attitudes towards products derived from organic waste could be identified. On the other hand, the interviews do not suggest that these issues are necessarily of major concern for the stakeholders: the legislative EU and UK provisions on organic waste are clear and stakeholders seem to perceive these issues simply as a matter of how best to achieve these given ends or, with respect to producers, how to get ahead in the market. Nevertheless, there is considerable leverage in how to accomplish such targets and a variety of regulatory and socio-technical options could be conceived. As a result, dissimilar attitudes may be held amongst the producers of different organic recyclates possibly depending on the outputs they produce that is the partial market they supply. For instance, MBT process companies argue for a compost standard defined on the basis of output rather than origin (Archer et al 2005). This would not only depart from the current PAS100 standard but also challenge today's compost markets, which are based on source-segregated material. A consultation by Defra on this matter has shown that the majority of those questioned favoured the retention of existing source segregation although the respondents agreed as well on the need for some form of output standard (DEFRA & WAG 2006). From the interviews, there is nothing indicating an overly competitive attitude amongst the actors on the market that would, for instance, defy cooperation in disseminating information. Instead, we find economic actors who work together in integrative institutions, like Sustainable Organic Resources

[6] For completeness it should be mentioned that the same fees accrue for sewage sludges if these are stored or spread to non-agricultural land (cf. Evans 2006: 10).

Partnership (SORP), and participate in pluralistic stakeholder dialogues along the management of the production chain.

Yet, the demand for organic waste-derived products is much less understood than the supply-side. WRAP (2005) commissioned a study to assess the demand for green waste compost in the landscaping industry. It concluded that there is a continuing growth of green waste compost in this sector with the highest growth rate of all organic matter products (only animal manure and forestry residues grow as well). At the same time growth is said to be limited by insistent perceptions and traditional habits of users. On the other hand some perceptions also strongly work in favour of compost: *"peat and peat based products are 'less likely' to be specified by respondents with strong supporting comments against the use of peat, whereas encouragingly for green waste compost, the majority of respondents stated that they would be 'more likely' to specify this in future, particularly if there was an increase in local availability and proof of quality and consistency."* (WRAP 2005: 19) The increasing elimination of peat is largely driven by public concerns about the future of moors, which leads landscapers to specify their product-demand accordingly. This in turn does not necessarily mean that in the future industry will demand more PAS100 accredited products. Although the standard is known by 60% in the landscaping sector only few say they actually want to purchase PAS100 products; the large majority rank it rather low on their specification list (ibid). Still, there is a particular demand for products certified by the standard, which supports the predominantly good perception of compost in this particular sector.

3.3 The social dimension

Social drivers for the use of organic waste resources used on land concern issues of perception and attitudes, willingness to participate in sustainable behaviours (such as separating food and garden waste for collection), as well as wider issues concerning the role of civil society. Attitudes to the use of organic wastes on land whether they are considered to positively enhance farming practice and bring benefits by recycling natural organic materials back to the land, or negatively with concerns about pollutants and contaminants, are the focus of this research. The literature dealing with this is reviewed in the next section. Attitudes to carrying out sustainable behaviours are also covered in that section but they will only be lightly touched on in relation to the role they can play in driving the organic waste issue. The public's willingness to participate in source-segregation schemes could have an impact on both the quantity and quality of the material available for use on land.

There is a specific role for civil society in delivering more sustainable waste systems. The Waste Strategy 2007 has emphasised the role of the third sector in delivering a sustainable waste system. It acknowledged the specific social — as opposed to an economic — character of voluntary social organisations and small enterprises: "*The third sector, ranging from voluntary and community organisations, charities, co-operatives and social enterprises, has the ability to deliver multiple benefits – social, economic and environmental – for the communities it serves and the Government recognises the sector as an important partner in achieving its strategic objectives. Government will raise awareness of the third sector among potential customers and address barriers to its greater involvement in delivering public services, including on waste."* (ibid: 96) The government perceives the particular strengths of the third sector

in three key areas of waste management: waste prevention, re-use and separate kerbside collection. A number of studies have been and are being carried out exploring the role of social enterprises in sustainable waste management and public engagement including these supported by Defra within the Waste Evidence research programme: 'Replicating Success: Social Enterprises and the Waste Sector in London' (WR0501), 'Social Enterprises and Sustainable Waste and Resource Management: Evaluating Impacts, Capacities and Opportunities' (WR0502), 'Benefits of Community Sector Involvement in Waste Management' (WR0506), and 'Unlocking the Potential of Community Composting' (WR0211).

Community composting schemes have played a part in progressing recycling in the UK and will probably also be able to seize opportunities for social engagement in the future. Still, 'society' is not all about the economic third sector. The active role of civil society is limited for a number of reasons. The capacity of the third sector for providing source-segregated organic waste collections is limited due to, for instance, the logistic complexity of biodegradable waste collection, or the capital investment necessary to provide collection and treatment infrastructure. Furthermore, voluntary social organisations face the dilemma that increased professionalism often endangers their social coherence (Cohen & Arato 1999). There can be a payoff between organisational professionalism and social integration or, in other words, economic expansion can become incompatible with voluntary action (Slater 2008). If social organisations are perceived as market institutions or are held responsible for immediate policy outcomes, they may quickly loose fragile social support.

This danger arises, for instance, from unintended effects in the institutional development of the waste system. They rarely result from organisational 'mistakes' but from complex social interactions of social, economic (including technical infrastructure) and legal institutions. Most of the time they are not possible to foresee since the outcomes emanate from uncoordinated sequential and parallel decision-making of different organisations. Social theory refers to 'structures' or 'systems' to signify these phenomena. They tend to spin-off from the daily experience of citizens or loose their social-embeddedness. In regard to waste policy this concerns most of all the legal and economic institutionalisation of waste policy, which feeds back into society again and raise questions such as:

- How do market fluctuations for recyclates impact on the motivation of people to separate and recycle waste if they learn that recyclates still get burned or disposed as a result of price instabilities?
- Up to which level can the potential of available biodegradable waste be explored through well run collection schemes?

One analysis reports that the UK collects about 10% source-segregated organic waste, while the Netherlands collect 50% and Germany even 70% (BMU 2007). Yet there is no reason why the amount collected in the UK should not be increased. The '2007 Survey of Public Attitudes and Behaviours toward the Environment' (DEFRA 2007b) shows a strong motivation among the UK's population to deliver more sustainable action in particular on recycling. A majority of people believe that recycling has a major impact on climate change. Consequently, over 50% have the perception "*that a lot or quite a lot of people would be willing to recycle more*" (ibid: 7). In fact, recycling is the most common environmentally friendly behaviour according to the survey — closely followed by avoiding wasting food. A majority of people would even favour a waste

system that rewarded them if they recycled everything they could and penalised them if they did not (ibid: 18). Thus, motivation and environmental action are important for waste management and strongly influence the progression of the entire waste system; but this is never independent from the institutional path waste policy and implementation is taking. This is probably most obvious concerning the capability of consumers to draw on infrastructures to deliver 'their bit' and it is also present as political support for policies to end unsustainable patterns and structures.

This refers to the need to understand society in a broader context that allows study of potential latent conflicts or antagonistic as well as consensual views. In regard to sustainable waste management individuals have a dual position: on the one hand they are addressed as proactive consumers who should undertake efforts in avoiding, sorting and recycling waste; and on the other hand they have to be addressed as competent citizens who have a democratic right to participation. In fact, civil society is all about the discursive appreciation and settlement of conflicts as they arise (Habermas 1999). The integration of civil society should be even more welcomed on questions of developing new socio-technical systems, which rely on social input in order to function properly.

The methodological approach chosen in this project reflects this participatory demand from civil society. Participation programmes can inform key decision-making at the national level by

- identifying and prioritising key issues
- considering objectives, and
- identifying options and alternatives (Brady & Fuller 2002).

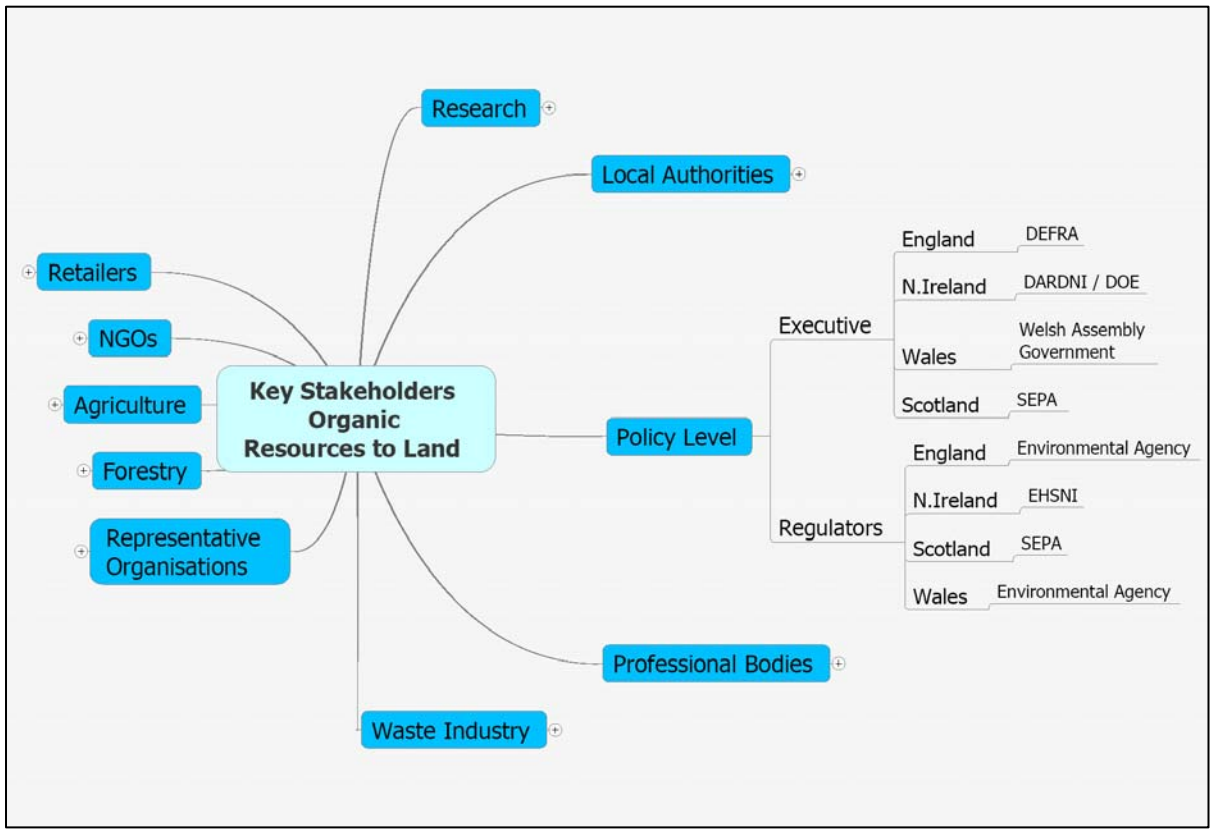
Looking at discourses and facilitating them permits a deeper understanding of attitudes and beliefs than would be gained by representative surveys alone. It may reveal relations between different stakeholder groups that could not be detected otherwise and it can thus qualify initial survey findings. It should provide deeper insights into the motivations and reasons for individuals or organisations to act in a given way than a quantitative study alone.

4 Attitudes to use of organic waste resources on land

This issue is the primary focus of this research project and needs to be explored in the context of understanding the processes, drivers and constraints for different stakeholders involved in the use of organic waste-derived resources on land. The literature concerned with the attitudes of these stakeholders including policy and position statements and attitudinal research was reviewed and supplemented with scoping interviews with a selected range of key stakeholders to identify what they perceived to be the main issues at stake. A more detailed mapping of these views is provided in a separate interim report to Defra.

The range of people and organisations involved in, and potentially affected by, the use of organic waste materials on land is extensive, covering those who produce the wastes, process it into organic waste derived resources, apply it to land, purchase and/or consume products or services from that land, and those who regulate these activities. The research will explore the attitudes of these stakeholders and at an early stage in this project several stakeholders, representing the sectors illustrated in Figure 6, have been approached and asked for interviews. These were considered as key stakeholders possessing enough knowledge to provide the team with intimate understanding of the issues at stake.

Figure 6: Key stakeholder groups



When moving further away from the functional context with its immediate legal and economic drivers to the social context with its plurality of actors it is helpful to consider

who might be in a comprehensive list of key stakeholders. Actors or stakeholders involved in spreading organic wastes to land include:

- **Regulators** who are entrusted by society to ensure that recycling is safe and environmentally acceptable and who are responsible for keeping regulation in line with other existing legislation and EU directives.
- **Enforcing agencies** responsible for implementing the regulations
- **Consumers and companies** that produce waste. They have to dispose of it according to the legal requirements, and the services available to them, guided by cost and convenience.
- **Companies** that provide facilities and services to recycle or recover a product from waste. They have to ensure that their operations are carried out within the given regulations and with economic considerations.
- **Farmers and foresters** who look for an agricultural benefit usually within a given economic structure of dis- and incentives. They also have to consider customer requirements and diverse environmental and health regulations.
- **Landowners** who have an interest in maintaining the value of their land. They can influence the application of organic waste to their land via the lease contract.
- **Insurance companies** that may offer in the future insurances against damages resulting from the application of organic waste to land.
- **Local government** has a complementary role to the enforcing agency in some respects. They have to deal with nuisance caused by odour and traffic, and have a role in waste management.
- **Non-governmental organisations** that represent civil society and that may or may not draw on attitudes held by the wider population.
- **Food and drink processors/manufacturers** that operate within a very competitive market highly sensitive to customer demands.
- **Retailers/supermarkets** that operate in a highly competitive food market. They rely on effective signalling to consumers who in turn can easily change brands or products.
- **Media** which can play an influential role in forming and shaping attitudes. Besides mass media there are also expert newspapers that spread specific knowledge on this subject e.g. farming journals.
- **The public** who consume food or other products grown on land to which organic waste-derived resources have been applied, generate organic waste or who are affected by the use of organic waste to land in other ways.

4.1 Perceptions of organic waste to land

Although there are numerous scientific publications on compost, sewage sludge etc, there are few publications dealing with social issues. Nevertheless, there is some indication that a scientific and public discussion is about to start: people working in the field are taking up the social issues around the application of organic waste to land. For example, the Sustainable Organic Resources Partnership (SORP) held a conference in Manchester (18.4.2007) on the topic of 'Recycling Organic Resources to Land: Ensuring Sustainable Solution'. The topics of the presentations included issues like: 'Public Acceptability of Specific Forms of Using Organic Waste in Agriculture' and 'Technology Developments and the Evolving Strategy of the Environment Agency

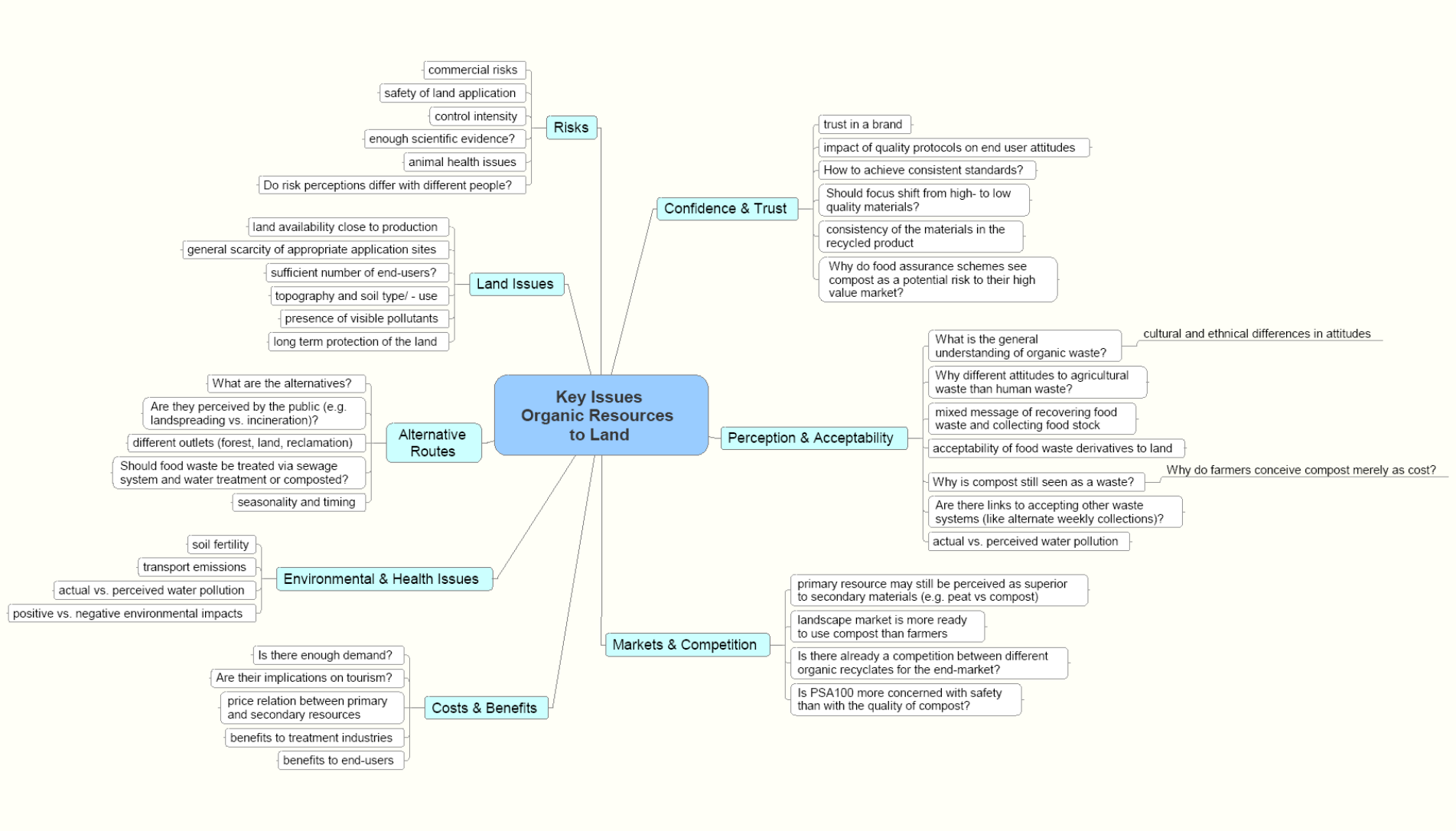
towards Recycling Organic Waste to Land'. Another conference 'Benefits of Composting to Agriculture' held recently by SORP (25/10/2007) focused on the issues of using compost in agriculture. Other relevant seminars include one held by The Composting Association with the Chartered Institute of Waste Management (CIWM) on 'Anaerobic digestion: working together to spread best practice' (28/09/2007), and another run by the CIWM and The Open University on MBT issues 'The Bankability of Biostabilisation' (17/04/2007). Both featured papers on the issues of the use of organic materials applied to land and mentioned the acceptance issues. Furthermore the 'Waste: a Global Resource' conference organised by the Chartered Institute of Waste Management and held in Paignton (12-15/06/2007), touched upon this topic though rather marginally. Presentations dealt with household food waste,. the social drivers and barriers of wasteful behaviour and with issues of the use of organic resources on land. Further, last year's Waste 2006-conference in Warwickshire (19-21/09/2006) had several papers on social aspects around composting, MBT etc., which were related to the topic in some way. Finally, there have been many conferences and events that have discussed attitudes towards sustainable waste behaviours such as recycling and waste minimisation.

The stakeholders' key issues map demonstrates the importance of confidence and trust for the stakeholders of the project advisory panel (see Figure 7). Questions of concern include: What sources and types of regulation and controls are needed? Do protocols and standards provide sufficient stakeholder support concerning food grown on this agricultural land? Questions like these have also been addressed throughout the telephone interviews. They open up a whole set of different technical and social options. While all stakeholders see and agree on the significance of taking health and environmental issues seriously — both being perceived as the most important threat to confidence and trust — they may still prefer distinct socio-technical options. Accordingly, their framings differ: whereas end-users of organic-waste derived resources have especially stressed concerns about traceability, retailers have expressed worries about the potential impact on brands.

In addition to the views of the project's Advisory Panel and the initial interviews, this literature review has also attempted to find and draw together as much written evidence as possible in order to collect and understand the diverse perceptions of stakeholders. Although the statements, position papers, reports etc. may display different degrees of knowledge in relation to the topic of organic waste to land they still add to a comprehensive overview.

Greenpeace, for instance, has not yet developed a particular position on organic waste although the 'Cool Waste Management' report (Greenpeace Environmental Trust 2003a) reads as a plea for mechanical-biological waste treatment, which "*is a safer and cleaner alternative to burning rubbish in polluting incinerators or burying it in landfill sites*" (Greenpeace 2003b: 1). This, however, is only one report and may not reflect the organisation's overall position on the matter.

Figure 7: Key issues map – initial findings from the scoping study



Friends of the Earth have pushed a claim for separate collections for recycling in their briefing 'Biowaste – A guide for local campaigners' (Friends of the Earth 2005), where it takes the view "*that household biowaste MUST be source-separated to ensure that the input and the output are clean. This applies whether the waste is destined for composting, recycling, anaerobic digestion or another technology*" (ibid: 8). In addition they comment: "*Friends of the Earth supports the use of anaerobic digestion as an option for dealing with source-separated biodegradable waste*" (ibid: 7) while they do not support mass-burn incineration for any waste and opposes the burning of biowaste or refuse-derived fuel in cement kilns and power stations. The position is backed by their conclusion about the environmental benefits of digestion over composting and the poor pollution and abatement technologies of these burning facilities. The briefing also points to the obligation of local authorities to assess options and to involve the public (Friends of the Earth 2007).

The group Surfers Against Sewage (SAS) has provided a detailed report, called 'A Green Blue-Print For Sewage Sludge Disposal' (Surfers against Sewage Sludge 2004), which carefully discusses the different application options and sustainable sludge reuse in agriculture. Interestingly, the report also contains a brief survey (n = 384), which indicates that about 2/3 of the people questioned would eat crops fertilised with treated sludge if it had been applied in accordance with all the legislation and guidelines.

A more comprehensive view has been developed by the Green Alliance (Hislop 2007). It urges policymakers not to tackle nutrients as individual substances conflicting with the standards for soil, water and air but aiming instead at cycling through the economy as an overall gain in resource efficiency. According to the Green Alliance such a policy framework would have to follow five principles:

"1. The use of nutrients already in the economy would take priority over the manufacturer and import of additional nutrients.

2. Nutrients would be transferred between the players in the nutrient cycle – the produces and users of nutrients – because of their value; regulations governing nutrition concentrations or prescribing nutrient back management practices would be secondary.

3. Soils (cultivated or otherwise) would be explicitly recognized as part of a national nutrition resource bank.

4. Innovations which aided the recycling and reuse of nutrients and/or the maintenance of the nutrient resource bank would be encouraged and could be supported using measures which discouraged further additions to the nutrition cycle and in excess of demand.

5. Information on nutrient stores and transfers (involving air, soil or water) would be used to establish, at national level, the size of our nutrition surplus and the options for limiting its growth."

(Lloyd 2007: 6)

As concrete measures, Green Alliance calls firstly for a certification-use scheme, akin to the safe sludge matrix, that would build up trust between the food industry and land managers. Secondly, they call for policy measures, which diminish phosphate in relation to nitrates (e.g. a levy on phosphates derived from non-dietary (detergent or industrial) sources or a ban on some products containing phosphates (ibid).

However, a survey undertaken at Cranfield University by Merlin-Jones Ager (2003), which studied key stakeholders of biosolids application (including water companies,

NFU, sludge spreading contractors, food and drink producers, food retailers, BRC, government and regulators, academic and commercial researchers, medical profession landscaping and horticultural industry) suggests that the chain management is hierarchical — but from the bottom up as down-stream operators do not have to accept any risk if they don't want to. The problem is left to the water companies since the food producers and processors are not obliged to apply sludge. Enhanced treatment as a voluntary measure may thus become a reasonable marketing instrument to sell biosolids to farmers. In addition Merlin-Jones' study suggests that there might be market for thermally dried pellets of biosolids that could be sold to gardeners.

The same study also looked at the public perception of biosolids. It concluded that "*while a significant proportion of people do not like the idea of sewage sludge in agriculture, there are also large numbers who support it and are happy to eat the produce grown on it. The poor negative perception could form a significant part of the retail market and supermarkets may be right to be concerned about customer backlash to learning how their food is grown*"(ibid. 66). The acceptance of biosolids tends only to increase with education and experience (e.g. specialists and scientists trust in the safety of biosolids). Besides this study, there is no other UK study except for the aforementioned, non-representative 'A Green Blue-Print for Sewage Sludge Disposal' report.

However, the application of sewage sludge particularly in agriculture has gained some attention and it is the only organic waste, which could in this regard serve as a historical model for other organic waste derived resources. The UK Water industry is aware of this and has started thinking about addressing the public via the internet and is engaging with local communities (Water UK 2006b). The importance of the local communities has also been observed in a study carried out for WRc on behalf of a consortium of water companies (according to Water UK 2006)[7]. The public is said to be largely unaware of sewage treatment processes and not yet ready to recognise that sewage sludge has to go somewhere. Low nuisance (odour) is more acceptable to people who grow up in the country and indeed the attitudes of rural communities will be decisive for how much organic waste might be applied to land in the future. The study addresses another interesting subject, namely the possibility of considering the public as a stakeholder responsible for not tipping toxic substances down the sink. Putting the public in the role of waste producer and as responsible for 'clean' waste streams would be even more important for composting, which would require active efforts of consumers.

Given the fact of this historical archetype, it is illuminating to have a look at other countries' experiences. In the USA, with an estimated 49% (+/- 6%) of all sewage sludges put to land in 2004 (BioCycle May 2007: 47), the Water Environment Federation (WERF) has sponsored a comprehensive study called "*Public perception of biosolids recycling: developing public participation and earning trust*" (Beecher et al. 2004).

The key findings of these studies show that the public is supportive of the use of biosolids when it offers clear benefits such as creating reusable energy or recycling. Concerns are amplified when biosolids include industrial wastes or when they are

[7] This study has not been available to the authors.

generated in large cities but unease is softened when biosolids are supervised locally or if people knew about the recycling program beforehand. People were also found to distrust any biosolids that were applied with a profit motive (ibid.).

In France an extensive sociological study seems to indicate the importance of the local level as well. This research has been carried out in order to understand the social reaction to sewage sludges (d'Arcimoles & Borraz 2003). The authors argued that France has developed a particular 'practice of locality', which has, on the one hand originated from the strong political standing of the French farming lobby, and on the other from a loss in confidence in the public administration's ability to manage the spread of sewage sludge properly. Given the centralist tradition of the French state, the local public-private agreements that have arisen do indicate quite well the potential difficulties of applying organic waste to land. A multitude of actors with diverse attitudes and interests have to be successfully coordinated in order to increase the use of biodegradable material in agriculture, forestry and reclamation. However, in the UK with its long tradition of local administration (Peele 2004) local authorities have greater experience and influence in administering waste policy.

In respect to application, farmers' attitudes are very important since they ultimately decide about using organic resources or not. Surveys on attitudes of farmers on biosolids to land in the UK do not however exist in any meaningful sense. This interim report has therefore looked at the available Farm Practices Surveys (published by DEFRA annually since 2004) to provide some relevant information. Only 3% of all farms do apply sewage sludge or biosolids (dried sewage pellets/cake), 1% uses paper sludge and less than 1% utilise either waste from food and drinking processors, residuals from abattoirs or other organic material including Gypsum, steel works slag, limex 70 mushroom compost or green compost, bio-EMA programme. In total not more than 3% of the farmers imported waste materials (DEFRA 2001: 66). It is also important to consider that "*the most popular manner of formulating a nutrient management plan is through the Entry Level Scheme (40% of holdings). The most common ways for calculating fertiliser requirements are by using farm experience and seeking the advice of a professional (65% to 67% depending on fertiliser type and 58% to 61% respectively of those using fertiliser)*" (DEFRA 2007a). Although this analysis only includes farmers who spread manure but do not assess nutrients it gives some indication of how farmers perceive organic fertilizers.

These results correspond well with an earlier survey (McArthur 1995) on farmer's perception of agricultural pollution (emanating from slurry, silage liquor, manure etc.). McArthur found that farmers mostly rely on information directly provided by statutory organizations. These disseminate technical advice and explanations of legislative changes and, somewhat surprisingly, have a very much higher influence on behaviour than farmers unions or farm consultants. This high standing of the administrative informational path is reinforced by statutory instruments such as the cross compliance scheme. Besides the public bodies, farmers rely strongly on agricultural journals for information whereas the general press/media is of minor importance (ibid). These general findings on the dissemination of knowledge may hold for other organic waste materials as well.

Still, quotes like: "*I feel that pollution is not just a matter for farmers — but where farms do try to cut down on artificial fertilizers and replace it with manure just as many*

complaints are made by the local community — it would seem that we just can't win." (McArthur 1995: 204) can be read as an ad hoc support of this hypothesis. On the other hand, organic wastes do hold opportunities for farmers not only in the application of waste-derived products but also in the bioprocessing of these wastes, namely through digestion and composting. To seize these, however, farming business will rely on an accommodating framework that will lay to a large extend outside waste policy and touches, for instance, upon energy policy.

Only one pilot survey has emerged on the use of compost. This was carried out by the Soil Association for the Agricultural Supply Company (2007). It questioned farmers on their current use of compost and their willingness to increase these amounts. Although this survey is not representative it does highlight the importance for farmers of guaranteed quality of compost. Worries about the safety of products potentially brought to land were expressed and the belief that the farm's own organic manure or slurry provides a more reliable and less costly alternative

4.2 Social research

In order to make sense of the plurality of perspectives on this issue it is helpful to draw on the social scientific literature to provide insight through related issues as it was noted earlier that this literature does not deal directly with the specific research question raised in this review. However, building on social scientific research even in analogy provides a context on the grounds of generalised social knowledge. In the absence of previous studies this will allow the framing of stakeholder statements in a more balanced way. To this purpose this review has drawn on insights gained from risk sociology, sustainable consumption and recycling attitudes and behaviour. Finally, it considers a media study that addresses the application of an organic waste resource to land, namely biosolids. While the impact of mass media on public perception may seem interesting in its own way it will be argued that the emerging patterns in conflicts about waste application can be important for any future policy on organic waste resources whether or not the policy is contested.

4.2.1 Risk studies

The high sensitivity for risks associated with waste to land makes risk assessment more than an academic issue in relation to attitudes to the use of organic waste resources on land. Risk is an issue that was highlighted by the Advisory Panel members as well as by those stakeholders interviewed so far in the research.

Studies in risk analysis have often endeavoured to communicate risks to a wider audience. Often implicitly, the communication is thought to be unidirectional, which implies a hierarchical notion of risk with experts possessing objective knowledge of risks and unknowing laypeople that have to be educated. This presents an expert-lay discrepancy in the perception of risks, which sometimes is also referred to as the 'knowledge gap' or 'cognitive deficits model.' Whereas lay people are said to judge risks according to uninformed, subjective perceptions experts are seen as drawing on well-informed objective knowledge gained and validated with the help of scientific methods.

One area where perceptions of risk can be considered relevant to this study is that of food related risks which can provide useful insights into how the risks associated with

the use of organic waste resources in agriculture may be perceived. Many studies of food related risks adopt a psychometric approach, which has been developed in cognitive psychology. The approach presumes a cognitive deficit between experts and lay persons and asks for the variations between different hazards in the lay-audience. It is considered to be the dominant paradigm in risk perception study (Hansen et al. 2003). The approach tries to adopt the complexity of issues involved by suggesting that lay-people perceive risks multi-dimensionally. Sparks and Shepherd (1994) found that 87 % of the variance in perceived risks connected with various food hazards could be explained by three factors alone: the perceived severity of the risk, concern about unknown risks or the extent to which risks may be unknown, and the number of people exposed.

Sparks and Shepherd (1994) concluded that the relationship between general and specific hazards is indeed complex and that the relationship depends by and large on how hazards are represented or described. Part of this complexity can be elaborated further by distinguishing between risk management and risk issue management (Leiss 2003). Risk management relies on scientific risk assessment to estimate the probable harm to persons and environments resulting from activities. Risk issue management is quite distinct from this. "*The most important difference is that risk issues, as they play out in society at large, are not primarily driven by the state of scientific risk assessments. Rather, such assessments are just one of a series of contested domains within the issue. Risk issues are configured by the competing attempts of the various stakeholder interests to define or control the course of social action with respect to health and environmental hazards*" (ibid: 359). Whereas risk management aims to assess and control a risk domain, risk issue management responds to a risk controversy. For quite some time agencies and their experts have focused on risk characterisation whereas above all risk issue management seems to be needed. On the other hand risk issue management is governed by strategic considerations of organisations or individuals who are all involved in these risk negotiations mixing factual and ethical claims. This interplay of interests defies any optimal solution and "*competence in risk issue management should not be understood as seeking to control the outcome*" (ibid: 360).

This is even truer in the face of modern, functionally differentiated societies where different parts of society follow different codes. Companies follow the rules of the market whereas administrative agencies those of legislation and adjudication. These particular foci for different organisations make it difficult to initiate discourses across the systems' borders since the actors keep referring to their specific rationale. Still, there is frequent dialogue between administration and business (e.g. through consultation or lobbying) but there are fewer dialogues between experts and lay people representing civil society (for instance in stakeholder conferences). In this situation mass media becomes quite important since it is the key space for society's self-reflection. However, this form of reflexivity can differ in quality.

A study, which took up the particular problem of mass communication, was carried out by Tucker, Whaley and Sharp (2006) who analysed 'Consumer perceptions of food related risks'. The authors note that the majority of people in 19 of 34 countries feel that their food is less safe than it was 10 years ago. Given that consumers at the counter will be the final judges of food products and processes they asked what people actually perceived as risks and which factors influenced this perception. In order to spell out the

expert-lay-discrepancy hypothesis in a more complex way the authors took in media dependency theory according to which lay people use media rather selectively in order to satisfy their individual preferences.

In the case of food safety and similar sensitive issues, media coverage tends to focus on potential problems and picks up controversies related to personal experience such as human health. Intensive media coverage of food safety issues could, according to the authors, escalate into food scares, particularly when unexpected health dangers become apparent. Coverage of food safety issues tends to cluster around such crisis situations. Given these known effects Tucker et al. expected that increased dependency on mass media could be associated with higher sensitivities towards food safety risk.

However their findings speak a different language: The respondents generally expressed moderate levels of perceived risks for all food safety issues addressed. However the highest levels of perceived risks were from pesticide residues in food and contamination of drinking water, which were related to agricultural production. The authors find this apparent lack of discrimination for very different food risks puzzling and admit the limited value of their theoretical model. Nevertheless, they suggest "*more formal working relationships between communicators and food safety specialist to prepare newsworthy mass media stories and publications that will attract readership without creating undue public concerns*" (ibid: 143).

This educational approach is not without contradictions: "*It is important to note that food safety programs are often justified on the basis that they educate and empower audiences by providing useful information to help avert risks. Under these circumstances, it would be expected that increased reliance on mass media for food safety information would result in lower levels of perceived risks. The findings that increased reliance on food safety information tends to result in higher levels of perceived risks raises some question as to the effectiveness of current communication programs*" (ibid: 144).

This puzzling finding is quite typical for expert-lay-discrepancy approaches. Such attitudes can be found, for instance, in the food industry's magazines (Beckeman & Skjoldebrand 2007) or agricultural journals. However it is unclear, as some authors have argued whether lay people's knowledge is really in deficit or whether people may just have other concerns than those asked by science (Tesh 1999). In fact, people may be able to raise questions science is not capable to address (Peters 2000). Although analysts of risk communication have widened their perspective and are increasingly acknowledging the concerns of laypeople there is a strong case for arguing for a genuinely dialogic process.

This need becomes even more obvious when considering how society is continuously relying on scientific-knowledge. Scientific knowledge is indispensable for understanding potential risks and benefits of new technologies. People can not judge the complex effects by direct personal experience and, thus, rely on information about innovations. This has resulted in a twofold development: on the one hand science has become political leading to the 'politicisation of the natural sciences' and on the other this has caused the 'scientification of politics' (Weingart 1983) by more problem-oriented research under conditions of uncertainty (Nowotny et al. 2001).

In debates about genetically modified food people have expressed considerable disapproval of food industry and regulators even though they were well aware that their

consumption patterns constituted a part of the problem (Grove-White et al. 1997). This touches upon another topic that has motivated risk communication research: trust. On first sight trust seems to be a valuable concept that allows complexity to be reduced by limiting the number of variables to be studied. Studies may just simply ask how much confidence people have in an organisation. This direct approach may be altered by systematically looking at the co-variations of trust with perceptions of risks (or other social or economic variables). However, it can be argued that such approaches fail to understand trust in a very basic sense.

If a distinction between 'tacit' and 'reflexive trust' is made, the difficulties of studying trust empirically become very obvious (Slovic 1999). People who are unaware of the trust they put into something or someone can hardly elucidate the relevant aspects of their tacit trust. In trying to do so trust becomes reflexive and it may then be questioned by others' arguments or justified against others' claims. Sjöberg (2001) has argued that people who express concern about technological risks do so less because they distrust scientists but because they are sceptical about the completeness of the information scientists provide. People generally perceive experts as sincere and knowledgeable but are more concerned about the limits of a particular knowledge base and unknown risks (NRC 2002). In this regard one should also bare in mind that modernity is said to have fundamentally questioned the ontological security of society (Giddens 1990) and that we find ourselves in a risk society (Beck 1992). This raises the questions whether different risks could be traded against others in order to regain a sense of safety.

4.2.2 Sustainable consumption

How these risk sensitivities might influence consumption and the adoption of sustainable behaviours and hence attitudes to the use of organic waste on land are significant issues for this research.

Obviously there is an immediate link to food and the mid 1990s food safety crises around BSE gave environmental and ethical issues more visibility. In the aftermath retailers started to understand the crisis as an opportunity to promote organic and fair-traded food, which had until then been marketed almost exclusively by small niche stores. Supermarkets started to sell organic and fair-trade products alongside health-oriented products and low-pesticide fruit on a large scale and for the first time mass markets became the target for organic food. Today the market for organic and ethical food is fast growing and highly competitive. The emerging mass market is facing the challenge of matching the signalling to the consumer of distinct labels and individual brands with the benefits of socially and environmentally benign food production. Yet, "*efforts to harmonise signals created by these attributes are obstructed by problems of organisation and collective action*" (Codron et al. 2006: 284).

Codron et al. (2006) argue that the organisational and collective problems arise from a divergence between the logic of consumer perceptions and the action taken by the producers. They criticise the state of the scientific debate, which has not addressed this issue since market research studies exclusively analyse perceptions and consumer behaviour (cf. also Sjöberg/ Engelberg 2005) while the formation of signals (by suppliers) with the related coordination issues is exclusively studied by political economists. Research needs to study the interaction of consumer perception formation of environmental and social attributes and its relationship to supplier signalling with labels, certificates and brands.

Codron et al. see two waves of ethical values impacting on the food market: a radical one in the 1970's and a reformist in the 1990's. The first was initiated by local NGOs, small growers, cooperatives and small specialized retailers to focus on niche markets and brought about two larger radical movements (organic and fair-trade). The reformist wave of the late nineties also saw two reformist movements (integrated-agriculture and ethical trade) that wanted to modify conventional agriculture. All four movements were competing through the proliferation of labels, associations and lobbies. They employed different signalling strategies. Although there has been some convergence between some of these movements today's situation is characterized by a growing divergence that is being brought about by the different social and political strategies.

While the two radical movements have been highly successful in establishing European and international standards their recent market success has, paradoxically, started to threaten their organisational basis. While some groups within the two movements opt for staying outside the mass market to prevent the weakening of their labels and standards others fully embrace the newly, Government-supported standards since they see the opportunity to increase the market share of organics (for Germany cf. Brand 2006). One the other hand the two reformist movements have not succeeded in setting up widely recognized standards.

The integrated-agriculture movement is still trying to build organisational structures, which has proved difficult given the heterogeneous economic interests involved. And given this heterogeneity it comes as no surprise that it has not yet provided any guidelines for signalling a specific product quality to the consumer. 'Communication' mainly takes place via brands. Furthermore, the creation of specific new standards for integrated agriculture is not endorsed by governments, which has also been true for the ethical-trade standards. There are no ethical trade labels at EU-level yet. At times the cooperation between trade companies to achieve collective guidelines is undermined by internal, private guidelines. In fact, these internal systems prevail although they're not considered credible by the NGOs. This in turn is why some NGOs have attempted to get involved with ISO standard-setting although with little success so far. In summary then, even organisational success may not result in higher signalling power while low signalling power may just increase divergence.

Consumers appear in general to be less concerned about environmental and ethical issues then about price and quality. They are also often confused by the different signals and do not clearly distinguish between certified products and non-certified ones. This brings up the question whether consumers who buy organic or integrated agricultural products share values with those consumers who buy fair-trade products. The authors claim that the later hold universal values only, whereas consumers of environmental products have rather mixed values (including universal and self-centred values). But according to one study (Sylvander 2000) there are important differences amongst European countries on this issue.

In this context, some would argue that assurance schemes could be understood as attempts to overcome some of these uncertainties in the food market. However, against the background of socially contested risk issue management consumer behaviour seems hardly predictable in the way it was prior to the food crisis of the 90s. In addition, there is not always a direct causal relationship between a certain policy measures and consumers' response. Ortwin Renn speaks of 'complexity' and 'ambiguity'. Complexity

refers to the many interfering factors between cause and effect, which can reinforce or weaken this relationship. Ambiguity "*means that one and the same identical behaviour or statement will be assessed entirely differently by different groups*" (Renn 2006: 835). Ambiguity is supported by the very logic of the market that allows the easy substitution of one good against another. Everybody can be an instant vegetarian if meat is said to pose a health risk. Yet, as shown above there are also lasting long-term changes in consumption. Consumers adopt more sustainable consumption patterns and behaviours as numerous studies have shown. Research on sustainable consumption thus provides some context for understanding public attitudes towards the use of organic waste resources on land. It provides a framework for this study for considering lasting changes in cognition and behaviours motivated by environmental concerns.

Concerns around sustainability and sustainable consumption and production have increasingly focused on sustainable consumption behaviour and how to promote behavioural change. Tim Jackson's report to the Sustainable Development Research Network (Jackson 2004) providing the most comprehensive review of the literature on consumer behaviour and behavioural change. Jackson summarises the difficulties and complexity associated with inducing pro-environmental behavioural change, and highlights need for policy to come to grips with (and to influence) the social and institutional context of consumer action, as well as attempting to affect individual behaviours (and behavioural antecedents) directly. He commented that far from being able to exercise deliberative choice about what to consume and what not to consume, for much of the time people find themselves 'locked in' to unsustainable consumption patterns through economic and institutional constraints, as well as a mixture of habits, routines, social norms and expectations and dominant cultural values.

Policies to encourage pro-environmental behaviour have tended in the past to favour interventions through either the provision of information to change attitudes and hence behaviour, by influencing the private economic costs and benefits associated with individual behaviours, or by providing facilities to make the behaviour easier or more accessible.

Recognising that encouraging pro-environmental behaviours, including waste minimisation, requires more than the provision of the means to act – i.e. both information to encourage rational choice of reasoned actions and the infrastructure to remove barriers (both physical and economic) to make these actions easier. Although an important precursor to behavioural change, recent understanding of consumer behaviour through social-psychological models has emphasised the need to account for the broad social and cultural context on attitudes and motivations – moral, social, symbolic and affective components of consumer behaviour, including the role of social norms and the importance of habit. Successful behaviour change initiatives need to overcome problems of consumer lock-in, deconstruct old habits and form new ones. They also need to understand the complexity of the social logic in which individual behaviours are embedded before negotiating new social norms.

Key opportunities for those thinking about behavioural change that were highlighted by Jackson included recognising the importance of social norms in behaviour change policies; by initiating, promoting and supporting community-led initiatives for social change; by supporting the community management of social resources; and by designing effective community-based social marketing strategies (McKenzie-Mohr

2000a, 2000b). Approaches might include social learning, participatory problem-solving and the discursive unfreezing of embedded, routine behaviours. The model of discursive social change not only offers the advantage of tackling entrenched routine and habitual behaviours; it also presents a way of overcoming the 'lock-in' associated with descriptive social norms and it draws support from other conceptual viewpoints such as social learning theory.

4.2.3 Research on attitudes and waste recycling behaviour

In waste management there has long been recognition of the vital importance in actively engaging the public in participating in recycling schemes, and more recently in waste minimisation and other sustainable behaviours. Early research on pro-environmental attitudes and behaviours, and in particular concerning recycling, focused on examining differences in participation, and attempted to identify those more likely to participate, what influenced their behaviour, what role attitudes and motivation played, as well as examining extrinsic factors such as barriers to participation, and the role of information, publicity and education programs.

There is extensive literature in this field which spans academic research, public policy analyses, and also encompasses a wealth of recorded experience within public opinion surveys, and from environmental and community groups, local authorities and the waste management industry This literature has been the focus of several detailed and comprehensive reviews including Tucker and Douglas (2006), and Darnton (2004). Some of this research has sought understanding in psychological theories of behaviour, whereas other work has been more empirically based on market research and public attitudes surveys, seeking to identify links between attitudes and behaviour. Some studies have focused on the understanding of recycling and environmental issues, where others have tried to build up a profile of the recycler and non-recycler to relate behaviour to demographic variables; attitudes to and understanding of recycling and environmental issues; the influence of education and publicity materials; and the effect of design factors of the recycling schemes available.

Recyclers were generally found to be more aware of publicity and more knowledgeable about recycling, with non-recyclers more concerned about incentives to recycle and convenience. However recyclers and non-recyclers were similar in their pro-recycling attitudes, but non-recyclers needed more guidance on how to participate. Negative influences (e.g. the amount of work and effort required to recycle, lack of storage space, inconvenience and distance to recycling facilities) were more often found to act as constraints and barriers to non-recyclers. In general attitudinal research shows a commonality that people consider recycling a 'good thing' to do, express a desire to participate, but do not always act accordingly; that many have 'time and space constraints', feel their actions would have little effect, or just that they don't have convenient facilities (MORI, 2002; SEERA, 2003; Thomas, 2004 and Waste Watch, 1998).

It has been pointed out that campaigns for recycling as well as sustainable consumption in general may have problems due to their AIDA logic. These campaigns have tried to raise people's ***A****wareness*, to provide them with ***I****nformation* and bring them to ***D****ecide* and to take ***A****ction*. However, they have often suffered from a lack of success although people claim to support the aims expressed in such campaigns. In studies in waste

policy this has commonly been termed the value-action gap and it has gained substantial attention.

There is convergence in waste policy research in the UK towards studying behaviour from the bottom up. As a consequence, most studies are carried out on individualistic premises, though they regard preferences as endogenous to the model. Most studies draw on means-end-chain-theory, such as the Theory of Reasoned Action (Ajzen & Fishbein 1980) or the Theory of Planned Behaviour (Ajzen 1991), and they usually do not presume that values are self-interested or that rationality must be related to optimization. Thus, they depart from economic models of individual behaviour. The Theory of Planned Behaviour has become prominent in academic discussion about recycling performance in the UK. It developed out of the Theory of Reasoned Action, which can be summarised as: people hold certain *beliefs about outcomes*. They also *evaluate these outcomes*. Both lead to an *attitude* towards the behaviour, which is one of two main influences on people's intention to act in the given way. This *intention* is also formed by a second influence: a person's *subjective norm*, which is constructed by the person's belief about how other people who are important to her or him regard a specific behaviour. This is different from a *personal norm* that expresses what an individual believes about the morality of the given behaviour. In this regard, subjective norms comprise some sort of social reflexivity. However, the role of habits, affective, or moral factors is not well covered by the model. And in many cases studies are limited by what they discover through questionnaire surveys and/or interviews. Thus, a narrow definition of the context can determine the entire outcome of the study.

The Theory of Planned Behaviour extends this idea to adjust to situations in which actions are not under full volitional control. It conceptualizes social behaviour as an outcome of two main influences: the *intention to act*, which is again shaped by the *attitude towards the behaviour* and the *subjective norm* and the *perceived behavioural control* (over the action in question). Thus, intentions result from both subjective norms and attitudes towards the intended behaviour. However, perceived behavioural control is quite dominant in this model. Holding intention constant, the success in actually carrying out that intention depends on the strength of the belief or the ability to carry out that behaviour. Ajzen (1991) even goes as far as to claim that perceived behavioural control can be taken as an indicator of actual behaviour control. This seems to point to the stronger notion of self-efficacy. The theory has been applied in 154 different contexts according to a recent study (Armitage & Conner 2001).

Drawing together the literature from psychology and environmental psychology in particular Stewart Barr (Barr 2006; Barr & Gilg 2006) has developed another model especially for the context of recycling which builds on the Theory of Planned Behaviour. He has identified (environmental) values, situational variables and psychological variables as determents of individual behaviour immediately related to recycling. Also Peter Tucker and others have applied somewhat similar conceptual approaches in his work (Tucker et al. 2003; Tucker 2003; Taylor & Todd 1997; Tonglet, Phillips & Bates 2004; Tonglet, Phillips & Read 2004).

Within the category of *environmental values,* especially open-minded and altruistic individuals, who are more likely to take action, have been identified as important. Also individuals who hold the belief that the environment has intrinsic value take more often environmental action. Regarding the eco-centric or techno-centric attitude of people

studies indicate that people who are working with nature to find solutions for environmental problems are more pro-environment than people who develop merely technical solutions.

The *situational variables* relate to an individual's situation at a given time. Here, structural factors, socio-demographics, knowledge and prior behavioural experiences influence individuals in their daily routines. Regarding waste, factors like convenience of the service provision, understanding of the collection scheme on site, social status and education etc., have all been reported to influence recycling behaviour.

Finally, *psychological variables* can be distinguished according to moral obligations to act, intrinsic motivation, subjective norms, environmental threat, response efficacy, self-efficacy and logistical factors and, finally, rights and responsibilities. What do these different factors mean? The altruistic attitudes, for instance, lead individuals to resolve problems when they have the opportunity to do so. If people can draw an intrinsic motivation from, say, recycling they are more likely to begin and maintain this action. Environmental threat provides a strong extrinsic motivation to act pro-environmental because individuals start to believe in the immediate necessity to overcome this environmental state. Closely related to this observation is the concept of response efficacy that reflects how individuals believe that they can make a difference to the state of environment. Subjective norms influence behaviour as well. Barr refers to Tucker's finding that recycling behaviour is influenced by the behaviour of neighbours. Aspects, such as time availability, storage space and convenience are referred to as logistical factors and they affect consumers' routines as well. According to Barr , apart from this, rights and responsibilities related to environmental citizenship define the political status of actors,.

Obviously, the three key variables, further refined by specific sets of sub variables, are not easily separated not even at the analytical level. In addition, in practice these variables do interfere. Still, together they point to a positive attitude towards environmental protection, which has been confirmed in many surveys.

Given the generally positive attitude towards recycling it begs the question of why participation in waste recycling is often low. Barr claims "*research has been lacking that examines these factors in relation to the fundamental assumptions [...] that a stated intention to be pro-environment is matched by behavioural commitment*" (Barr 2006: 45). In some sense this problem definition could be understood as a verification of psychological theory given the detailed variables. However, this is not what the concept is after even though Barr conceives this value-action gap as *the* dominant phenomenon in regard to environmental behaviour (ibid.).

Apart from their focus on the value-action gap all three approaches share the conviction that the behavioural complexity can be studied through quantitative methods of data generation. Accordingly, the data and the hypotheses are subjected to reliability analysis suggesting providing not only accurate data on the influences on human behaviour but also meaningful hypotheses. These may give insight into the motives of people for acting contrary to their environmental attitudes. This approach argues, "*that existing theoretical constructions of attitudes and behaviour can provide the basis for understanding and affecting behavioural change through targeting policies which address specific attitudes and values within defined social groups*" (Barr & Gilg 2006: 908).

However, this aspiration seems too keen in regard to policy. First of all, most studies explain only about one-third of the observed variances in recycling behaviour. Studies explaining up to 79% of the variances (Barr 2004) are still rather exceptions. There is a notable dissatisfaction amongst the authors of these studies about these results. Secondly, Davies, Foxall and Pallister (2002) have pointed out that the virtually infinite number of causal variables defining context in these approaches face the problem to find the right ones. Qualitative research may be of some help here.

Finally, all variables, key and sub variables alike, can interact in the course of policy implementation. This may result in unintended effects even in policies that share a large public support according to surveys. However, without a discourse resonating in society all individual statements become less self-binding. This is especially crucial when policy measures rely on direct cooperation with consumers and on long-term backing from voters.

4.2.4 Media Research

Earlier in this study reference has been made to the public or civil society as both raising concerns and recipients of responsibility. It has been noted that calling upon the public in this context will be a difficult and complex task that must consider the role of the mass media, because mass media strongly influences public perception. Yet, the public is notoriously difficult to grasp and the impact of the media probably impossible to assess quantitatively. However, there are discernable structures that have been studied.

A prominent example of this is the social amplification of risk framework (SARF) worked out for the US-context but also applied to the UK (Petts et al. 2001). SARF was developed by risk researchers to study media's role in risk communication. Within this framework media are conceived as transmitters of information potentially amplifying 'events' by pronouncing certain aspects of a message. Media communicate messages by drawing on symbols and images that are easy to understand by the audience. Focussing on the tensions between scientific risk assessments and diverging public priorities for risk management, SARF has been a valuable research heuristic for studying risk societies (Kaperson et al. 2003). On its own right, however, the unmodified SARF-approach would frame the research question of this project too tightly. However, it is helpful to approach media's influence on public perception.

A very informative study on the media presentation of biosolids was carried out by Goodman and Goodman (2006) in the U.S. They analysed how newspapers frame the issue of biosolids by studying articles in newspapers from Florida, Virginia and California from 1994 to 2004. The authors noted a lack of public acceptance although tremendous efforts had been undertaken to convey scientific data and information. They refer to research from the National Academy of Science that found no documented scientific evidence for failing public health protection (1996, 2002). Still, the later of the two reports went on to demand additional scientific research to reduce persistent uncertainty about the potential for adverse human health effects. Referring to the study of Beecher et al. (2004), Goodman and Goodman see a contradiction in increasing public involvement if participation is resulting in increased public scepticism.

They developed an analytical framework to study media content, which allowed analysis of the coverage of environmental, scientific and health issues. The authors

chose these three topics because these were seen as representing the 'hotbeds' of public debate. Using factor analysis to group content, they found that 75% of all stories fell into two frames: the legal/ regulatory debate and the management/ public perception/ public nuisance frame. Journalists structure biosolids predominantly as a legal/regulatory issue or explore the effects on the public. The most frequently used source was local government officials. The research team also observed that bad press is often caused by local 'whistleblowers' with a particular point of view on the issues.

This seems to indicate two almost separated discourses on organic waste to land: a mass media discourse mostly concerned with perceived dangers of organic waste to land (bad news is good news) and an (agricultural and waste business) expert discourse that can be located in agricultural journals, statutory advice agencies and consultants disseminating information on the application of organic waste to land.

In their concluding discussion Goodman and Goodman give some advice on a pro biosolids public relation strategy. Firstly, they note that the environmental research frame is much less important than assumed for instance by the US water industry. Secondly, they suggest training local officials especially since they are most often approached as the main source by journalists reporting on biosolids. Thirdly, since most cases and conflicts of biosolid use are local issues they can be best dealt with at the local level. Since waste systems rely on both technical infrastructure and motivated users, there is a place for public relations in disseminating information. Embedded public relation efforts can be successful in supporting waste management, but this "*is dependent to a great extent upon its surroundings, e.g., the attitudes and habits of, as well as the access to, the target group*" (Salhofer & Isaac 2002: 75). Standardised public relation efforts may not work especially if they are perceived as strategically employed. 'Embedded' public relation would instead refer to accessible institutions and systems and open dialogues.

Regarding the transferability of Goodman and Goodman's results to the UK context, the differences in the newspaper press profile need to be considered. The UK has a strong national daily newspaper sector unlike the US. The national press in the UK is divided into three market segments: broadsheet, mid-market, and tabloid. The segments differ recognisably in reporting style and in composition of the readership. Also different from the US, is the major role in most people's TV viewing that the two national free-to-air channels still play, despite the inroads made by cable and satellite services (Petts et al. 2001). One may therefore infer that the strong local focus of press coverage on biosolids in the US would be less in the UK, although this may be mediated by the commonly available free local newspapers. These factors certainly impact on the dissemination of information to some degree, although as to how far these hypotheses are correct is beyond the scope of this project and specific media research would be needed to confirm it.

Related to this is the difference between a monologue and a discourse. Whereas the former is unidirectional (and might be used for spreading information), the later is dialogic (and may include arguing about future developments). Mass media are characterised by a one-way flow of information to the audience and thus by a unidirectional or 'push' monologue. Participatory (risk) assessments differ from this in that they are open to everybody (affected or concerned) and they are dialogic by nature. Webler, Rakel, Renn and Johnson (1995) applied this method to moderate proposed

applications of sewage sludge. Such dialogic processes may at times be frustrating since the (positive) facts seem all too clear for the experts (Tomassone 2002) and the (negative) scepticism or the ethical claims of the population unjustified, but in order to have any meaning the process must be open in respect to the outcome or else it is not dialogic. Still, the question is where (on which level of hierarchy) and how (using what dialogic procedure) to carry out participatory (risk) assessments (cf. for the USA Fiorino 1990). There is also a need to assure the possibility of framing of the issue beyond risk assessment.

5 Comments and conclusions

This review began by setting the context with the question 'what organic waste-derived resources are used on land?' It has described the full range of organic wastes and briefly the main waste treatment processes in producing bioprocessed materials which are or can be applied to land in the UK. It is clear from this data that untreated agricultural manure and slurries are by far the largest group of waste materials currently used on land, followed by bioprocessed compost and sewage sludge. However the organic wastes with the most potential for expanding their recycling for land application are those from municipal or household and commercial and industrial sources. Currently there is in the region of 10 million tonnes of municipal, commercial and industrial organic wastes disposed of annually in the UK that could potentially (if segregated and processed) produce resources suitable for land application.

The EU landfill directive and subsequent regulation in the UK have been identified as the key drivers for diverting biodegradable waste from landfill. To deliver their challenging targets will mean a shift from landfill to other methods of treatment and recycling. The choice of options will very much depend on costs associated with available technologies, regulatory standards and evolving organic recyclates markets, which in turn will depend — for some options possible more than for others — on attitudes towards applying these materials to land.

The picture is thus broader than just economics and the drivers and constraints set by the waste market and regulation. Attitudes of stakeholders will influence the use of organic waste resources on land, but these drivers and constraints will also play an important role in shaping the context in which the attitudes and behaviours of many stakeholders develop. On the other hand attitudes can develop quite independently from the regulatory and economic context of waste policy. Attitudes — or sometimes assumed attitudes — impact on the actions of different stakeholders in their social interactions.

In exploring the literature in relation to attitudes to organic wastes to land, one immediate and expected conclusion is the lack of a coherent literature base to frame the research project. Little of the vast literature found in this area was of direct relevance and this was true for both the academic literature and areas of 'grey' literature such as policy documents, briefings and reports. As a consequence, it was necessary to draw on a broader spectrum of related scientific research areas which offered insights into understanding what might be the key issues of concern. Understanding how attitudes to risk, to other environmental issues, to sustainable consumption and behaviours, as well as to how media is used to influence attitudes can help frame an exploration of attitudes and perceptions in this field. This review has considered relevant literature in each of these areas to inform the project and to underpin a methodological framework for the analysis of stakeholder attitudes emerging from the quantitative survey and qualitative research.

The lack and incoherence of the available academic literature, however, was not a surprise and was, consequently, anticipated in the project methodology. In the initial scoping of the research field this exploration of the literature was supplemented with telephone interviews and a stakeholder meeting. Both were important since they

revealed attitudes held by some *key* stakeholders while highlighting at the same time policy-relevant issues. This was supplemented by further policy documents and briefings published by the different stakeholders. However this empirical literature base must also be considered as incomplete at this stage and no systematic discourse analysis has yet been possible; and this will be explored further. Nevertheless, taking all the information together, the scoping study has identified some key issues of applying organic waste to land and these will be addressed in taking forward the quantitative and qualitative research.

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Appendix 1: Literature sources

The literature survey has drawn mainly on the following databases:

- Scopus,
- Agricola (USA National Agricultural Library)
- Academic Search Premier, and
- ENVIROnetBASE.

All databases were interrogated with the keywords:

- organic waste,
- sewage sludges,
- biosolids
- compost,
- attitudes,
- (public) perception,
- risk communication.

In addition more journals have been searched for articles related to the social scientific research question. These were: *Waste Management*, *Waste Management and Research* and *Journal of Material Cycles and Waste Management* resulting, however, in no hits. The results have been condensed with regard to the research question of WR 0510.

Besides the literature search by means of databases the review has used sources provided from our own library and others provided by the projects expert advisors. We have also asked the Advisory Panel of WR 0510 to provide information on grey literature, e.g. publications from NGOs, consultant agencies, and public bodies. This has been extended by scanning the internet for additional publications.