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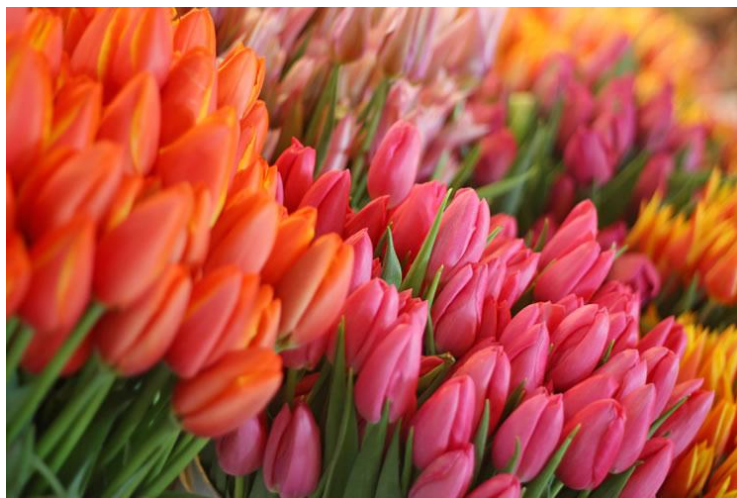
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*Cut flower waste management*

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*Centre for Environmental Policy*

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*January 2015*



## **Executive Summary**

The UK is bound by the EC Landfill Directive (99/31/EC) which sets mandatory targets for the reduction of biodegradable municipal waste (BMW) sent to landfill. Additionally the Government has established national targets for the recovery of municipal waste and recycling / composting of household waste. Thus it is evident that waste management has started gaining public attention and the subsequent questions that arise include but are not limited to increasing scrutiny on where waste is coming from and what can be done both from a bottom up (consumer level) and top down (government level) approach. Thus this offers an opportunity as well as a challenge on the way biodegradable waste is managed. Waste produced through floriculture is an essential part of today's waste production in the UK and could be used as a potential resource and therefore needs effective management and planning to account for this. Cut flowers as a sub-sector of floriculture are showing increasing consumption patterns but information on what is happening to cut-flower waste is rather limited.

The horticultural sector in the UK occupies only 4% of the agricultural land area, but the high intensity of production implies that their environmental impact is likely to be disproportionate to the area of land under cultivation. Moreover given that the UK's level of cut flower consumption ranks so highly worldwide, far higher than the level of flowers it produces; it makes sense to link domestic demand with supply in a sustainable manner. Environmental damage from this industry is inevitable and is driven by consumption of its outputs, and decorative products including fresh cut flowers. To examine the current waste management practices, a combination of desk research and empirical research methods, such as semi-structured interviews and personal communication with professionals working in the floriculture sector, were conducted simultaneously. This allowed the collection of large datasets for analysis. London was used as the case study of this research being the capital of the UK where the greatest production of cut flower waste occurs.

From the seven wholesalers' interviewed, two were selling plants, two were selling flowers and the rest were selling both flowers and plants. In the total of wholesalers' interviewed, only one out of six stated that the remaining cut flower waste from its business is disposed in the residual waste bin, one (who is also a grower) stated that any remaining waste goes back to the farm for composting, whereas the rest stated that any cut flower and plant waste generated is managed by the New Covent Garden Flower Market (NCGM) authorities, representing 14%, 14% and 72% of the sample, respectively. All wholesalers however claimed that cut flower waste generated is generally very low.

This is because during the closure of the market the prices of the flowers tend to drop a lot leading to an increase in the sales, and hence the lessening of remaining, unsold flowers.

Overall it is evident that waste management of cut flowers is an area worth investing on and which has a lot of room for development. Especially when taking into account the current legislation as the EC Landfill Directive (99/31/EC) which seeks to avoid waste generation and to use waste as a resource, to help move the EU closer to a "recycling society". Diverting cut flower waste from landfill will have positive impacts both in terms of carbon emissions being released into the atmosphere and also financial benefits for the people involved in the cut flower sector. As for growers they will have the direct benefit that if they can use the product that would be generated for instance by composting cut flower waste, which they could then reuse for further production. Also the following parts of the flower supply chain would be benefited through lower prices in the end product they would buy as costs would be internalised at the production level. In any case if a scheme incorporating recycling, composting or waste-to-energy technologies is to be established, this must be market-orientated and there must be markets for the by- products and energy produced.

Based on the research conducted and the information gathered, the following recommendation can be made:

- Further research in the type of waste produced needs to be performed in order to understand the exact management options that need to be implemented.
- Collaboration between all members of the cut flower chain is essential in order to understand the market conditions better and find ways to cooperate with regards to waste management of cut flowers.
- There is a need for national coordination of these activities for national targets outlined in the Landfill Directive to be met. Initiatives such as the *Code of Practice for the Management of Agricultural and Horticultural Waste*, which is currently voluntary should actively encourage 'best practice' in the disposal of waste from plant produce and become mandatory for all.
- Further opportunities for waste management should be explored for instance the potential of recovering energy from cut-flower waste.

## Contents

Executive Summary.....	iii
1. Introduction .....	1
2. Aim and Objectives .....	2
3. UK Cut flower and floriculture industry.....	3
3.1. Introduction .....	3
3.2. UK's cut flower industry supply chain.....	5
3.3. Market consumption and purchasing patterns .....	10
3.4. Maintenance of quality along the supply chain.....	11
3.4.1. Quality assessment .....	11
3.4.2. Factors affecting cut flower quality .....	12
3.4.3. Quality maintenance practices .....	13
3.5. Waste Management Context.....	14
4. Waste management practices of cut flowers .....	16
4.1. Introduction .....	16
4.2. Current waste management practices in the cut flower and plant industry.....	17
4.2.1. Survey.....	18
4.2.2. Personal Communication.....	18
4.2.3. Participants selection.....	18
4.2.4. Results and analysis of data collected on cut flower waste management.....	19
4.3. Limitations of the research .....	24
4.4. Changing the landscape in cut flower and plant waste management .....	25
5. Conclusions and Recommendations.....	28

6. References .....	30
Appendix 1 .....	33
A1.1. Survey questionnaire conducted for the purposes of the study .....	33
A1.2. Personal communication questionnaire conducted for the purposes of the study.....	39
Appendix 2 .....	40
A2.1 Factors that affect the quality of cut flowers .....	40

## List of Figures

Figure 3-1 The main channels for fresh cut flower distribution (CBI, 2011, Drabble 2012).....	7
Figure 3-2 UK's supply chain .....	8
Figure 3-3 UK's five main channels of distribution .....	9
Figure 4-1 Number of respondents per sector .....	22
Figure 4-2Wholesalers' cut flower waste management.....	23
Figure 4-3 Retailers' cut flower waste management.....	24



## List of Tables

Table 3-1 Leading DC supplier of fresh cut flowers and foliage to the EU27, in 2012 (Eurostat Comext; calculations LEI).....	4
Table 3-2 International flower markets size and per capita expenditure based on data of 2002 (TIPS and AusAID, 2006).....	5
Table 3-3 The length of time cut flowers spend at each stage of distribution (days) (Nibber, 2013)..	10
Table 4-1 Matrix of data collected from empirical research on cut flower waste management in the UK.....	19

## 1. Introduction

The UK is bound by the EC Landfill Directive (99/31/EC) which sets mandatory targets for the reduction of biodegradable municipal waste (BMW) sent to landfill<sup>1</sup>. Additionally the Government has established national targets for the recovery of municipal waste and recycling / composting of household waste<sup>2</sup>. Thus it is evident that waste management has started gaining public attention and the subsequent questions that arise include but are not limited to increasing scrutiny on where waste is coming from and what can be done both from a bottom up (consumer level) and top down (government level) approach. Thus this offers an opportunity as well as a challenge on the way biodegradable waste is managed. Waste produced through floriculture is an essential part of today's waste production in the UK that could be used as a potential resource and therefore needs effective management and planning to account for this. Cut flowers as a sub-sector of floriculture are showing increasing consumption patterns but information on cut-flower waste management is rather limited. Therefore, this project principally addresses the issue of cut flowers and their waste given the fact that the world production and consumption of cut flowers has seen an unparalleled growth over the last years.

Cut flowers are widely used for decorative purposes including vase arrangements and bouquets within domestic settings and at events such as weddings and funerals. They are popular as gifts on special occasions and holidays throughout the year (Vringer and Blok, 2000). Cut flowers include the blooms or inflorescences and foliage. Due to their limited life they are highly delicate (Bonarriva, 2003). They can be fresh, dried or preserved.

The question that arises when looking at the high consumption of fresh cut flowers is their fate after their short lifetime. Being organic in nature, it could be assumed that their management is based on processes that aim to recover the calorific value of this waste and use it either for energy or for compost generation. However, the picture of cut flower waste management is unclear and emerging waste management regulations with regards to biodegradable waste diversion from landfill necessitates further research to examine the fate of this waste and assess the impacts of its management.

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<sup>1</sup> i.e. that the amount of BMW sent to landfill in 2020 is reduced to 35% of 1995 levels i.e. 10.2 m tonnes

<sup>2</sup> In this context 'Recover' means to obtain value from waste through recycling, composting, other forms of material recovery, and recovery of energy.

## **2. Aim and Objectives**

In light of the amount of cut flower waste produced in the UK and emerging waste management regulations, there is a clear need to investigate current practices of waste management in the cut flower sector.

The project will deliver the following objectives:

- Understand the amount of cut flower waste produced in the UK;
- Review current cut-flower waste management practices in the UK and report on alternative potential systems and waste management options;
- Identify opportunities and make recommendations for sustainable management of cut flower waste.

### **3. UK Cut flower and floriculture industry**

#### **3.1. Introduction**

Fresh cut flowers can only maintain their short life by taking up water through their stems. Dried and preserved flowers are cut, bunched and then dehydrated in mechanical dryers or in the sun, or are preserved chemically by placing them in a glycerine solution for 3 to 7 days. This chemical preservation is based on the property of glycerine to replace the water in the flowers yielding a product that is soft and flexible for years. The glycerine-preserved flowers are then placed in industrial dryers at temperatures between 15 and 25° Celsius to remove any remaining humidity that may affect the final product. Dyes can also be applied to the flowers to make them more vivid, as they naturally turn into a brown colour when the tissues degrade. The dyed flowers are further dried out for a period of 3 to 4 days before they are packed for sale.

Cut flowers are sold as single flowers, mono-bunches, in mixed bouquets, or in compositions, whereas mono-bunches are bunches of a single type of flower and mixed bouquets are bunches of different flower varieties, often combined with foliage (Rikken, 2010). Dried and preserved flowers fall into the market segment that includes also dried and preserved foliage and other plant materials such as pods, sticks, stalks, weeds and other that will not be discussed herein.

Global consumption of cut flowers is estimated at £24 billion per year with Europe and North America being the leading markets (Rikken, 2010). In the EU the fresh cut flower market growth has slowed down since the beginning of the economic crisis in 2008, but even so the imported value of cut flowers and foliage grew by 7.5% between 2008 and 2012 (CBI, 2013). Despite the recession, cut flowers continue to be a common purchase for consumers as they are used for a myriad of practices and as symbols of cultural significance (Nibber, 2011). The cut flower supply to the EU originates primarily from developing countries (DC) with Kenya being the largest of all the suppliers (CBI, 2013) (Table 3-1).

**Table 3-1 Leading DC supplier of fresh cut flowers and foliage to the EU27, in 2012 (Eurostat Comext; calculations LEI)**

	Euro x million, 2012	Share in Extra-EU imports, 2012	Annual growth, 08-12
<b>Kenya</b>	366	32%	1%
<b>Ecuador</b>	150	13%	4%
<b>Ethiopia</b>	140	12%	20%
<b>Colombia</b>	114	10%	-1%
<b>Costa Rica</b>	45	4%	-5%
<b>Uganda</b>	26	2%	1%
<b>Other DC supplies</b>	305	27%	-4%

Nonetheless, the Netherlands play a key role in the production and distribution of cut flowers in Europe by being the biggest European producer and supplier with 60% of all imports in Europe entering via the Netherlands. Other cut flower producing countries in Europe are Germany, Italy, France, the UK, Spain and Poland. However, countries like the UK and Germany have seen a decline in their production over the past years (DG Agri 2011; CBI, 2009). Despite this observation, Germany and the UK are the biggest cut flower import markets in the EU. An indication of the expenditure in the flower market in the EU is given in Table 3-2.

**Table 3-2 International flower markets size and per capita expenditure based on data of 2002 (TIPS and AusAID, 2006)**

International flower markets							
The EU				Other selected countries			
Country	US\$-million	Pop (million)	US\$ per capita	Country	US\$-million	Pop (million)	US\$ per capita
Germany*	3,278.49	81.3	40.3	US	5,253.96	276.0	19.0
UK	2,195.79	60.5	36.3	Japan	3,362.13	127.0	26.5
France	1,743.35	59.7	29.2	Switzerland	549.05	7.4	74.2
Italy	1,600.80	56.5	28.3	Norway	235.87	4.5	52.4
The Netherlands	761.44	16.2	46.9	China	925.07	1,306.0	0.7
Spain*	823.34	40.8	20.2				
Belgium	389.58	10.2	38.1				
Austria*	373.47	8.0	46.7				
Sweden	272.70	9.1	30.1				
Poland*	289.65	39.0	7.4				
Denmark	193.90	5.3	36.3				
Greece	162.03	10.8	15.1				
Finland	156.72	5.2	30.1				
Portugal	144.32	10.2	14.2				
Hungary*	133.69	9.7	13.8				
Ireland	108.90	3.8	28.3				
Czech Republic*	102.92	10.8	9.5				
Slovenia*	53.05	2.0	26.5				
Slovakia*	96.55	10.1	9.5				
	<b>12,880.70</b>	<b>449.3</b>	<b>28.7</b>				

As shown in Table 3-2 the three leading markets in Europe in terms of expenditure are Germany, the UK and France, whereas in the rest of the world it is US and Japan. In terms of consumption value per capita the leading markets of the world are Switzerland, Norway, the Netherlands, Austria and Germany.

### **3.2. UK's cut flower industry supply chain**

The UK is one of the two leading markets of cut flowers imports in the world (CBI, 2013). All cut flowers and plants are imported from the Netherlands, Colombia, Ecuador, Kenya and Israel, with the Netherlands accounting for approximately 75% of all UK cut flowers imports (IBIS World, 2014). After the Netherlands, according to data from 2007, the major sources of cut flowers in the UK are Colombia, Israel and Kenya, which are currently the most established producers of cut flowers exporting in Europe. However, it must be highlighted that the Netherlands imports many of the

flowers that it then exports to other countries and as such the figures on cut flowers origin are sometimes misleading (War on Want, 2007). Other developing countries including Ethiopia, Malaysia, China, Zambia and Tanzania have started to gain a dominant place in the cut flower market, principally due to the quality of the flowers produced and the advantage of lower prices due to a reduced labour cost compared to developed countries. Due to the lower prices, the demand for cut flowers has increased leading to the promotion of the expansion of their flower export sectors.

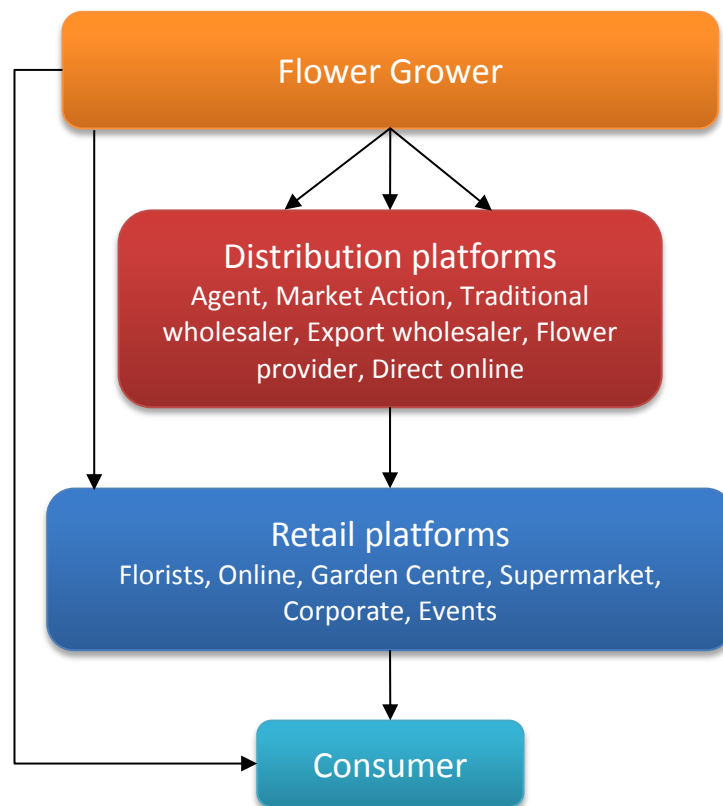
In the UK production of cut flowers has dropped dramatically over the last few years and it currently accounts for 10% of the local market, a decrease from 20% in 2000 and 45% in 1990. Currently there are over 30 growers producing cut flowers for local markets, florists and retailers across the UK (Department of Agriculture and Rural Development, 2014). On the contrary, consumption patterns in cut flowers are projected to continue to rise at a rapid rate, with global consumption predicted to be 30% greater by 2014 (Defra, 2007). Most consumers make their purchases at either a florist shop or supermarket, with supermarkets and discount chains gaining importance due to price and convenience. In addition, online purchases have started gaining importance lately (Bonarriva, 2003).

It is calculated that from 600 tonnes of cut flowers imported in the UK each week amounting to 31.2 thousand tonnes per year, and an additional 3.47 thousand tonnes produced in the UK, **the total amount of cut flowers consumed comes to 34.67 thousand tonnes per year.**

The UK's position as a world leader of cut flower consumption is an important one, especially considering the consequences of the waste generated after the end-of-life of fresh cut flowers as well as the amount of money spent on a product with such a limited lifespan. Supermarkets have included in their sustainability policies transportation and other logistics related to cut flower and plant supply chains (Defra, 2007).

The flower and plant industry in the UK currently consists of 593 businesses employing 12,072 people (IBIS World, 2014). There are many ways that a flower may reach the consumer from the grower, through direct sales at the farm level, to a chain involving up to 4 intermediaries (Figure 3-1). In the UK the cut flower commodity chain can be considered as an increasingly buyer-driven chain (Xia et al., 2009). As far as the structure of the market is concerned the retail trade through which cut flowers are sold in the UK used to consist of traditional florists until the early to mid-1990s (Hughes, 2000). The commercialisation of flowers in ready-made mixed bouquets for sale in

supermarkets and other retail outlets offers further opportunities for economic benefits (Defra, 2007).



**Figure 3-1 The main channels for fresh cut flower distribution (CBI, 2011, Drabble 2012)**

Rising retail flower prices as well as increasing demand for locally sourced flowers and plants led to the industry's 5.2% annual growth between 2010 and 2015 (IBIS World, 2014). The general structure of the cut flower supply chain as already mentioned involves many intermediaries from the source until it reaches the end consumer. These include the importers, wholesalers, pack houses, retailers which are florists in their majority and supermarkets. The roles of these players in the UK cut flower industry are as follows (Nibber, 2013):

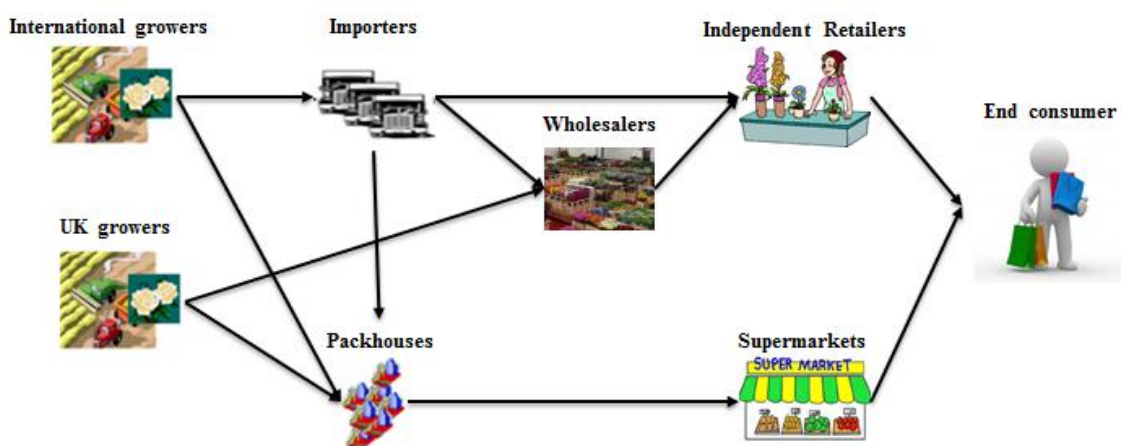
- **Importers:** import cut flowers and plants and distribute in bulk
- **Wholesalers:** Sell cut flowers and plants in bulk
- **Pack houses:** rearrange and repack for distribution to the supermarkets
- **Independent retailers:** specialised cut flower retail outlets that stock a wide variety of cut flowers to suit consumers' specific needs.
- **Supermarkets and other big chain retailers:** non-specialised cut flower retail outlets that stock cut flowers alongside a wide range of other products.



Importers purchase cut flowers in bulk from international growers and are responsible for the shipping of cut flowers into the UK. Cut flowers are imported via ship or plane depending on the origin of the cut flowers. Importers serve only wholesalers and pack houses because it is more economically viable for them to distribute in bulk. Wholesalers buy their cut flowers in bulk either from UK growers or importers, as due to high costs it is not economically viable for them to import the cut flowers directly (Nibber, 2013). While wholesalers sell their products to independent retailers of varying sizes, pack houses' role is to only serve supermarkets across the UK. Pack houses are responsible for the arrangement and packaging of cut flowers based on each supermarket's specifications and to ensure that cut flower arrangements meet the strict health and safety guidelines that supermarkets have in place (Nibber, 2013).

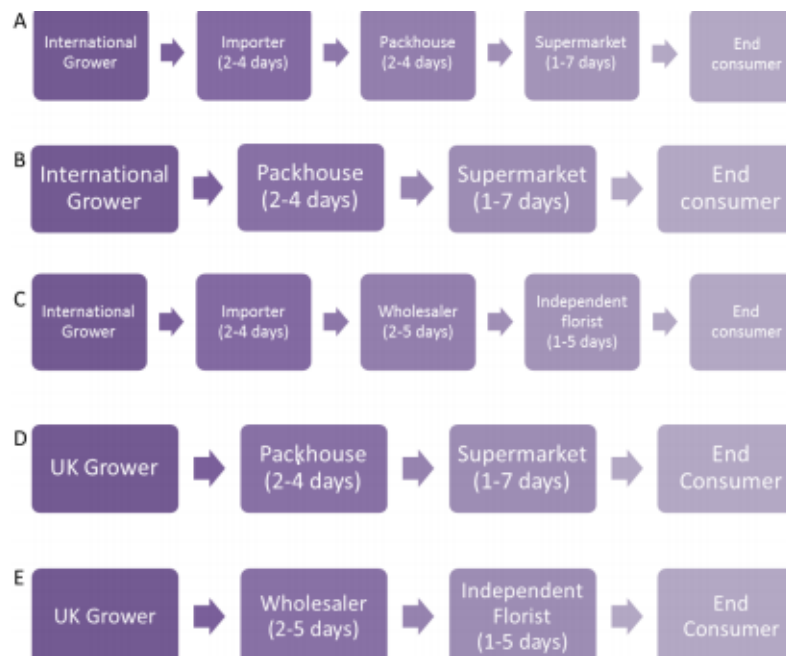
The structure of the UK cut flower supply chain was analysed and constructed by Nibber in 2013 based on secondary data collection. More specifically, Nibber (2013) conducted an online survey that was sent out to a sample of 12 importers, 21 wholesalers, 8 pack houses, 150 florists and 6 supermarkets across the UK, to cover all levels of the supply chain. The response rate acquired from the online survey was around 40% corresponding to a sample of 58 respondents from the various levels of the supply chain.

The findings of Nibber's study (2013) were validated by industry experts from each stage of the distribution chain that provided their feedback on the legitimacy of these structures. The feedback given was aggregated and re-occurring themes/comments were incorporated into the distribution chain structure.



**Figure 3-2 UK's supply chain**

Figure 3-2 is a depiction of the UK's cut flower supply chain, derived from the literature, whereas Figure 3-3 presents the five main distribution channels identified in Nibber's study (Nibber, 2013). It must be emphasized that each channel has a different timescale owing to the linkages that it involves.



**Figure 3-3 UK's five main channels of distribution**

As shown in Figure 3-2, the long distribution channels indicate the sourcing of cut flowers from international growers. Also, in this figure it is possible to notice the period of time that cut flowers spend in each step of the distribution chain. These time periods are estimated from the time cut flowers reach each stage of the supply chain to the time it leaves the particular stage and moves to the next. These time periods can be divided into five key stages of the supply chain. These key stages and the time that cut flowers spend in each as identified by Nibber (2013) are presented in Table 3-3.

**Table 3-3 The length of time cut flowers spend at each stage of distribution (days) (Nibber, 2013)**

Linkage	Length of time spent at each stage (days)
Importer	2-5
Pack house	2-4
Wholesaler	2-5
Florist	1-5
Supermarket	1-7

It can be suggested from the above table (Table 3-3) that the average time cut flowers spend from the importer to the end consumer is between 3 and 15 days. Cut flowers purchased from florists may spend anywhere between 4-12 days in transit and/or storage before reaching the end consumer. This time can be vital in terms of preserving cut flowers freshness, and can be an important factor of cut flower waste arisings in the various steps of the supply chain.

### **3.3. Market consumption and purchasing patterns**

In the UK production of cut flower has dropped dramatically over the last years and it currently accounts for 10% of the local market, showing a decrease from 20% in 2000 and 45% in 1990. Currently there are over 30 growers producing cut flowers for local markets, florists and retailers across the UK (Department of Agriculture and Rural Development, 2014). Consumption of cut flower however has increased notably with a 250% increase observed in the cut flower and plant industry over the last 20 years (DG Agri 2011; War on Want, 2007). This industry is worth £2.2 billion per year and only 10% of this industry is for flowers produced in the UK (Drabble 2012; CBI, 2007). This figure represents an average expenditure on cut flowers and plants per person per year of £36 (£28 on flowers and £8 on plants), a 350% increase from the 1984 value of £8 per person (Flowers and Plant Association, 2009).

In the UK, the majority of cut flowers purchased come from supermarkets, which currently hold the highest proportion of cut flower sales in Europe (War on Want, 2007). An indication of the scale of this market share is that in 2011 supermarkets' cut flower sales contributed to 62% of the total UK cut flower sales (Flowers and Plants Association, 2011). More recently, it was reported that 90% of

the UK flower sales are through the six major supermarkets namely, Asda, Morrisons, Marks & Spencer (M&S), Sainsbury's, Tesco and Waitrose (Honeysett, 2012; CBI, 2013), contributing to an increase in their sales to over 30% per year (Scott et al., 2007). Their popularity for cut flower purchases, have driven supermarkets in establishing direct relationships with producers in East Africa and Colombia in order to gain direct and quick access to the supply of large quantities of cut flowers. Supermarkets such as M&S and Tesco import flowers from Colombia, while Sainsbury's, Tesco and Waitrose import cut flowers from Kenya. However, it must be noted that there is currently no supermarket with a dominant market share in the sector (IBIS World, 2014).

Although, most cut flowers consumed in the UK originate from abroad, recently there has been a turn towards more locally produced flowers. In fact, M&S, has committed to increase its purchases from British growers and there are plans to introduce more informative labelling of the flowers' origin in order to promote local produce (Plasmeijer and Yanai, 2009). In either case consumption continues to increase, and as such, cut flowers represent a component of modern people's embodied environmental impact.

### **3.4. Maintenance of quality along the supply chain**

#### **3.4.1. Quality assessment**

Physical and physiological properties are the most important intrinsic product attributes to cut flower quality assessments, followed by the origin of cut flowers as well as their variety. Amongst the reported signs of quality drop are discolouration, wilting and shrivelling, weak/bent stem, pest/disease presence and abscission. Yellowing of leaves and other organs of the flowers is a complex process that can be caused by many environmental factors, however, most often is associated with the end of life of cut flowers (especially for some particular species like alstroemeria and lilies). Wilting and shrivelling is a result of inadequate watering of the cut flowers or obstruction of water supply due to cut stems. Weak/bent stems are a common sign of quality loss and reduced life-time. Abscission is also a sign of poor quality and is a problem often associated with presence of ethylene in the air or other environmental factors (Reid, 2009; Nibber, 2013).

In the study of Nibber (2013), it was reported that wilting and shrivelling of cut flowers was a sign of quality loss amongst all steps of the supply chain. Discolouration was also reported especially during the period when cut flowers spend in the supermarket. Nevertheless, supermarkets were not the

only ones who reported discolouration as a sign of low quality, as wholesalers have also indicated discolouration to be of greatest importance to cut flower quality assessment relative to the other signs of quality loss including weak/bent stem and wilting/shrivelling. This indicates that an important amount of cut flower may not be fit for sale and hence, be disposed at an early stage of the supply chain.

Packhouses reported that weak/bent stem was the most popular sign of quality loss, whereas importers suggested that pest/disease presence and wilting/shrivelling were the two most popular signs of quality loss observed during the cut flower quality assessments. Weak/bent stem can be associated with improper handling and inappropriate storage of cut flowers and thus, maintenance practices should be more strictly implemented.

Florists reported the greatest variance regarding the signs of quality loss. More specifically, four signs of quality loss were reported by the majority of florists which based on their occurrence are ranked into wilting/shrivelling, pest/disease presence, abscission and weak/bent stem.

Nevertheless, the difference in the reported quality assessment of cut flowers might be a reflection of the different functional roles and their position in the supply chain that impacts opinion and assessment in different ways (Nibber, 2013). Florists, who are at the far end of the supply chain, serving the consumers directly, have higher expectations on the cut flower quality, and thus their opinion differs widely from that of importers and wholesalers. Importers and wholesalers are more relaxed when it comes to the assessment of the various quality criteria. In the case of supermarkets although they also serve the end consumer directly, they have less stringent quality criteria in place compared to florists. This is because supermarkets do not rely much on the sales of cut flowers for making profit, while also packhouses are responsible to assure the quality of cut flowers arriving at their shops alleviating the responsibility from them. However, quality criteria between the two ends also differ as supermarkets view discolouration and wilting/shrivelling to be of higher importance than weak/bent stems and wilting/shrivelling that is considered by packhouses to be the most important criteria.

### **3.4.2. Factors affecting cut flower quality**

Maintaining quality in cut flowers is important for preventing their rapid deterioration and thus, the loss of their freshness and quality. This is important as it extends the lifetime of cut flowers and limits their wastage at the various stages of the supply chain. The factors that affect the quality of cut flowers are many and varied. These include:

- flower maturity
- temperature
- food supply
- light
- water and water quality
- bacterial plugging
- ethylene
- pests/disease

Further details on the way that each of these factors affects the quality of cut flowers can be found in Appendix 2. What is important to highlight here is that the cut flowers are fragile products and appropriate quality measures have to be practiced at all stages of the supply chain in order to assure the quality of the end product.

### **3.4.3. Quality maintenance practices**

Growers, importers and wholesalers who are the main cut flower providers are required to implement optimum post-harvest handling practices, but florists also have maintenance practices in place for ensuring the freshness of their products.

The most important practice of maintaining the quality of harvested flowers is temperature control. Most cut flowers should be held at 0-2°C, whereas species like anthurium, bird-of-paradise, some orchids and ginger should be held at 10°C (Reid, 2009; Nibber, 2013). To ensure that packed flowers during transportation and distribution are adequately cooled and dry, it is important to pack them in a cool, dry room. However, it is important for refrigeration systems to be carefully designed and sized for forced-air cooling. Food source and water supply are amongst perhaps the second most important techniques for boosting the freshness, and hence quality of cut flowers and making them look more attractive.

Nibber (2013) highlighted that temperature was the only variable that was considered important by all groups of participants surveyed during his study. Furthermore, it was reported that temperature was not always properly controlled during storage, handling and transportation of cut flowers. Nevertheless, stringent temperature control measures were an important quality maintenance practice for the majority of florists and wholesalers. With regards to food source, florists were reported to practice cut flower feeding during storage, transportation and handling, whereas

wholesalers and importers were reported to be responsible for providing their customers with a food source and practice feeding only during the storage of cut flowers.

Water supply as a quality maintenance practice was implemented primarily by florists and wholesalers in order to preserve the quality and freshness of their products for longer, especially during storage and transportation. These two groups were also reported to monitor the quality of the water to ensure that this is not going to affect the quality of their products. Supermarkets were also reported to handle their cut flowers with water during storage and transport. Nevertheless, none of the importers or packhouses was reported to provide cut flowers with water at any point of the handling and processing.

Sanitation activities and disinfection of storage containers was reported to be practiced by all groups of participants indicating the importance that chemicals may have on the quality of cut flowers.

### **3.5. Waste Management Context**

The EC Landfill Directive (99/31/EC) is seeking to avoid waste generation and to use waste as a resource, and should help move the EU closer to a "recycling society". In particular, the Sixth Community Environment Action Programme calls for measures aimed at ensuring the source separation, collection and recycling of priority waste streams. In line with this objective and as a means to facilitating or improving its recovery potential, waste should be separately collected if technically, environmentally and economically practicable, before undergoing recovery operations that deliver the best overall environmental outcome.

Member States are asked to support the use of recyclates, such as recovered paper, in line with the waste hierarchy and with the aim of a recycling society, and whenever possible should not support the landfilling or incineration of such recyclates. In order to implement the precautionary principle and the principle of preventive action enshrined in Article 174(2) of the EU Treaty, it is necessary to set general environmental objectives for the management of waste within the Community. By virtue of those principles, it is for the Community and the Member States to establish a framework to prevent, reduce and, as far as possible, eliminate from the outset the sources of pollution or nuisance by adopting measures whereby recognised risks are eliminated.

In order to enable the Community as a whole, and each Member State individually, to become self-sufficient in waste disposal and recovery of mixed municipal waste collected from private

households there is a need for a network of disposal installations and installations for the recovery of mixed municipal waste. This must take into account geographical circumstances and the need for specialised installations for certain types of waste. Any scheme incorporating recycling, composting or waste-to-energy technologies must be market-orientated. There must be markets for products and energy. There is also a strong argument for national coordination if national targets are to be met.



## 4. Waste management practices of cut flowers

### 4.1. Introduction

The horticultural sector in the UK occupies only 4% of the agricultural land area, but the high intensity of production implies that their environmental impact is likely to be disproportionate to the area of land under cultivation (Warwick HRI, 2007). Moreover given that the UK's level of cut flower consumption ranks so highly worldwide, far higher than the level of flowers it produces; it makes sense to link domestic demand with supply in a sustainable manner. Environmental damage from this industry is inevitable and is driven by consumption of its outputs, and decorative products including fresh cut flowers.

One crucial aspect of environmental pressure on behalf of cut flowers is the type and amount of waste produced. Preliminary research shows that waste management practices are poor or even non-existent. In domestic gardening, it was reported that cut flowers are discarded through either regular waste disposal or home composting (EFSA PLH Panel, 2013). Originally composting was implemented as a solution to large amounts of plant waste and has now become more popular at the household level because the rich organic amendment obtained not only is an excellent fertiliser but also contains high amounts of beneficial organisms that prevent and help control soil-borne diseases (Pizano, 2002). Nevertheless, the likelihood of cut flowers carrying a number of emerging chemical compounds has been suggested to pose a significant risk to the environment as well as to human health which indicates that its disposal to landfill is one of the safest option (EFSA PLH Panel, 2013). However, because cut flowers are not consumable, they have escaped much of the anti-pesticide pressure that has begun to reform the way fruit and vegetables are grown (War on Want, 2007).

In the 1990s increasing public awareness on the environmental impacts of toxic pesticides and other chemicals used during cut flower production led national cut flower industries to develop a set of standards and voluntary codes of conduct. A 2002 study of 8,000 flower workers near Bogota found that workers had been exposed to 127 different pesticides (War on Want, 2007). Kenya and Colombia have been the first countries to develop their own national standards; for instance Kenya has implemented the Kenya Flower Council's standard, whereas in Colombia the flower exporters' association known also as Asocolflores has established the Florverde scheme which translates as "Green Flowers".

In the UK, M&S, Asda and Tesco (3 of the major supermarket chains) have been purchasing flowers from Colombia due to the Florverde scheme. However, a 2005 study by the World Health Organisation (WHO) disclosed that the chemicals used in the Florverde farms were considered to be extremely or highly toxic, despite the fact that Florverde's standards were believed to ensure environmentally friendly practices and safe working conditions (War on Want, 2007). It was revealed that the real aim of the Florverde's standard was not established for improving cultivating practices and working conditions on flower farms, but for trying to improve their competitiveness over the international cut flower market.

A few years later in 1998, a group of trade unions and NGOs developed the voluntary International Code of Conduct for the Production of Cut Flowers (ICC) that protects workers and includes their right to a living wage, a ban on child labour, a right to form unions, health and safety standards and reduced pesticide use (War on Want, 2007). Two competing international schemes that incorporate the ICC – the Flower Label Programme and Fair Flowers Fair Plants – have also been launched in recent years. However, there is still no agreement on a common international standard for the flower industry and although some standards already exist the lack of a coherent system conveys the risk of failure in properly protecting the workers. Colombian flower workers claim that plantation owners are given advance notice of inspections and ensure that everything is under monitoring and control in order to get their certification. These informalities highlight the need for regulation that will protect workers both from risks related to the use of toxic chemicals and the reservation of their working rights (War or Want, 2007).

The need for better management of biodegradable waste such as that from cut flowers combined with the presence of potentially harmful chemicals means that there is a requirement for a review of how waste arisings are dealt with and the associated risks.

#### **4.2. Current waste management practices in the cut flower and plant industry**

To examine the current waste management practices, a combination of desk research and empirical research methods, such as semi-structured interviews and personal communication with professionals working in the floriculture sector, were conducted simultaneously. This allowed the collection of large datasets for analysis. London was used as the case study of this research being the capital of the UK where the greatest production of cut flower waste occurs.

#### **4.2.1. Survey**

A survey was conducted with the aim of exploring the fate of cut-flower waste and management practices employed by growers, wholesalers and retailers, to examine practices related to the proper management of cut flower waste and gather information and perspectives from people involved in this and related activities.

The survey was designed based on a predetermined set of questions, but gave the participants the freedom to speak more broadly about the cut flower waste management and expand the discussion and elaborate on some points of interest. The survey questions were designed following an analysis of the relevant literature and having identified the treatment options normally used for treating green, organic waste. The questions were open-ended and were divided into the following three main sections.

1. Questions about the business itself (including specific information about the business nature and other details).
2. Questions about the products they sell (cut flowers, plants, soil, etc.) and their customer range.
3. Questions about waste generation and management practices.

The survey questionnaire can be found in Appendix 1.

#### **4.2.2. Personal Communication**

Personal communication was conducted on the basis of people not having the time to be interviewed properly and thus, was conducted via email and telephone communication. Retailers were the majority of those approached.

All email and telephone communications followed the same outline based on a set of questions that can also be found in Appendix 1. However retailers had the freedom to expand the discussion and elaborate on points of interest.

#### **4.2.3. Participants selection**

The participants chosen for the survey were selected on the basis of the following criteria:

- type of business (wholesaler, grower, retailer, etc.);
- different products and thus waste generated (plants, flowers, both);

- different size (ranging from large- to small-size businesses);
- different parts of London and thus different sections of the customer base;
- availability to conduct the interview.

The survey was conducted between December 2014 and January 2015 in London, either in person or by phone, and each communication lasted approximately 5-20 minutes.

#### 4.2.4. Results and analysis of data collected on cut flower waste management

A total of 26 participants representing a mixture of growers, wholesalers and retailers contributed to the research. The outputs of the survey and personal communication have generated a matrix of data on cut-flower waste management, presented in Table 4-1.

**Table 4-1 Matrix of data collected from empirical research on cut flower waste management in the UK**

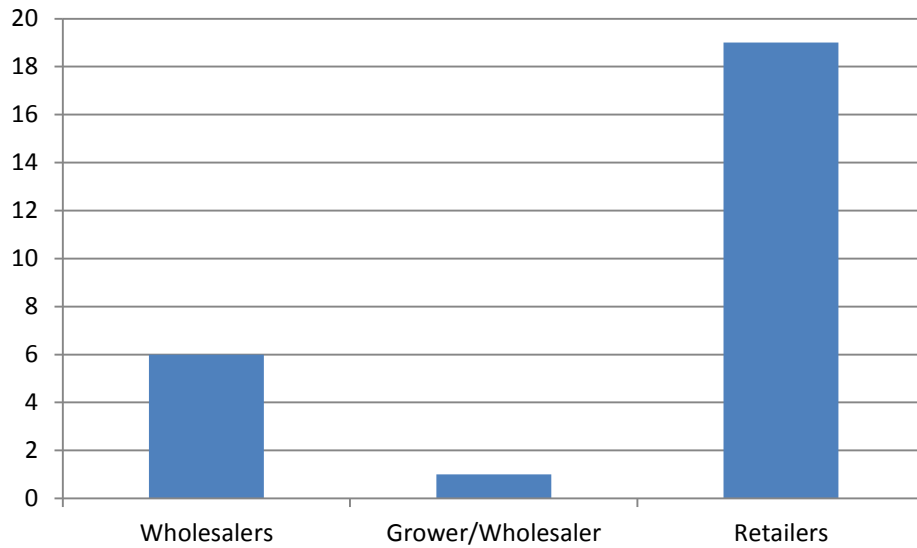
Name of business	Type of business	Products	Customers	Waste generated	Cut flower/plant waste management
<b>Evergreen</b>	Wholesaler	Plants	Businesses, Greenhouses, Florists, Restaurants	Plants, plastic	NCGM authorities
<b>Arnott and Mason</b>	Wholesaler	Plants	Businesses, Greenhouses, Florists, Restaurants	Plants, Soil, Plastic	NCGM authorities
<b>Pratley</b>	Wholesaler	Flowers, plants	Individuals, Businesses, Greenhouses, Florists	Cut flower, floral trimmings, paper/card, soil, plastic	NCGM authorities
<b>Robert Allen</b>	Wholesaler	Flowers	Individuals, Businesses, Greenhouses, Florists	Cut flower	NCGM authorities
<b>L Mills</b>	Grower/ Wholesaler	Flowers, plants, soil	Individuals, Supermarkets, Nursing homes, Businesses, Greenhouses, Florists	Plants, Soil	Composting on-site

Name of business	Type of business	Products	Customers	Waste generated	Cut flower/plant waste management
<b>Bloomfield of London</b>	Wholesaler	Flowers, plants	Individuals, Businesses, Cemeteries	Cut flower, plants	Residual waste bin
<b>Zest Flowers</b>	Wholesaler	Flowers	Businesses	n/a	NCGM authorities
<b>Kensington Flowers</b>	Retailer	Flowers, plants	Individuals, Deliveries, Hospitals, Businesses, Restaurants	Cut flower, floral trimmings, plants, paper/card	Collection by a private company
<b>Flowerstore (Whole Foods)</b>	Retailer	Flowers, plants	Individuals	Cut flower, floral trimmings, plants	Residual waste bin
<b>Waitrose</b>	Retailer	Flowers	Individuals	Cut flower, paper/card	Collected and treated together with food waste
<b>M&amp;S</b>	Retailer	Flowers	Individuals	Cut flower, paper/card, plastic	Collected and treated together with food waste
<b>Moyses Stevens</b>	Retailer	flowers, plants, soils	Individuals, Deliveries, Restaurants, Events	Floral trimmings, Plants, paper/card	Collection by a private company
<b>Chelsea Gardener</b>	Retailer	Flowers, Plants, Soil	Individuals, Businesses	Floral trimmings, plants, paper/card	Collection by a private company
<b>Pesh Flowers</b>	Retailer	Flowers, Plants, soil, other	Individuals, Businesses, Hospitals, Restaurants	Floral trimmings, plants, paper/card	Residual waste bin
<b>Flowers24hours</b>	Retailer	Flowers, Plants, Soil,	Individual, Businesses, Hospitals, Restaurants, Events	Cut flower, floral trimmings, plants, paper/card	Collection by a private company
<b>Laura Kuy</b>	Retailer	n/a	n/a	n/a	n/a
<b>Doris Florist</b>	Retailer	Flowers, plants	Individuals, Businesses, Hospitals, Restaurants	Floral trimmings, paper/card	Residual waste bin
<b>Wild at Heart</b>	Retailer	Flowers, plants	Individuals, Businesses, Hospitals,	Cut flower, floral trimmings,	Residual waste bin

Name of business	Type of business	Products	Customers	Waste generated	Cut flower/plant waste management
			Restaurants	paper/card	
<b>Josephines Flowers</b>	Retailer	n/a	n/a	n/a	n/a
<b>Angel Flowers</b>	Retailer	Flowers, plants	Individuals, Businesses, Hospitals, Restaurants, Events	Floral trimmings, paper/card	Collection by a private company
<b>Dawson Flowers</b>	Retailer	n/a	n/a	n/a	n/a
<b>Orchidya</b>	Retailer	n/a	n/a	n/a	n/a
<b>The Flower Stand Chelsea</b>	Retailer	n/a	n/a	n/a	n/a
<b>Appleyard London</b>	Retailer	n/a	n/a	n/a	n/a
<b>Town &amp; County Flowers</b>	Retailer	Flowers	Individuals, Businesses, Hospitals, Restaurants, Events	Floral trimmings, paper/card, plastics, other waste	Collection by a private company
<b>The London Flower Shop</b>	Retailer	Flowers, plants, others	Individuals, Businesses, Hospitals, Restaurants, Events	Cut flower waste, floral trimmings, plants, paper/card	Residual waste bin

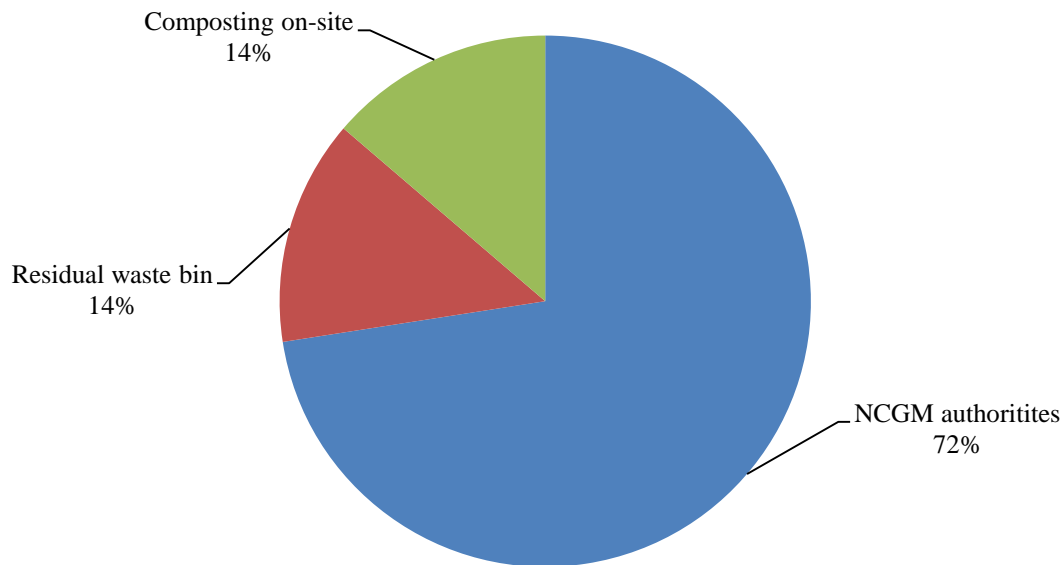
As evident from the matrix of data and clearly depicted in Figure 4-1 seven wholesalers, nineteen retailers and one grower (also counted in the wholesalers) participated in our research. All wholesalers and the grower were interviewed during the visit to the New Covent Garden Flower Market<sup>3</sup> (NCGM) which is the biggest flower market in the UK and the ultimate one-stop shop for florists. Retailers were either interviewed or contacted by email or phone. The following figure is a depiction of the sample in terms of participation.

<sup>3</sup> [www.newcoventgardenmarket.com](http://www.newcoventgardenmarket.com)



**Figure 4-1 Number of respondents per sector**

From the seven wholesalers’ interviewed, two were selling plants, two were selling flowers and the rest were selling both flowers and plants. In the total of wholesalers’ interviewed, only one out of six stated that the remaining cut flower waste from its business is disposed in the residual waste bin, one (who is also a grower) stated that any remaining waste goes back to the farm for composting, whereas the rest stated that any cut flower and plant waste generated is managed by the New Covent Garden Flower Market (NCGM) authorities, representing 14%, 14% and 72% of the sample, respectively (Figure 4-1). All wholesalers however claimed that cut flower waste generated is generally very low. This is because during the closure of the market the prices of the flowers tend to drop a lot leading to an increase in the sales, and hence the lessening of remaining, unsold flowers.



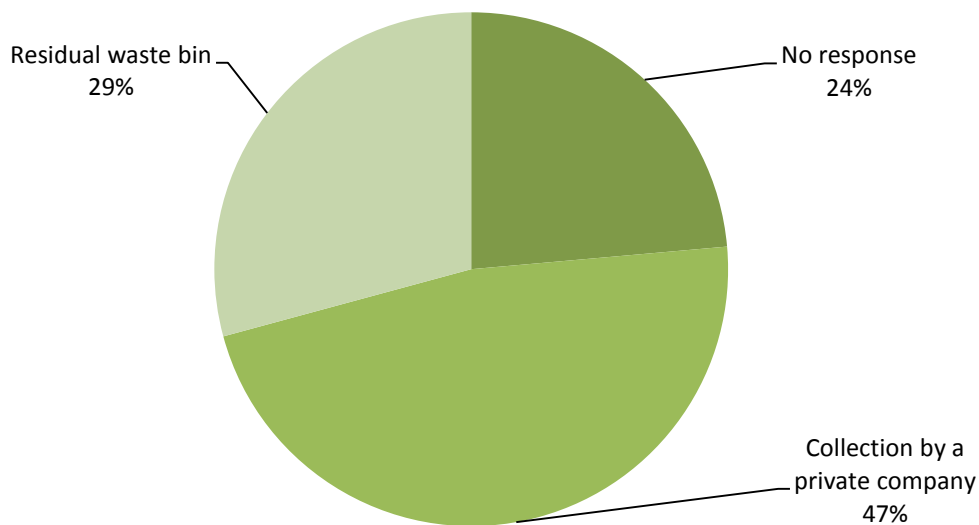
**Figure 4-2 Wholesalers' cut flower waste management**

Out of the 19 retailers interviewed, four expressed their wish not to respond to our questions, five stated that all cut-flower waste generated is disposed to the residual waste bin, whereas the rest stated that they have a contract with a private company that collects all their waste generated in their businesses, representing 24%, 29% and 47% of the sample, respectively. The companies with which retailers have a contract include amongst others the following:

- First Mile
- Raven Recycling
- Viridor
- Dirty Harris

Amongst the retailers participating in our research was Waitrose and M&S, two of the bigger retailers in the UK which claimed to treat all remaining flowers and plants together with food waste collected by private companies with which they have a contract.





**Figure 4-3 Retailers' cut flower waste management**

For the florists themselves, the response rate was poor as either because they were too busy, or because they were reluctant to provide any answers to the questions posed.

Nevertheless, the results of the survey and personal communication indicate that the cut flower waste management in the UK is still in its infancy. In particular, there is an apparent lack of awareness among some retailers in dealing with green waste in a sustainable manner, a significant deficiency of the waste management system, considering the value of the cut flower waste.

### **4.3. Limitations of the research**

The methodology followed in this study is adequate for a representative indication of cut flower waste management. Although the unbalanced sample set and low response rate and reliability on secondary data collected might be perceived as limitations, this have not had an impact on the recommendations made. This is because the sample can still be used to represent the current waste management practices of the UK cut flower industry. In fact three of the main supermarket chains that have numerous outlets across the country and constitute a large proportion of the UK's cut flower market, have been included in this analysis validating the results of the study. Supermarkets by definition are large companies. Wholesalers and growers in the UK are few in number compared

to the amount of independent florists so having a seemingly unbalanced number of samples is actually representative of the industry (Nibber, 2013).

#### 4.4. Changing the landscape in cut flower and plant waste management

As highlighted above, data on current waste management practices in the UK are limited. However, in 2008 a *Code of Practice for the Management of Agricultural and Horticultural Waste* has been published, which is currently voluntary and has no legal force on its own but nevertheless aims to encourage 'best practice' in the disposal of waste from plant produce (FERA, 2008). This code refers to disposal options for horticultural waste which may include:

- **Reducing waste:** by leaving as much waste as possible at source.
- **Recycling waste:** upon proper consideration to risks of spreading serious plant pests and pathogens and, if appropriate, special treatments are undertaken to eliminate them, materials should be re-used/recycled wherever possible.
- **Disposal:** where disposal of solids is unavoidable, either because they are of particularly high risk or because there are no cost-effective alternatives, there are two options either disposal at a landfill site or disposal in an incinerator.

As this code has still no legal force, UK Councils have established their own set of suggestions regarding horticultural waste and especially in regards to cut flower waste. Most UK councils advise their customers to put their cut flower waste together with their garden waste. The issue that arises with this practice has largely to do with the management of this mixture of wastes. Composting which is the most widely used process for organic waste management in the UK is separated into two specific options regarding the type of input, namely the windrow and in-vessel composting. Windrow composting is for green wastes whereas in-vessel composting is used for mixtures of food waste with green waste. The difference between the two processes lies on the fact that in-vessel composting ensures an enclosed environment, with accurate temperatures and monitoring to comply with the Animal By-Product Regulations (ABPR). These regulations were introduced in 2003 to ensure that all meat and other products of animal origin (including food waste from catering and households) are treated up to the appropriate standards to certify human health and environmental protection. This has means that strict procedures are in place to prevent cross-contamination and ensure pasteurisation and stabilisation of the end product.

Existing data from supermarkets suggest that cut-flower waste ends up in the green waste stream together with food and other organic wastes. To minimise its waste production Sainsbury's worked together with World Flowers to introduce fixed order quantities resulting in greater predictability across the supply chain (WRAP, 2011). They estimated that a 15% improvement in waste performance at the retailer is worth approximately £12,000 per week. To date there has been a soothing of the line for orders versus forecast and hence a reduction in total waste.

Furthermore an associated waste component of cut flowers is flower packaging, which creates a considerable amount of waste and may have severe impacts through the release of chemicals during production and degradation (Defra, 2013). To that end Morrisons took 2cm off the flower box flaps (saving 72 tonnes of card) and also all of the card is recycled back again into the flower boxes, which contain 95% recycled board (Morrisons, 2012).

Examples on changing waste management practices of cut flower waste from other countries exist and are promising as they indicate a shift in the area of cut flower waste management and a move towards a more innovative approach in their waste management. For instance, the flower industry in Kenya is known for taking measures to respond to environmental impacts by embracing alternative sources of resources, especially water and power (CDKN Africa, 2013). Also a pilot project in Kenya is converting the calorific value of cut flower waste into energy, with two projects operating at 60-63% of their load capacity and power generated being used to power water pumping generators and spraying (Kenya Flower Council, 2013). Moreover in India prototype digesters of 2 m<sup>3</sup> capacity were used and fed with flower waste which was digested in daily feedings; the process managed to remove many environmental pollutants as total solids, biochemical oxygen demand (BOD), along with biogas production containing 50% methane (Singh and Bajpai, 2011).

In India cut flowers are widely offered to the temples for spiritual purposes and it is estimated that over a thousand of cut flowers and plant leaves are offered every day on normal days at the temples, which on special occasions like Shrawan month and festival times can be many times more. The disposal of cut flower after they deteriorate has been a cause of concern as they are predominantly dumped into the Ganges posing a high risk of harmful effects on the river. In the Mahakaleshwar Temple in Ujjain, cut flowers after their deterioration are collected and used for the production of bio-fertiliser using vermicomposting. A particular variety of earthworms 'eisenia foetida' are used in such vermicomposting for which two-three kg of earthworms are required for per/metre cube volume, requiring only 400 sq/ft of land. Recognising the benefits of such practice, the Kashi Vishwanath Temple, one of the most famous Hindu temples dedicated to Lord Shiva, has

also decided to adopt floral waste management process to convert cut flower waste into bio-fertiliser. To do so they have asked agricultural experts from the Banaras Hindu University (BHU) and governmental organisations to provide their expertise and knowledge to initiate the project.

## 5. Conclusions and Recommendations

The UK is one of the two leading markets of cut flowers imports in the world and a crucial issue that arises is the type and amount of waste being produced and how this waste is managed. Background research indicated that waste management practices are poor or non-existent. Therefore, the investigation of cut-flower waste arisings and their management was investigated.

To identify the current waste management practices which are being undertaken a survey was conducted along with personal communication demonstrated that cut flower waste management in the UK is still evolving. The key findings from the research were:

- Cut flowers have a short shelf life and provide an opportunity in terms of as an organic or energy resource;
- It is estimated that approximately 34.7 thousand tonnes of cut flowers are consumed and wasted within the UK per year;
- There are a number of steps in the supply chain where cut flower waste arises;
- The amount of waste at each step depends upon the quality of the product and the specifications of the next member of the chain;
- The reduction in price of products to ensure as much is sold as possible at the end of the day can pass on the issue of waste management to the consumer;
- The results of the survey indicated that there was a general lack of awareness of what happens to the waste once it is collected, or the opportunities for waste management.

It is evident that waste management of cut flowers is an area worth investing on and which has a lot of room for development. Especially when taking into account the current legislation as the EC Landfill Directive (99/31/EC) which seeks to avoid waste generation and to use waste as a resource, to help move the EU closer to a "recycling society". Diverting cut flower waste from landfill will have positive impacts both in terms of carbon emissions being released into the atmosphere and also financial benefits for the people involved in the cut flower sector. As for growers they will have the direct benefit that if they can use the product that would be generated for instance by composting cut flower waste, which they could then reuse for further production. Also the following parts of the flower supply chain would be benefited through lower prices in the end product they would buy as costs would be internalised at the production level. In any case if a scheme incorporating recycling, composting or waste-to-energy technologies is to be established, this must be market-orientated and there must be markets for the by- products and energy produced.

Based on the research conducted and the information gathered, the following recommendations can be made:

- Further research in the type of waste produced needs to be performed in order to understand the exact management options that need to be implemented.
- Collaboration between all members of the cut flower chain is essential in order to understand the market conditions better and find ways to cooperate with regards to waste management of cut flowers.
- There is a need for national coordination of these activities for national targets outlined in the Landfill Directive to be met. Initiatives such as the *Code of Practice for the Management of Agricultural and Horticultural Waste*, which is currently voluntary should actively encourage 'best practice' in the disposal of waste from plant produce and become mandatory for all.
- Further opportunities for waste management should be explored for instance the potential of recovering energy from cut-flower waste.

Overall it stands to reason that the sector of cut-flower waste management is still quite underdeveloped, but is an essential part of the UK economy, therefore potential innovative waste management options should be further explored at a local and national level.

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## Appendix 1

### A1.1. Survey questionnaire conducted for the purposes of the study

#### Floral Waste Management Questionnaire – 2014

##### *An Imperial College London Survey*

#### Section 1. Personal details

Name of business: .....

Please indicate one of the following: Grower / Importer / Wholesaler / Retailer / None of these

In none of these please indicate business nature:

Owner:      Private       Company       Farm       Other

If other please specify: .....

Please indicate one of the following: Grower / Supplier / Retailer / None of these

In none of these please indicate business nature: .....

Business Address: .....

County: .....

Phone: .....

E-mail: .....

Website (if available): .....

#### Section 2. Products

##### *2a. Please indicate the types of products generated:*

Flowers

Plants

Soil

Other (Please specify): .....

**2b. Please indicate the main customers:**

a. Individuals/Household delivery

b. Supermarkets

b. Hospitals/Clinics

c. Businesses

e. Nursing homes

d. Greenhouses/florists

e. Restaurants

f. Other (please specify): .....

**Section 3. Waste generation and management**

**3a. Please indicate the types of wastes generated:**

Cut-flower

Floral trimmings/plants

Paper/card

Soil

Other (Please specify): .....

**3b. Do you accept any of this waste, or other waste from outside sources?**

No/Yes

Please explain: .....

**3c. What type of floral waste management options do you have in place:**

Anaerobic digestion

- Composting
- Incineration/Burning
- Collection by a private company
- Other

If other please specify:

.....

**3d. If anaerobic digestion is your floral waste management option:**

Do you charge a fee to take outside waste? No/Yes

Please explain: .....

If yes, does it depend on either the type of material or the source?

.....

How is floral waste digested?

- a. Plug-flow digester
- b. Fixed-dome reactor
- c. Rubber-balloon biogas plant
- d. Floating-drum reactor
- f. Other

Please specify: .....

Digestate management:

Is digestate sold? No/Yes

Is digestate given away? No/Yes

Free to anyone No/Yes

Free to local government users No/Yes

Free to residents No/Yes

Free to those who bring waste No/Yes

Free to others (please specify) No/Yes

.....

Is digestate used on site? No/Yes

Marketing and labelling:

Do you label your digestate product? No/Yes

What is on the label? .....

Do you give instructions for use? No/Yes

What are they? .....

Biogas management:

Is biogas used on site? No/Yes

Is biogas injected into the grid? No/Yes

Is biogas flared? No/Yes

Other types of management (please specify):

.....

***3e. If composting is your floral waste management option:***

Do you charge a compost tipping fee to take outside waste? No/Yes

Please explain: .....

If yes, does it depend on either the type of material or the source?

.....

How is waste composted?

- a. Piled, in windrows
- b. Piled, but not in windrows
- c. Forced aerated static piles
- d. Passively aerated windrows
- e. In-vessel composting type
- f. Other specify

Compost management:

- Is the compost sold? No/Yes
- Is compost given away? No/Yes
- Free to anyone. No/Yes
- Free to local government users. No/Yes
- Free to residents. No/Yes
- Free to those who bring waste. No/Yes
- Free to others specify No/Yes
- Is compost used on site? No/Yes

Marketing and labelling:

- Do you label your compost product? No/Yes
- What is on the label? .....
- Do you give instructions for use? No/Yes

What are they?

.....

**3f. If incineration/burning is your floral waste management option:**

Do you take outside waste?                      No/Yes

Please explain: .....

If yes, what type of material?

.....

**3g. If your waste is collected by a waste management company then please indicate which:**

.....

### **A1.2. Personal communication questionnaire conducted for the purposes of the study**

1. What happens to the cut flower waste generated in your business?
2. Do you have a contract with a waste management company? if yes for which types of waste?
3. Do you have any waste treatment options in place (e.g. Anaerobic digestion, Composting, Thermal Treatment, other)?
4. Do you charge a fee to take outside waste like garden waste and plant trimmings?
5. What are the by-products (if any) of the treatment process you follow and how do you handle it (Sell/ Use on site/Free)?



## Appendix 2

### A2.1 Factors that affect the quality of cut flowers

#### **Maturity**

The stage of maturity of the flowers before cut has an important role to play in their life time after harvest. Flowers that are to be stored, transported and distributed to international markets are best harvested in the bud stage so that they can be opened afterwards extending their lifetime that way. This technique apart from quality purposes also increases the packing density and reduces mechanical damage and desiccation. However, flowers that are to be distributed locally, the maturation stage is less important before harvesting.

#### **Temperature**

Temperature is an important factor of post-harvest quality and this is because temperature is closely associated with respiration. Respiration in the thermogenic cells of the flower causes the production of heat as a by-product. When temperature increases, respiration of the flower also increases leading to its rapid maturation. This indicates how significant the role of temperature is on the quality of the cut flower. Cooling and maintenance of the low temperatures during storage, transport and distribution of cut flowers is really important for reducing the rate of cut flowers aging (Reid, 2009). The optimum storage temperature for most flower species is near 0°C. Some species like anthurium, bird-of-paradise, some orchids and ginger may deteriorate at temperatures lower than 10°C, and therefore extra care should be taken. Transportation of cut flowers through air in an uncontrolled environment can lead to rapid deterioration of cut flowers due to their response to temperatures. As such, it is of great importance that the transportation of cut flowers takes place in a controlled environment at which the temperatures are low.

#### **Food supply**

Starch and sugar formed during the photosynthesis of flowers that occurs during the day is important for the growth of the flower. Therefore, to prolong the quality of cut flowers after harvest a solution containing sugar is used to feed them. However, the feeding period must be short in order to prevent the rapid maturation or even deterioration of flower due to extreme feeding. Sugar is an important tool of making flowers more attractive as it can be used to open the buds of flowers before distribution.

### **Light, water and quality of water**

Light is only important for some species of flowers that under darkness can either turn yellow or black. Water however, is really important for sustaining the freshness of cut flowers. Species with leafy stems and large surface should be stored at humid conditions to minimise water loss that can lead to their deterioration during storage. Low temperatures can reduce the loss of water and therefore, cooling conditions are usually practiced during storage and distribution of cut flowers. However, the quality of the water is an important factor to the quality of the cut flower. Chemicals commonly found in tap water such as sodium (Na) and fluoride (F) can be toxic to some flowers, and hence special consideration must be given to the quality of the water. Also hard water reduces flower's water movement through the stems, and therefore deionised water is most usually used to water cut flowers.

### **Bacteria plugging**

The cut surface of a flower stem releases proteins, amino acids, sugars, and minerals which are an ideal food source for bacteria. These organisms are fed by the material released from the cut flower and are multiplied producing slime. This slime can plug the waste supply system of the cut flower leading to its rapid deterioration.

### **Ethylene**

Some species of cut flowers when they age release ethylene which can be highly toxic (>100 ppb)<sup>4</sup> to other species of cut flowers like carnations, gypsophila and some rose cultivars (Reid, 2009). Ethylene is generated during the ripening of some fruits and the combustion of organic materials.

### **Pests and diseases**

Flowers are very susceptible to pests and diseases, and the transfer from cold storage to warmer areas can result in the formation of moisture that can be an important factor for the germination of disease organisms, gray mold (*Botrytis cinerea*). Greenhouse hygiene, appropriate temperature control, and reduction of condensation on the harvested flowers can reduce losses caused by pests and diseases.

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<sup>4</sup> ppb: parts per billion – This unit is used to describe concentrations of contaminants in air as a volume fraction. For example, 100 ppb ethylene represents one hundred parts in one billion parts of air.

