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The value of resource efficiency in the food industry: a waste minimisation project in East Anglia, UK

Stefan Henningsson [a,*], Katherine Hyde [b], Ann Smith [c], Miranda Campbell [d]

[a] *NUTEK - Swedish Business Development Agency, Department for Sustainable Development, 11786 Stockholm, Sweden*
[b] *Environment & Sustainability, Taylor Woodrow Technology, Stanbridge Road, Leighton Buzzard, Beds LU7 42H, UK*
[c] *Department of Environmental Sciences, University of Hertfordshire, College Lane, Hatfield, Hertfordshire, AL10 9AB, UK*
[d] *Environmental Consultant, Cortex, CEL International Ltd, 256 Foleshill Road, Coventry CV6 5AB, UK*

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Abstract

Waste minimisation can be as successful in the food and drink industry as in other industries often seen as more polluting. £1.1m was realised in annual savings by 13 companies in the East Anglian Waste Minimisation in the Food and Drink Industry Project, which exceeded the Project investment of £412,000 plus the £335,000 invested by companies in cleaner technologies. The 13 food and drink companies annually reduced: raw materials use and solid waste production by 1400 tonnes; CO_2-emissions by 670 tonnes; and water use by 70,000 m^3.

Significant amounts of food grade material are rejected from the production line for their unsatisfactory quality. This can be for visual, physical, microbiological or compositional (chemical or biochemical) reasons. The reduction in the use of raw materials carried the greatest potential for financial savings. This reduction at source approach exceeded the corresponding savings in landfill costs by more than two orders of magnitude. This reinforces the importance for companies to identify opportunities for source reduction rather than end-of-pipe solutions and the relatively low cost of disposal for the food and drink industry.

Minimising the packaging of food products presents an opportunity as well as considerable challenges to the food and drink industry as the main concern in the supply-chain is for food safety. Initiatives to reduce electricity and water consumption and to improve effluent quality did not individually carry the same potential for costs savings as the other areas. Consequently, these potential savings were given a lower priority within the companies. However, many electricity, water and effluent initiatives were implemented by fairly simple means and led to substantial savings.

Changes in technology brought significant savings in manpower, as well as for materials and utilities. These savings are controversial in sustainability terms and attention has to be focused on ensuring that increased efficiency creates alternative work for people, as well as for equipment. Procedural changes often focused on auditing, material handling and staff training, and with low associated capital cost, these proved to be keys to success.

The results from the Project have shown that there is a great potential for more sustainable production and consumption systems simply through improving dialogue between producers, retailers and consumers.

Keywords: Resource efficiency; Waste minimisation; Food industry

1. Introduction

The maintenance of food hygiene and product quality presents a challenge to the minimisation of raw material wastage in food and drink production since the former requires the rejection of substandard raw materials and the latter seeks to minimise the rejection rate of feedstocks. Retail and consumer demands drive the market and tough food safety regulations invoke penalties for non-compliance with hygiene and quality requirements. Characteristically, 40% or even as much as 50% of raw vegetable or salad by weight may be rejected at various stages along a production line. Some hygienic and nourishing food products may be rejected and become waste because they exhibit physical attributes considered 'flaws' by principal retailers. Some of these sub-standard

* Corresponding author. Tel.: +46-8-6819364; fax: +46-8-6819445.
E-mail address: stefan.henningsson@nutek.se (S. Henningsson).

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food products may be sold for fast food processing, use in prisons or hospitals but in general, market barriers restrict the use of such products for other applications. In the case of the disposal of putrescible and biodegradable wastes, the logical solutions include the continuing use of wastes for animal feedstocks. Additionally, the application of composting solutions where appropriate provides a mechanism for waste food materials as conditioners and fertilisers to be returned to the soil, thus providing a clear life cycle benefit.

Of all the manufacturing industries, the food industry makes the largest demand on packaging and finding ways to reduce this packaging quantity and its subsequent waste is a demanding task [1]. In practice, optimised packaging criteria for least environmental impact are often difficult to define without extensive dialogue. The needs of the consumer, the requirements of the retailer and the optimisation available to the producer or manufacturer may variously conflict with one another. The Producer Responsibility Obligations (Packaging Waste) Regulations (1997) [2] have gone some way towards defining companies' environmental responsibilities associated with packaging. Nevertheless, the Regulations have done little so far to stimulate producers, suppliers and consumers to act on their collective supply chain responsibilities.

In order for waste minimisation to provide continuing environmental improvement in the key areas of putrescible wastage and packaging, improved consensus and dialogue is required between purchasers, including both consumers and the major retailers, and those that produce and manufacture. Better market opportunities and incentives are required for second grade food products and for compost products. If waste minimisation in all aspects of the food and drink industry is to be achievable, retailers must actively pursue and disseminate purchasing policies based on better supply chain optimisation, which include environmental criteria and objectives. Food producers and manufacturers must give greater priority to reducing raw material wastage as far as practically possible and to identifying the process options that result in a lower waste burden. Contractual agreements must be agreed to reinforce these options and good alternative uses or composting solutions for wasted raw material must be found.

2. The food and drink industry in the UK

Consumer spending on food, as defined by the Key Note UK Food Market Review [3] was £42.5bn in 1997. Almost 420,000 businesses are involved in farming, food production and food services in the UK; approximately 59% of these are in food processing and farming, while the remainder include retailing, wholesaling and catering. There is an annual trade deficit in the food sector that was estimated to be in excess of £7.25bn in 1997.

Food sales in 1997 comprised 28.1% meat and meat products; 26.3% fruit and vegetables; 18.2% bread and bakery products; 17.3% milk and dairy products; 4.8% fish and fish products; 4.7% other food products, and 0.7% sugar.

Fresh fruit sales have benefited from increased customer awareness of health and nutrition issues and fruit sales increased in 1997. The vegetables sector has seen a decline in sales due to the weakness of the potato market and increasing pressure from foods such as pasta and rice. However sales of other vegetables have increased both in fresh vegetables and in convenience, prepacked and prepared salads and vegetables.

An assessment conducted in 1999 of environmental reporting and the implementation of environmental management systems in the UK showed that of 722 certifications to ISO 14001, only 16 had been in the food and drink sector and out of 66 certifications to EMAS, none were in the food and drink sector [4]. Furthermore, of 2314 world-wide certifications to ISO 14001, 37 of these had been in food and drink businesses, representing less than 2% of the world-wide certifications.

3. Waste minimisation project in the food and drink industry

In 1997 the East Anglian Waste Minimisation in the Food and Drink Industry Project (referred to hereafter as the Project) was initiated in East Anglia as a partnership between ten organisations and companies including Business Link Norfolk and Waveney, the University of Hertfordshire, March Consulting Ltd, the Environment Agency, Environmental Technology Best Practice Programme (ETBPP), Tesco Stores plc, Anglian Water Services, Norfolk County Council, British Standards Institution (BSi) and East Anglian Business Environment Club (EABEC) [5].

The aim of the Project was to promote waste minimisation as a means of improving environmental performance, profitability and competitiveness. This was achieved by establishing a Waste Minimisation Business Club through which training and technical support in waste minimisation was provided to members.

The Business Club met regularly through a prescribed training programme, the outline of which was agreed at the inception of the Project by the funding bodies, the member companies subsequently having an opportunity to suggest variations to the programme. The training programme was specifically designed to address a broad range of issues from mass balance and materials loss calculations to project management skills in waste minimisation. The programme provided three components to every training day: firstly, the taught workshop sessions; secondly, the progress sharing sessions; finally, the 'fast track' training on specific technologies and techniques

associated with for example, water saving devices, energy saving devices and monitoring and targeting software. The software capability enabled companies to accurately track consumption according to many variables such as utility and raw materials, and enabled objective targets to be set for reducing consumption.

Initially, fifteen businesses were recruited to join the Waste Minimisation Business Club ranging from a small family-run hotel and other SMEs to large companies employing in excess of 1000 employees during peak summer months. The range of businesses included companies that produce vegetable products, meat products and baked beans, frozen desserts, condiments, soft drinks, beer, wines, a cold store operation, a charity housing trust, a small hotel and a sandwich maker.

Evidence drawn from the Project has produced the observations and conclusions discussed later in this paper: specific examples are provided where appropriate.

4. Waste production from the food and drink industry in Norfolk, UK

Waste arisings from the food and drink industry contribute significantly to the total arisings of Commercial and Industrial wastes (CI wastes) in East Anglia. The largest single category in the region is 'Food, Drink, Tobacco Manufacturing' providing an estimated 30% of the total arisings of CI wastes [6]. If this estimate is added to the arisings from 'Hotels and Catering', an aggregate contribution to total arisings in Norfolk of over 33% is obtained. In the whole of the UK, waste from hotels, catering and food and drink (including tobacco) processors represents 16% of CI wastes, which is less than half of the fraction in Norfolk.

The variety of different types of wastes arising from 'Food, Drink, Tobacco Manufacturing' and from 'Hotels and Catering' ranges from putrescible and biodegradable matter which is rejected from the product line, to packaging waste, glass, waste processing oils and other general commercial or factory wastes. In practice it is difficult to gain a clear idea of the relative amounts of various types of wastes arising from the food and drink manufacturing and catering sectors.

4.1. The environmental value of increased resource efficiency

The Project demonstrated the achievement of financial and environmental performance improvements through waste minimisation techniques. On the output side, some 1370 tonnes less solid waste per year needed to be disposed off, with reduced associated transport impact on the environment. In addition, 5950 m^3 of liquid effluent was avoided per annum from polluting rivers and streams. The Project's contribution to the reduction of emission of global warming gases was evident in the member companies' reduction of carbon dioxide emissions by 665 tonnes per year. The large difference between identified and implemented liquid effluent savings can be related to one specific opportunity that alone could save 164,000 m^3 of effluent from entering the local effluent treatment plant.

The reduced use of natural resources amounted to 1.2 GWh less electricity taken from the national grid per year, due to the implemented opportunities. Some 70,000 m^3 less water were abstracted annually, and 1400 tonnes less raw material were used, whilst maintaining the same rate of production. Quantified savings in consumables were fairly small; this was partly due to the fact that these had a lower priority, and partly due to difficulties in quantifying the savings of some initiatives.

4.2. The economic value of resource efficiency

A total of 115 implemented opportunities gave rise to total financial savings of £1,100,000 per annum by 13 member companies. On average this represented annual achieved savings of 0.4% of the member companies' turnover. The larger savings in waste minimisation often had an associated capital cost, with rarely more than one year's payback time. Comparing total capital expenditure by member companies and total annual savings achieved by member companies shows that the average payback time for all implemented opportunities was less than four months.

In all, some 90% of the total capital expenditure by member companies was related to technology change as a waste minimisation implementation method, and on the whole, payback periods for such outlay proved relatively short, at less than 8 months. Many of the other initiatives required less in the way of financial outlay and, wherever possible, input changes, product modification and good housekeeping were used to pick 'low hanging fruit', maximising returns and free resources for other work. Approximately £350,000 of savings was achieved through procedural change with an average payback time of less than one month. Procedural changes are the changes that change the approaches to thinking and acting within organisations. These require a dedicated focus by managers and the training of personnel in waste minimisation, in order to effect change. Whilst the capital cost is low, changing other people's way of thinking and acting requires time. As much as 40% of the obstacles to waste minimisation are socio-psychological, including bureaucratic resistance, human conservatism, public ignorance and misinformation [7], which was confirmed by the East Anglian Waste Minimisation in the Food and Drink Industry Project.

4.3. Putrescible and other raw material waste

The Project identified a common characteristic of salad and vegetable product manufacturing that raw material yields typically fall within the range 60–70% of the gross raw material input. Raw material wastage typically falls between 30–40% of the gross raw material input, although in some cases up to 50% wastage has been observed during the Project. These levels of wastage have been observed in the preparation of raw vegetables for supermarket shelves in convenience, prepacked and prepared salads and chopped vegetables. Where many thousands of tonnes of raw material are processed per day, thousands of tonnes of raw material waste are produced as a result. The significance of such figures is supported by the fact that the contribution to total waste arisings in 1993/1994 from food processing waste and vegetable waste was 11% of all wastes recorded [6]. The fact that raw material savings in the Project were worth 150 times more than the equivalent savings in landfill avoidance indicates that the landfill tax in the UK is doing little to stop this trend.

The high wastage of raw material also represents major potential for financial savings through resource efficiency for the food industry. A total of £700,000 in annual savings was achieved with an average payback time of 2.3 months. This represented 67% of total savings in the Project. Another resource efficiency project reported that 65% of the savings from 5 food manufacturing companies came from more efficient raw material use [8].

Extremely large quantities of food and vegetable wastes are sent to landfill in the UK at present. Landfill however will be more heavily regulated in future since the European Directive on the Landfill of Waste [9] was adopted. This Directive requires the characteristics of waste to be better defined and wastes will only be accepted which either is exempt from treatment or which have been pre-treated. Specifically, the amount of organic or biodegradable waste to be deposited in landfill sites will be controlled with the ultimate objective of stimulating the use of these wastes for compost feedstock.

Some sub-standard or ‘seconds’ standard food products may be sold on for use by fast food chains, prisons or state-funded hospitals, but market barriers prevent these products from being available to other consumers. The definition of sub-standard does not imply a lack of hygiene or nutritional quality, only that the visual characteristics may be impaired, as permitted by hospital purchasing guidelines. Some manufacturers experience an increasing stockpile of such products in coldstore. Ultimately, if these products are not sold they, like the sub-standard raw material, will have to be discarded.

In the case of the disposal of putrescible/biodegradable wastes, logical solutions indicate the continuing use of wastes for animal feedstocks, and the application of composting technology. Both these solutions return nutrients to soil and to the food chain, thus providing a very suitable life cycle benefit. The Ministry of Agriculture, Fisheries and Food set up an Advisory Committee on Animal Feedingstuffs (ACAF) in 1998 to consider if and how the food eaten by animals affects human health. There is growing concern over the use of food waste as animal feed due to the outbreaks of Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth disease. A statutory instrument regulating animal feeding came into force in 1999 [10] and a proposed amendment to this order [11] was issued in March 2001 that could partly or completely ban the use of waste from canteens and other food processors for livestock feeding.

In principle, composting facilities present an ideal solution to the challenge of turning food waste into a valuable product. A survey by the Composting Association (1998) [12] showed that the proportion of biodegradable waste entering composting schemes from commercial sectors in the UK has risen from 2% of feedstocks in 1993 to 31% in 1998.

The technical feasibility of using food waste has been principally questioned in relation to uncertainties surrounding the homogeneity of the process of destruction of pathogens during composting. Maintaining a high enough temperature within the compost piles enables the process of pathogen destruction [13] [14]. However, effective management regimes such as compost turning are essential to ensure the homogeneity of pathogen destruction throughout the compost mass [15]. Controls and evidence of strict operating criteria are required to demonstrate that food waste composting is conducted safely to meet Health and Safety requirements.

Operational evidence from the USA demonstrated by Kunzler and Farrell (1996) [16] indicates that the minimisation of waste disposal costs is increasingly focussing on the opportunities presented by food composting. The majority of the sites surveyed in 1995 had continued to thrive by 1996 and, in some cases had increased the amount or diversity of food waste accepted. Many of the American food businesses are reported to be likely to be offered tip fees at composting sites of around half or less that of the ‘local disposal option’, offering a clear financial advantage. The biggest savings are reported by institutions that conduct on-site composting.

In the UK, the DETR Composting Development Group has produced a report on the development and expansion of markets for compost [17]. Sadly, little attention was directed towards market factors associated with feedstock sources and feedstock compatibility. This has already been shown to be an important factor affecting the viability of the composting of food and vegetable wastes since other suitable compostable wastes are required for mixing.

5. Packaging waste

In 1997, sales of packaging to the food and drink industry were estimated at £5.82bn that amounted to over half of the total value of the packaging industry [18]. An increase in packaging use of 10% is predicted between 1993 and 2000 due to increased consumption and the increase of people living in smaller sized households [19]. This demographic trend is not only due to people living longer, but also to an increase in divorce rate and more people choosing to live alone.

The Project obtained industry-based information demonstrating that food producers and manufacturers have a number of viable and available options for reducing the weight of primary packaging. Additionally, manufacturers and producers are likely to have several options for eliminating or reducing the amount of secondary packaging. Many factors are involved in the successful identification of the most suitable options and their implementation.

Consideration is given firstly to food safety and hygiene when assessing the suitability of packaging of food products. Furthermore, if environmental criteria are then added, the packaging solutions for food products become more complex. Additionally, supermarket specifications impose constraints and these specifications may conflict with an optimum packaging solution chosen according to environmental criteria. In many cases that have been observed, it is the retailer specifications that are not flexible in terms of finding compromise packaging specifications.

In one example, top grade vegetables have portions shaved off in order to meet the contract specification for the number of items per crate. Alternative uses for the wasted part of the product were very limited and mainly ended up in landfill. If the bulk purchase contract specified sale by absolute weight rather than by price per heads of vegetable, the objective of reducing raw material wastage might be more achievable.

In another example, a gross weight of vegetables is packed according to a provisional order size so that they are ready for quick dispatch. Upon receiving the final confirmation order, the actual requirement is frequently smaller than that required by the provisional order. The unwanted vegetables then have to be unpacked in order to make them available for resorting and re-labelling and the packaging goes to waste. In this case, it is not operationally feasible to simply change the outer labelling since the vegetables will attract different batch specifications and despatch dates.

Each supermarket places different specifications on the packaging of any one vegetable. In a recent survey of celeriac production it was found that different supermarkets impose different packaging specifications per vegetable head:

- Two supermarkets require cling film packaging and a label,
- One supermarket requires no cling film packaging and no label,
- One supermarket does not require cling film packaging but specifies a label to be attached directly to the vegetable head.

The latter specification is difficult to fulfil in practice due to poor adhesive properties.

Following the EC Directive on Packaging and Packaging Waste (94/62/EC), the UK Government legislated for recovery and recycling targets under the Producer Responsibility Obligations (Packaging Waste) Regulations (1997) [2]. Under these regulations the ‘producer’ is defined as owning the packaging that he supplies whether it be to another stage in the supply chain, or to the final user of the packaging. The national targets set for 2001 are 52% for recovery, including 16% recycling [20] [21].

In practice, optimised packaging criteria designed to produce the least environmental impact are difficult to define without extensive dialogue. The various requirements of the supermarket, the needs of the consumer and the optimisation available to the producer or manufacturer may give rise to conflicting demands. The Producer Responsibility Regulations have increased the awareness of packaging use in the food and drink industry and strongly influenced the actions for reduced packaging use in the Project.

The Project has demonstrated that the design of packaging criteria to meet wide-ranging waste minimisation requirements produces a potential for financial savings. Most of the £65,000 achieved in annual savings came from the £52,000 invested in packaging technology such as wrapping machines. Extensive and open dialogue between supplier and supermarket is required in order to achieve non-technological progress in packaging efficiency. The Key Note Packaging (Food and Drink) Market Report (1998) [22] confirms that this dialogue is important:

> ‘the food and drink industry is at the forefront of packaging design, and manufacturers and designers are very dependent on the attitudes of the major national grocery supermarket chains, which account for the bulk of their sales’.

6. Energy

Approximately 15% of all electricity produced in the UK is used for refrigeration and air-conditioning, making it one of the most important energy-using technologies, comparable with lighting [23]. In the food and drink industry, the use of energy for refrigeration results

in one of the sector's most significant environmental impacts. Savings of £50,000 in the Project were directly related to refrigeration. This represented more than 75% of the total savings in electricity. Most successes in saving electricity were made by procedural changes and good housekeeping measures with no capital expense. Very few investments were made in cleaner technology to save electricity and the ones that were made had an average payback of 18 months, which was larger than the average payback for other waste minimisation savings.

Transport is another major energy user. Some transport savings were found by optimising distribution systems so that maximum carrying capacity is used in transport fleets at all times, but very few initiatives were taken to source raw material more locally and unsurprisingly no initiatives were taken to localise consumption. Between 1975 and 1990 more than a third of the increase in demand for freight was accounted for by the food, drink and tobacco sector [24]. Transport is an important focus area for sustainable food production and consumption systems, but at the moment very few incentives exist to persuade the industry to take this issue seriously.

6.1. Water and effluent

Water use in the food and drink industry is extensive at approximately 3000 Mm^3/year in the UK [25]. Cleaning accounts for a significant percentage of the total water use, as much as 70% in some food and drink sectors [26]. For the food and drink industry, a proportion of the water used often becomes part of the product. However, even in the brewing and soft drinks industries, where water is a major component of the product, only 20–30% of the total water consumed leaves in the product [27], with the rest being accounted for in atmospheric emissions or effluent. The effluents from the food and drink industry often have high Biochemical Oxygen Demand (BOD), thus contributing to the degeneration of local water bodies. Procedural changes and good housekeeping to reduce water use and effluent generation were fairly successful with more than £15,000 saved without any significant capital cost. Some changes in technology were made as well, but as for electricity the saving potential was not high enough to generate low payback times on investments. A lot of food and drink manufacturers use borehole water, which is charged on a consent basis rather than a water rate basis. This was a barrier to water savings.

6.2. Discussion of manufacturing site improvements for resource efficiency

The largest potential for the food and drink industry to reap financial benefits through waste minimisation is in reduction of raw material losses at source. This is evident from the East Anglian Waste Minimisation in the Food and Drink Industry Project, as well as the waste minimisation project carried out by Hillsdown Holdings Plc. [18]. Careful auditing, raw material handling and staff training have proved to be the keys to success. It is worth noting that the equivalent saving in reduced off-site disposal is less than 1% of the savings achieved in reduced raw material cost. This suggests the importance of reducing waste at source wherever possible, rather than by end-of-pipe treatment or recycling. It also suggests that the landfill charges, including landfill tax, have a very small impact on driving improvements in waste reduction in the food and drink industry.

A lot of the changes to cleaner technologies not only resulted in reduced use of materials or utilities, but also brought quantified savings in manpower. The level of manpower savings was surprisingly high, representing 12% of the total savings achieved in the Project. The companies claimed that staff was transferred to different parts of the organisation rather than being made redundant in all but one saving relating to manpower. Staff reductions are not in line with the aim of waste minimisation and sustainability, but the transferring of skills and jobs to areas where they can be more efficient is appropriate. The Project itself employed a significant number of people for an, albeit limited, time period. The companies achieving manpower savings (and other savings) are also more likely to be more competitive in the future and thereby grow, to enable further local employment.

The packaging reductions were often combined with reductions in staff, because of the trend to handle standardised packaging both faster and more material efficiently, by the use of machines rather than staff. Further packaging reductions must involve the supply-chain and this is discussed below. Electricity, water and effluent do not carry a high enough cost to provoke expenditure in cleaner technologies, but there are many small housekeeping initiatives available that together bring substantial savings. The low cost of effluent, water and electricity put them as low priority areas in most food and drink companies and this does not reflect the environmental impact of the industry.

Procedural changes accounted for £420,000 of the total annual savings with a 0.6 months average payback time. This indicates that there are a lot of easy and quick ways of improving the resource efficiency of operations as long as people are trained and start to question the existing operation.

6.3. Discussion of supply-chain improvements for resource efficiency

The evidence provided by the East Anglian Waste Minimisation in the Food and Drink Industry Project demonstrates that improved dialogue and consensus is required between consumers and the major supermar-

kets, and between the major supermarkets and producers and manufacturers. This will stimulate and enable further opportunities for waste minimisation and continuing environmental improvement. The Integrated Pollution Prevention and Control Directive will be implemented in the food and drink industry between 2002 and 2005 and includes waste minimisation and energy efficiency. This is likely to force the food and drink sector to pay more attention to environmental issues in the early years of this millennium.

Purchasing policies have the potential to make an important contribution to resource efficiency in the supply chain. If waste minimisation in all aspects of the food and drink industry is to be achievable, retailers must actively pursue and disseminate purchasing policies based on better supply chain optimisation including environmental criteria and objectives. A move towards more sustainable production and consumption systems will require purchasing policies that take into account the environmental impacts of production, packaging and transportation of food products.

It is highly desirable that the food and drink manufacturers' trading associations should promote dialogue in order to encourage better supply chain cooperation in relation to trade that minimises the use of primary and secondary packaging. Such a policy could apply market pressure and would contribute in turn to customer affirmation and spending behaviour. The British Retail Consortium could also apply market pressure by including cleaner production measures in their technical standards for companies supplying retailer branded food products.

A shared savings business model is described [28] as an arrangement between retailers and supplier whereby both receive financial incentives for reducing resource inputs and waste. This type of arrangement has received some attention in the US and is reported to have achieved success.

Alternative uses for the by-products of food production must be sought. These valuable by-products are often of prime quality and are only rejected from the production line as a result of standardisation requirements or retailer specification. In these cases offcuts may be sold on for use in fast food, soups or baby food. Better and more stable market opportunities are required for second grade food products. This will also involve the process of carefully specifying these by-products in order to eliminate health risks. BSE is one result of 'bad recycling' and 'poor specification' where waste meat products have been fed to herbivorous animals. The Foot and Mouth outbreak in the UK in February 2001 was probably caused by a farm feeding its pigs with canteen waste from a local restaurant that was not rendered according to existing specifications (heated to 100 °C for at least 1 hr). Since specifications are not always followed, the risk of human error will have to be taken into account. At current levels of concern about health risks and fear of epidemic outbreaks, there will always be a balance where health issues decide what level of resource efficiency is appropriate. Other novel approaches to using food and drink production wastes will be required, such as applications in natural dyes or in other natural products such as toiletries or cosmetics.

Better market opportunities are required for compost products incorporating food production waste. While the DETR Composting Development Group is currently addressing matters surrounding the market opportunities for compost, little indication is yet apparent of specific initiatives supporting food composting.

7. Conclusions

The value of resource efficiency in the food and drink industry can be as high as in other, more 'polluting' industries. The £1,100,000 annual savings achieved by the 13 member companies significantly exceeded the investment of £412,000 in the East Anglian Waste Minimisation in the Food and Drink Industry Project. The project indicated that resource efficiency can be improved at a low cost as long as people are trained and start to question the existing operation. Savings in raw materials carry the greatest potential for financial savings in the sector, whilst landfill charges in the UK, including landfill tax, have a very small impact on driving improvements in waste reduction in the food and drink industry.

If more sustainable food production and consumption is to be achievable:

- All sectors of this industry must actively pursue and disseminate policies based on a resource efficient supply chain that include the whole system of farming, processing, packaging, transportation, retail and consumption of food products;
- Manufacturers must give greater priority to reducing raw material wastage as far as practically possible, and to finding good alternative uses or composting solutions for wasted raw material;
- The balance between human, animal and environmental health needs to be researched further and properly addressed; and
- Increased resource efficiency must not replace manpower, but lead to job transfer and maintained or even increased number of job opportunities.

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