

Waste Minimization at Abattoir and Processor End in Beef Supply Chain

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ABSTRACT

The UK beef industry holds around 12% value of total agriculture in UK. However, it is currently suffering because of some series of events in the past like outbreak of BSE (Bovine Spongiform Encephalopathy), Foot and Mouth disease and reforms in CAP (Common Agriculture Policy). These events led to the ban on exports of British Beef, loss of headage subsidies of beef farmers and significant fall in demand of beef within the UK. The revenue of beef industry could be highly compensated by minimizing the waste in beef supply chain. According to a report by Food Chain Centre (UK), around 20% of costs incurred within the beef supply chain adds no value. It is a major concern for beef sector considering they are already in crisis as mentioned above. This article focuses on identification of root cause of waste in beef supply chain at abattoir and processor end. Thereafter, certain good management and operation practices are recommended to cope with the waste in beef supply chain. These good practices will boost the sinking fortunes of beef industry and create value for customers. These practices will further help in reducing the environmental pollution caused by the meat wastes.

1. INTRODUCTION

World population will be around 9 billion in 2050 as per UN's prediction. If current dietary consumption patterns persist, there will be a need to produce as much food in next 40 years to feed 9 billion people as we have done in the last eight to ten thousand years [1]. This constantly increasing demand for food has led to more transportation, greater exploitation of natural resources and high risk of food waste due to longer supply chains [2]. There should be greater emphasis on reducing food waste in supply chain to address global food security. Approximately, one third of the food produced is wasted along their supply chain from farm to fork [4] and is calculated as around 1.3 billion tonnes per annum. This waste is costing food producers (except fish and sea food) about \$750 billion annually [4]. Apart from global hunger issues, the environmental impact of inefficient food supply chain also needs to be taken into consideration like inefficient use of natural resources, for example water, fertile land and energy. Moreover, this waste is being predominantly disposed to landfill which causes pollution and emission of greenhouse gases like methane, whose potency as greenhouse gas is 23 times more than carbon dioxide. In the UK, government is working on diverting these wastes away from landfill through taxation, strict regulation and public awareness. It has been estimated by charities such as FareShare that up to 25% of food waste sent to landfill by retailers and food manufacturers is edible and can feed thousands of people. Because of all these reasons, food waste is drawing more attention from government bodies, Non-Government Organizations (NGOs) and other divisions of food supply chain like fresh meat, agriculture, retailers, packaging and catering.

Beef is an integral part of diet of British people and it accounts for around 12% of value of output of UK agriculture. The UK beef industry has suffered a lot in terms of decline of domestic consumer demand, reduction in their market share of total meat consumption and ban on their exports because of the outbreak of Bovine Spongiform Encephalopathy (BSE) and Foot and Mouth disease in previous decades. Other factors affecting beef industry are relatively high price, quality consistency, health and food safety concerns and changes in lifestyle. Moreover, since 2006, beef farmers have lost their headage subsidies and reduction in overtime because of the reforms in Common Agriculture Policy (CAP). They are now struggling with increasing costs for feed and other inputs, which has led to the decline in the number of large producers of beef. These events were accompanied by introduction of strict regulations, which are till date financially affecting all segments of beef supply chain. Many producers and processors of beef are struggling for their sustainable profit. The concentration of power of beef supply chain is lying in the hands of retailers. The processors are weak as compared to retailers because they don't have enough opportunity to create brand loyalty at

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consumer level and also retailers are flexible enough to switch from domestic products to imported products from abroad. Moreover, UK is a net importer of beef so there is an ample opportunity to increase the share of domestic beef by making their supply chain more efficient. It can be achieved by having an appropriate waste minimization strategy at every segment of supply chain and dedicated team of skillful people working for it. One of the major obstacles in this direction is that often, these wastes in supply chain are underestimated and not properly reported. Hence, they keep getting neglected. People in all the segments should be made aware of this negligence. Furthermore, the maintenance of quality of the product and its hygiene and merchandising standards of processors and retailers is a major issue for the minimization of waste. This article highlights the waste occurring at the abattoir and processor end. It gives the root causes of waste in the management and operation strategies of abattoir and processor, followed by some recommendations to overcome them. The next section highlights the waste in fresh meat industry, classifies the waste into various categories and explains these categories.

2. WASTE IN FRESH MEAT SUPPLY CHAIN

OECD/Eurostat (2005) have defined waste as materials that are not prime products, i.e. products produced for the market for which the generator has no further use for his own purpose of production, transformation or consumption and which he discards or intends or is required to discard. Waste may be generated during the extraction of raw materials, during the processing of raw materials to intermediate and final products and during any other human activity. Another definition of waste from EU Council Directive Waste 75/442 /EEC[91/56/EEC] (EU,1991a,b), as any substance or object the holder discards, intends to discard or is required to discard.

2.1. CLASSIFICATION OF WASTE

There are different kinds of waste occurring at various stages in beef supply chain. These wastes can be broadly classified as following: -

1. Animal By products (at slaughtering and Processing)
2. Product waste (from Processor to Retailer)

1. Animal byproducts are the products or carcass derived from animals, which are not fit for human consumption. They can be further classified into following categories depending upon the risk they pose to living beings: -

a. Category 1 (High Risk material) – It can only be disposed by incineration/processing in an approved plant. It includes specified risk material like brain and spinal cord. It constitutes around 12.1 % of total live weight of cattle [3].

b. Category 2 (Medium risk material)- It can be composted or used in biogas production. It includes deceased animals, blood & digestive tract content. It constitutes around 1.9 % of total live weight of cattle [3].

c. Category 3 (Low risk material) – it can be used in manufacturing of pet food, oleo chemicals, fertilizer etc. It includes waste from trimmed fat, rejected primals from metal detectors etc. It constitutes around 19.2 % of total live weight of cattle [3].

2. Product waste - It is the actual loss of edible meat during all stages of supply chain viz. farm, processor and retailer. This waste is then rendered along with animal byproducts and is not good enough for human consumption. This article deals with the product waste occurring in the abattoir and processor end in beef supply chain.

This section briefly explained the classification of waste occurring in the beef supply chain. These two broad categories of product waste and animal byproducts are related to each other. Product waste is usually caused by the human errors or deficiency in management practices. This product waste generated is then treated along with animal byproducts depending upon the hazards associated with it. For example, fat trims generated because of over trimming of primals, which is a form of product waste, is usually treated as Category 3 waste. But, if it is too much contaminated then it is treated as Category 2 waste. The next section briefly includes the work done by researchers in the field of red meat supply chain and certain approaches followed for minimization of waste in this domain.

3. LITERATURE REVIEW

There is lot of research being carried out on waste minimization in manufacturing industries like automobile industry, textile industry etc. However, the research on waste minimization is still in its primitive age, when it comes to food industry especially fresh meat industry. There is increasing concern over the sustainability of red meat industry in recent past, which led to some research being done to confront the waste associated with it. David et al [5] have highlighted the main difficulties faced by red meat supply chains in UK. For example, carcass imbalance, bullwhip effect etc. They have used value chain analysis approach. This project was carried out by red meat industry forum and was funded by UK government. They have given suggestive measures to enhance product flow and resource utilization in British red meat supply chains. David H. Taylor [9] have also employed value chain analysis method and discussed the model of integrated supply chains. They have highlighted the need for strategic modifications in British agri-food supply chains. They have included two case studies on pork supply chains and explained the benefits of integrated supply chains in agri food products. The summary report of Food Chain Centre [7] has followed the lean approach to confront waste associated with red meat supply chain. They have highlighted some crucial factors, which are very influential for waste in red meat supply chain. They have laid emphasis on supply chains having strong horizontal and vertical coordination among stakeholders, which would increase the operational efficiency. Hornibrook et al [11] examines the influence of information asymmetry and environmental uncertainty on contractual relationships between the stakeholders of beef supply chain. They have included two stage case studies stressing on coordinated supply chains based on perceived risk theory and principal agent theory. Moreover, they have explained the benefits of coordinated supply chains. Victoria [12] explained the utilization of information technology in various activities in beef supply chain. They have reviewed various technologies being adopted in this domain. They have mentioned the economic and institutional factors affecting the adoption of information technology in strengthening the linkage in beef supply chain. Ferry et al [8] have drawn a comparison in management practices followed in beef supply chain in Australia, United Kingdom and United States. This comparison was drawn on the grounds of legislation, value attributes, and structure of industry and consumer confidence. They have suggested which strategy will be suitable for the beef supply chain of these aforementioned countries. Ferry et al [6] have identified the performance indicators in context of Australian beef supply chain. They have done survey of personnel associated with all stakeholders of beef supply chain viz. farmers, producers, retailers. Their opinion was analyzed using regression analysis and it was shown which performance indicators are valuable for a particular stakeholder. Kees –Jan [9] highlighted the evolution of product information for beef because of BSE (Bovine Spongiform Encephalopathy). They have used two case studies explaining beef labeling in pre and post outbreak of BSE. Moreover, it has mentioned the importance of traceability for all stakeholders of beef supply chain. The Economist Intelligent Unit [10] has also explained the significance of traceability in beef supply chain. It has explained the difficulties in maintaining traceability at each stage of beef supply chain. The next section explains various components of beef supply chain and explains the product flow between them.

4. BEEF SUPPLY CHAIN

This section explains the complete beef supply chain from farm to fork. The schematic diagram of complete beef supply chain is shown in Figure 1. Farmers at beef farms, grow up their cattle till the age of 3 months to 30 months depending upon the breed of cattle. Then, these cattle are transferred to abattoir where they are slaughtered and cut into primals. These primals are sent to processor where they are developed into specific products like steaks, mince, dicer and stirfry, burger/meatball etc. These products are packed and labeled at processor and sold to wholesalers and retailers. Some, wholesalers in turn further sold these beef products to retailers. Then, rest of the products left with wholesalers, are sold to food service industry which serve the customers with cooked beef. The retailers sold the raw beef received from the retailers and wholesalers to the consumers. This article deals with the product waste occurring in the operation of abattoir and processor, which is described in next section.

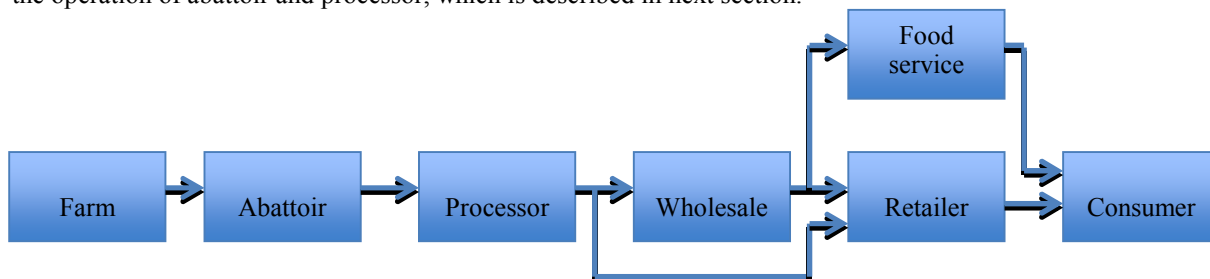


Figure 1. Showing complete beef supply chain [15].

5. ABATTOIR AND PROCESSOR

Cattle are brought from farm to slaughterhouse when they are ready for finishing. They are slaughtered by giving them electric shock in the stunning chamber. Now, the carcass is cut into forequarter and hindquarter. Then, forequarter and hindquarter are transferred into Maturation Park where they are being matured for about 7-21 days depending upon its breed, weight and conformation. This maturation process is performed because the meat derived from matured carcass is having much better attributes like tenderness and flavour. Thereafter, these quarters are then further cut into primals. These primals are then taken to boning hall where they are being de boned. Thereafter, they are processed into different products like steak, joints, mince, dicer & stir-fry, burger/meatball etc. These products are then packed, labeled and sent to retailers or wholesalers for sale.

5.1. ROOT CAUSES OF PRODUCT WASTE AT ABATTOIR AND PROCESSOR END

The abattoir and processor end is one of the crucial stages in the whole beef supply chain because of its location being in the exact middle of supply chain. The product waste occurring here significantly affects entire beef supply chain and at times can amplify at some ends like towards farm end. The product waste at abattoir and processor end occurs at different stages because of different reasons. These reasons are described as following: -

1. Floor waste – In the process of butchering and boning, edible pieces of meat fall on to the floor because of carelessness of the butchering staff. These pieces are discarded for human consumption because of health and safety issues.
2. Over trimming of primals – Sometimes, primals are over trimmed because of the carelessness of butchering staff, which leads to loss of edible meat. These waste trims are then transferred to Category 3 waste for manufacturing of pet food.
3. Over maturation of carcass – Carcass are matured in chilled maturation park from 7- 21 days after slaughtering depending upon their breed, weight and conformation. But, if a particular carcass is over matured by mistake then the shelf life of the meat derived from it will be very less.
4. Rejection of cattle – When cattle arrive at slaughterhouse from farm, their ante mortem inspection is being performed. If they are suffering from any infection or a major physical injury, they could not be slaughtered and processed. Moreover, they should be isolated from other cattle as early as possible so that the infection is not transferred to the healthy cattle.
5. Inefficient operation – The butchery and boning process could be very inefficient and careless. They might not be following a standard calculated time called takt time for their whole operation from starting of the line till the end. This takt time is calculated in conjunction with the demand placed by the retailers so that extra products are not produced saving the space in inventory and the shelf life of beef. The boning line might not be balanced and the distribution of workload could be uneven for people working on the same line. Moreover, certain slaughterhouses have very bad ergonomics because of certain operations performed against gravity. Like, in some cases, during de boning operations, waste trims and bones are handballed, against the gravity to the overhead conveyors [14], which exhaust the staff more rapidly and take more time.
6. Product contamination – Sometimes, meat gets contaminated, if proper health and safety guidelines and sterilized instruments are not used by the butchery staff, which leads to the rejection of edible meat.
7. Failing metal detector test - Certain products derived from beef like mince, might fail the metal detector test carried on them after their packaging and labeling. This happens because the product was in excessively physical contact of metallic mincer and other metallic instruments. This phenomenon will lead to rejection of the product as it is unfit for human consumption.

8. Machine breakdown - Sometimes there could be breakdown of machinery, which leads to stopping of the whole line. This results in delaying of whole process and at times, there is some product discarded as well which was going through the processing in that machine.
9. Loss of traceability – There is a strong opportunity that meat derived from cattle of different farms might get mixed while getting processed at the processor. This is one of the challenges in achieving the traceability of beef.

These above mentioned root causes of waste in beef supply chain at abattoir and processor end are depicted in Figure 2. It shows that some of these root causes are interconnected and collectively all of them lead to product waste.

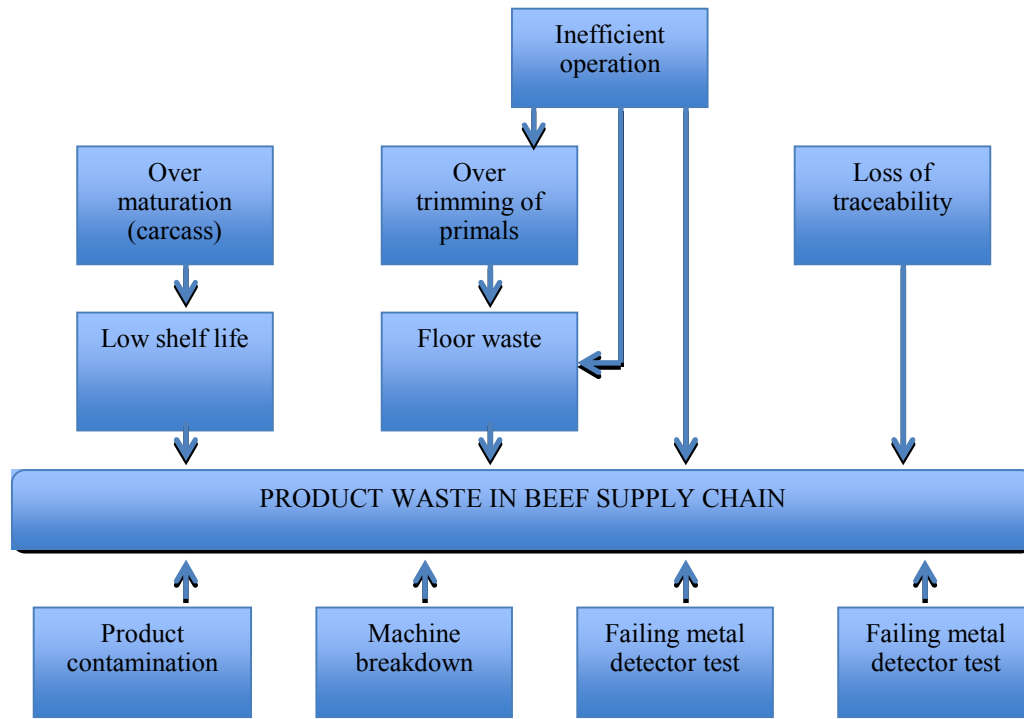


Figure 2. Showing the root causes of product waste in beef supply chain.

5.2. RECOMMENDATIONS

The root causes of waste at processor in beef supply chain shows that the waste is occurring because of some bad practices followed in operation and management at the abattoir and processor end. The issues highlighted by these root causes can be dealt with improvement in the conventional management practices followed. These good practices are listed below: -

1. Careful product handling- In the butchery and boning operations, meat should be handled carefully and skillfully so that it doesn't fall on the floor. It can be achieved by giving proper training to the butchery staff and avoiding their prolonged shifts and overtime.
2. Optimum trimming- The butchery staff should be taught well both theoretically and practically for performing trimming operations for a particular breed of beef so that edible meat is not lost in the form of trims. They must also be regularly inspected so that if somebody is not working as per guidelines, he could be trained again.

3. Proper maturation of carcass – There should be extra care taken that the carcass of beef is matured as per its breed, weight and conformation. It can be done by either having separate maturation park for a particular lot or extra precautions taken by staff in achieving the appropriate maturation for each carcass.
4. Well-being of cattle – The movement of cattle should be made stress free so that they don't incur physical injuries. The ante mortem inspection of cattle should be performed at an early stage when cattle reach to slaughterhouse from farms. This will help to diagnose the infections and physical injuries in the cattle so that they can be isolated from the healthy cattle thereby saving them from contamination.
5. Efficient operation - The operations in the butchery and boning processes should be based on a takt time calculated as per the demand placed by the retailers. This will help to reduce the waste and maintain equal workload among all the staff working on a particular line. Moreover, gravity ergonomics must be followed to increase the efficiency of staff and reduce the waste. The carcass should be attached to hook and moved along the lines so that staff can perform their operations and both meat and waste (like bones) fall on separate conveyors with the gravity. So, that they don't have to handball anything against the gravity to overhead conveyors.
6. Avoid product contamination – All equipment used in the butchery and boning operations should be carefully sterilized. Moreover, the staff should be trained so that their operations are as per the health and safety guidelines. They could be regularly monitored to ensure this activity.
7. Minimum contact with metal – All the processes in the processor end, especially mince should be designed so that there is no unnecessary contact of meat with the metallic equipment. This will save the meat from rejection in the metal detector test.
8. Preventive maintenance of machines- There should be regular operations of performing preventive operations of the machine so as to reduce the frequency of breakdowns in them thereby reducing the consequent product waste.
10. Traceability ensured – There must be extra precautions taken so that carcasses from different farms does not get mixed while getting processed. It can be achieved by giving proper training to staff or using appropriate barriers in between the carcasses (or meat derived from them) from different farms. Moreover, processor can go for processing carcass from one farm at a time. This could be an expensive option but can be trade off by the high cost derived from the premium beef, which claims 100% traceability.

This article deals with highlighting the root cause and then giving the corresponding recommendations to cope with them. The result of this research is being summarized in Table 1, showing both the root causes and recommendations against them.

Table 1. Showing root causes of waste at abattoir & processor & corresponding recommendations.

S. No.	Root Cause	Recommendations
1.	Floor waste	Handling of product should be done carefully while cutting and deboning so that it does not fall on floor.
2.	Over trimming of primals	Trimming of fat should be done carefully and butchery staff should be well trained.
3.	Over maturation of carcass	Carcass should be optimally matured depending upon its breed, weight and conformation.
4.	Rejection of cattle	Proper care should be taken in movement of cattle and ante mortem inspection should be done at earlier stage
5.	Inefficient operation	5.1. butchery and Boning processes based on Takt time. 5.2. Cutting operation should not be performed against gravity. 5.3. Line balancing should be ensured.
6.	Product contamination	All equipment used should be properly sterilized and proper procedures must be followed while processing the meat.
7.	Failing metal detector test	Ensure minimum contact of meat with metallic equipment.
8.	Machine breakdown	Preventive maintenance of machines on regular basis.
9.	Loss of traceability	Appropriate barrier between carcass from different farms or processing of carcass from one farm at a time.

6. CONCLUSIONS AND FUTURE RESEARCH

There is growing concern about feeding the increasing world population as farmers are gradually running out of land, water and other resources to produce proportionate crops and meat products. Moreover, meat industry consumes roughly about 13 times more off these resources as compared to crops in producing the same output. Therefore, there is a huge uncertainty in the future of meat industry. This cannot be dealt by developing new technologies to harness more output from our limited resources alone. There must be equal emphasis on waste minimization in meat industry simultaneously to confine the severity of this upcoming disaster.

This article deals with the concept of waste minimization in beef industry especially at abattoir and processor end. It classifies this waste into product waste and three categories of animal byproducts. It identifies the root causes of the waste. It further presents recommendations corresponding to each root cause in terms of good management practices to confront the waste occurring in beef supply chain at abattoir and processor end. This will help both the large scale and the small-scale abattoirs and processors to optimize their supply chain and boost both their product and financial output.

The limitation of this article lies in the fact that it deals with waste at just abattoir and processor end of beef supply chain. There is scope for future research at other segments of beef supply chain like farm and retailer or an interface of two segments like abattoir–retailer. Moreover, there is a scope of performing a pilot study at abattoir and processor end in beef supply chain, which can highlight the waste, occurred in actual figures and test the potency of suggestive measures in addressing them.

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