Shelf life extension and food waste reduction

Pegah Amani[1], Lars-Erik Gadde[2]

[1] SP Technical Research Institute of Sweden - Food and Bioscience, Gothenburg, Sweden
[2] Chalmers University of Technology, Gothenburg, Sweden
Pegah.amani@sp.se

Abstract

Waste is a significant problem in food supply chains. There is potential for spoilage of food products at any stage of the supply chain when the products reach their "best before" or "salable date". As a key to the food waste problem, there is a trend towards developing shelf life extension solutions that are intended to allow products not only to last longer but also to improve their quality and nutritional benefits.

The objective of this study is to explore whether shelf life extension actually results in the expected reductions of food waste. This issue is motivated by potential problems related to complexity in supply chains and consumer behavior.

The study is based on a comprehensive literature review and empirical findings from several studies of the structure and functioning of food supply chains undertaken by a food research institute.

This work concluded that the relation between shelf life extension and food waste reduction does not appear to be straightforward. Complex consumption behavior (e.g. shopping in larger volume results in longer storage periods at households), in combination with long supply chains and several storage points, implies that shelf life extension may not guarantee consumption before products have reached the "best before date". Another important factor is the increasing demand for so-called "fresh products", which may lead to the perception that products with longer shelf life are considered less fresh.

This study has shown the need to more closely investigate the effects of various measures (such as shelf life extension) that are applied to reduce food waste. To that end, it would be beneficial to develop a method to investigate and monitor the effectiveness of proposed shelf life extension solutions for the purpose of food waste reduction with a holistic system perspective. This would also help policymakers in their decision-making process as well as solution providers to improve the effectiveness of such solutions. With this perspective in place, the effectiveness of such solutions could be improved. This would also help policymakers in their decision-making process.

Introduction

Food waste is a significant contributor to the overall EU negative environmental impacts, responsible for 17% of direct greenhouse gas emissions and 28% of material resource use. The amount of annual food waste in Europe is estimated to increase from over 100 million tons in 2014 to about 126 million tons by 2020 (European Commission, 2015). The target set at the European level aims at 50% prevention of avoidable food waste by 2025 (European Parliament, 2012).

There is potential for spoilage of food products at any stage of the supply chain when the products reach their "best before" or "salable date". As a key to the food waste problem, solutions have been developed intending to allow products to last longer through a wide range of preservation techniques including packaging solutions (e.g., vacuum or modified atmosphere packing), chilling, freezing, pasteurization, sterilization, etc. (Gould, 1996). Other studies confirm the potential role of such technologies including packaging in providing a solution to other aspects of global food wastage through extending the shelf-life of fresh foods and thus preventing food spoilage (Williams et al. 2012, anonymous 2013a, b, Christiansen 2014, Bowling 2013).

However, there is lack of evidence whether a longer shelf life necessarily reduces waste in terms of guaranteeing consumption before reaching the best before date. This uncertainty is due to the complexity of food supply chains (Van der Vorst et al., 2005, van Donk et al., 2008, van Donselaar et al., 2006, Verdouw et al., 2010, Christopher et al., 2009, Taylor and Fearne, 2009, Gedenk et al., 2010, Roth et al. 2008) as well as consumption behaviors (WRAP, 2013, EC, 2010, EPRS, 2014, Gjerres & Gaiani, 2013, Grunert, 2014).

Objective

This study strives to explore whether shelf life extension actually results in the expected reduction in food date waste. This issue is motivated by problems related to the complexity in supply chains and consumer behavior.

Method

The results and conclusions presented in this report foremost build on a literature review in addition to selected empirical data gathered through study visits and interviews performed within the project "Reduced waste in the food chain – with a holistic perspective" (2011-2013), financed by The Swedish Board of Agriculture, the Swedish Food Federation and the Swedish Retailers Association aiming at elaborating the amounts and causes of food waste and possible ways to prevent food waste in the food supply chain as a whole (see Lindbom I., et al. 2014).

Analysis and discussion

This section is split into two parts, one considering the firms in the food chain and the other the consumer's side. This split seems useful since the consumer is more or less locked out of the processes on the production and retail side. Therefore, a separate approach provides a better focus on the consumer issues.

1. Shelf life extension and the food chain

The food sector has to manage a number of complexities generally dealt with in supply chain management, besides product perishability (van Donk, 2000, Van der Vorst et al., 2005).

These complexities include the handling of large volumes and overly increasing product variety in terms of packaging sizes and recipes (Van der Vorst et al., 2005, van Donk et al., 2008). Moreover the supply chain features variation in terms of production and delivery lead times for various products, although lead times in general are short (van Donselaar et al., 2006, Verdouw et al., 2010). The supply uncertainty is substantial, leading to low predictability and stability of supply (van Donk et al., 2008, Christopher et al., 2009). There is also demand uncertainty, largely caused by high and increasing frequencies of promotional activities (Taylor and Fearne, 2009, Gedenk et al., 2010). Finally, the multi-layered supply chain structure is strongly affected by the bullwhip effect resulting in poor visibility throughout the chain (Roth et al. 2008).

All these features impact on inventory management. The cost of lost sales is often higher than inventory-carrying costs (Ketzenberg and Ferguson, 2008). Therefore, firms would profit from increasing product storage in order to reduce the amount of lost sales. Keeping products in storage for a longer time is problematic when it comes to perishable products. A major trend in food supply chains has therefore been to rely on shelf life extension solutions.

There are “unwritten rules” by supermarket chains that they require products delivered to their shops to retain a substantial amount of shelf life. One Swedish retailer requires 2/3 of remaining shelf-life, while two others demand at least 80%. Consequently, the amount of remaining shelf life has to be taken into account in the preceding stages of the supply chain, ensuring that at the point of delivery, the respective date for this retailer has not been exceeded.

Data from the warehouse of one dairy producer showed a considerable reduction in waste when shelf life for cream and yoghurt was extended three times. A vast majority of cream products with shorter shelf life leave the production storage even before reaching their salable date. With this extended deadline, the cream with three times the shelf life shouldn’t yield any waste at all. Yet there is still a yearly waste of over 3 tons of products which never even enter the next stage of the supply chain.

Interviews with personnel working at production warehouses, as well as retail stores, revealed that they are more inclined to control the storage levels of products with shorter shelf life and prioritize their handling in comparison with long-life products. For instance, milk with prolonged shelf life passes through the retailer’s central storage while products with short shelf life are directly driven to the supermarkets.

This means that products with longer shelf life stay in storage longer. Moreover, the longer shelf life of these products also leads to less frequent production. For example, a product with one week of shelf life cannot be produced just once a week. But this production frequency might become an option when shelf life is extended to several weeks. Accordingly, the production frequency is linked to the shelf life. These conditions may be part of the explanation why the increase in the shelf life didn’t completely remove the waste at the storage: the flow of goods was slowed down from production to distribution.

The results for yogurt waste, with a similar shelf life at the production warehouse, varied depending on the demand for different flavors. Yogurt flavors in higher demand featured lower waste than those with low demand. In order to capture potential economies of scale low-demand yoghurts were produced in large batches as seldom as possible.

Figure 1 summarizes data from several randomly selected Swedish food companies concerning the average number of days that different product groups are stored before delivery. Product groups are sorted according to increasing shelf life from the left to the right. Figure 1 confirms the clear correlation between shelf life and the time products are kept in storage: the longer the shelf life, the longer the time in storage.

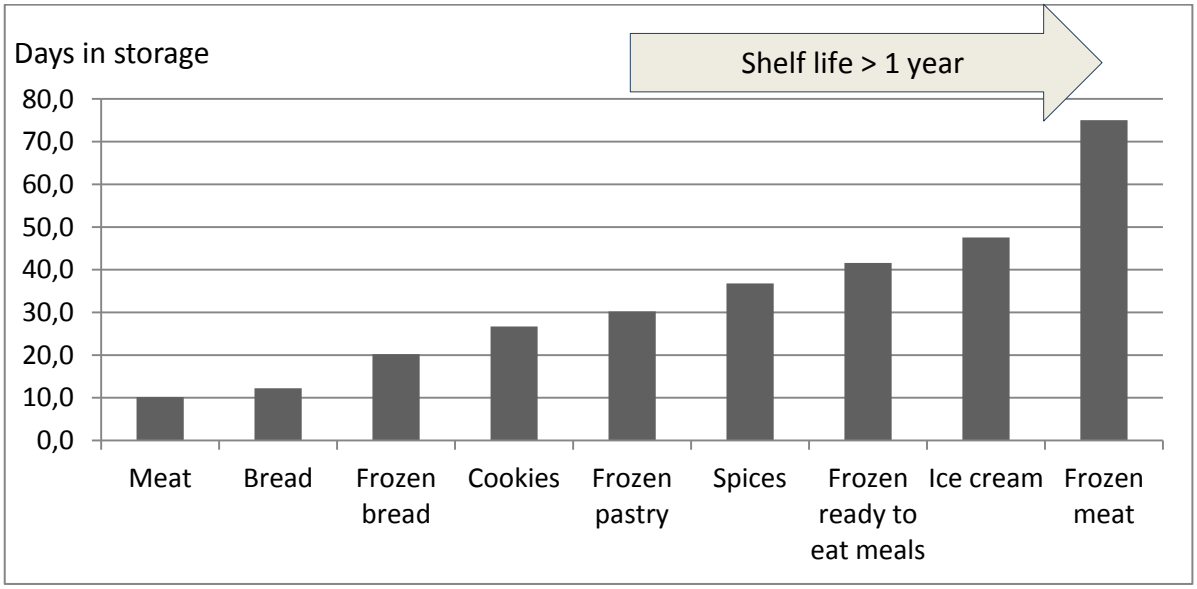

Figure 1- Shelf life and time in storage
(Adapted from Lindbom, et al. 2014)

Based on these data, it can be argued that the prolongation of shelf life does not necessarily reduce waste. Yet it may contribute to supply chain efficiency through increasing economies of scale.

2. Shelf life extension and the consumers

The consumer's primary point of contact with shelf life extension is through packaging. While packaging covers a range of other functions, it also has a significant role in reducing food waste. Some achievements in this regard are mentioned by WRAP (2013), including reclosing packs to prevent dehydration in the fridge; small sized and/or subdivided packaging (e.g. salads, sliced meats, bakery products), extra-filtered fresh milk, vacuum-packed fresh meat, and intelligent packs for fresh fruit & vegetables, which helps stop them over-ripening. Some packaging also advises the consumer to "freeze before the date" and use the product at a later date. Other studies mentioned other factors, such as improving the design of the secondary packaging (Bowling 2013), flexible packaging, resealability, less weight for shipping and transporting of the package, as well as using less volume to take up valuable landfill space. All of these measures contributed to a decline in food wastage (Wolford, 2014). Other investigated measures encompass improved pack sealing (Anonymous, 2014) and developing sensors for monitoring the release of gases in the food package (Huy Quoc et al., 2013).

Although the public perception of packaging is dominated by end-of-life aspects, when the packaging becomes waste (Barlow and Morgan, 2013), packaging is considered a "lesser evil". It is generally considered that the food production stage has much greater environmental impact than packaging,

wherefore packaging solutions may open as yet untapped savings potential (Silvenius, et al., 2014). Furthermore, it is stressed that food losses are seldom included in life cycle analyses of the food packaging system, nor are they included in the debate on sustainable packaging. This might then indicate a packaging less prone to food waste as a favorable alternative (Wikström and Williams, 2010). It is suggested that packaging attributes, such as desired quantity, mechanical protection, easy opening, and food safety/freshness information should be included in simple scenario techniques when deciding on packaging (Wikström, et al., 2014).

However, consumers' apparent lack of knowledge and awareness (Comber & Thieme, 2013; Whitehair, et al., 2013) and ability to manage their food provision, storage, preparation (WRAP, 2014; Farr-Wharton, et al. 2014; Terpstra, et al., 2005) or make the best and most effective use of such packaging creates problems. Such difficulties include people not making use of a packaging functionality (such as reclosing packs to prevent dehydration in the fridge). Moreover they do not always follow guidance on packages (e.g. when to consume by, how to store, whether the product can be frozen, etc.) Studies show that 22 % of consumers acknowledge that packaging "extends the life of the product" (WRAP, 2013), yet others remove food from the packaging before putting it into storage. Some consumers pierce the packaging to "let it breathe", even though the packaging is designed to keep the food fresh for longer (WRAP, 2013). Such an awareness level and attitudes/preferences (EC, 2010), consumer intentions (Evans, 2011, Watson & Meah, 2013), and culture and behaviour (EPRS, 2014 Williams, et al., 2012), and accordingly impact of ethical implications (Gjerres & Gaiani, 2013)) could vary for diverse consumer groups (WRAP, 2014). Activities which positively affect such influencing factors are likely to offer another valid approach to reducing food waste on the consumer side (WRAP, 2013).

Packaging could have an essential role to play in preserving the value invested in products by ensuring that they can deliver their designed service with minimum wastage. However, considering the complexities in supply chain and consumption behavior, solutions to the food waste problem must be critically examined to determine whether they can fulfill their promises of reducing food waste, considering the whole chain in the entire life cycle of the product. Only when these aspects are confirmed, such solutions can be described as more sustainable.

Conclusion

The relation between shelf life extension and food waste reduction does not appear to be straightforward. Complex consumption patterns (e.g. shopping in larger volume results in longer storage periods at households) in combination with a long supply chain and several storage points, imply that shelf life extension may not guarantee consumption before products have reached the "best before date". Another factor is the increasing demand for so-called "fresh products", which may lead to the perception that products with longer shelf life are considered less fresh.

This study has shown the need to more closely investigate the effects of various measures (such as shelf life extension) that are applied to reduce food waste. To that end, it would be beneficial to develop a method to investigate and monitor the effectiveness of proposed shelf life extension solutions for the purpose of food waste reduction with a holistic system perspective. This would also help policymakers in their decision-making process as well as solution providers to improve the effectiveness of such solutions.

While this study has been limited in its scope, further investigation over a wider range of products would prove helpful in creating a fuller image of such a holistic perspective.

References

Anonymous (2014). Making it stick - how better pack sealing can cut food waste. Food Engineering & Ingredients, 39(2), 22-25.

Anonymous (2013a). Packaging industry has vital role in reducing food waste. Popular Plastics & Packaging, 58(2), 62.

Anonymous (2013b). Proper packaging can reduce food waste. Ecos, (185), 1-2.

Barlow, C., & Morgan, D. (2013). Polymer film packaging for food: An environmental assessment. Resources, Conservation And Recycling, 7874-80.

Bowling, D. (2013). Waste not, want not. Food Magazine, 6-9.

Christiansen, K. M. (2014). Plastics in packaging: the year against food. Flexible Packaging, 16(3), 18-19.

Christopher, M., Towill, D. R., Aitken, J. & Childerhouse, P. (2009). Value stream classification. Journal of Manufacturing Technology Management, 20, 460-474.

Comber, R., & Thieme, A. (2013). Designing beyond habit: Opening space for improved recycling and food waste behaviors through processes of persuasion, social influence and aversive affect. Personal And Ubiquitous Computing, 17(6), 1197-1210.

EC (2010). Prepatory study on food waste across EU 27: Technical Report - 2010 - 054 (No. ISBN : 978-92-79-22138-5). European Commission. Retrieved August 15, 2014, from http://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf.

EPRS (2014). Tackling food waste The EU's contribution to a global issue: Briefing 23/01/2014.

European Commission. (2015). Food waste: http://ec.europa.eu/food/food/sustainability/index_en.htm.

European Parliament. (2012). Avoiding food wastage: http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P7-TA-2012-0014+0+DOC+XML+V0//EN.

Evans, D., Campbell, H., & Murcott, A. (2013). A brief pre-history of food waste and the social sciences. The Sociological Review, 60(2), 5–26.

Farr-Wharton, G., Foth, M., & Choi, J. (2014). Identifying factors that promote consumer behaviours causing expired domestic food waste. Journal Of Consumer Behaviour, 13(6), 393-402.

Gedenk, K., Neslin, S. A. & Ailawadi, K. L. (2010). Sales Promotion. IN KRAFFT, M. & MANTRALA, M. K. (Eds.) Retailing in the 21st century; current and future trends. 2nd ed. Berlin Heidelberg, Springer-Verlag.

Gjerres, M., & Gaiani, S. (2013). Household food waste in Nordic countries: Estimations and ethical implications. Etik i praksis. Nordic Journal of Applied Ethics, 7(1), 6–23.

Gould, G.W. (1996). Methods for preservation and extension of shelf life. International Journal of Food Microbiology, 33, 51–64.

Grunert, K. G., et al. (2014). Sustainability labels on food products: Consumer motivation, understanding and use. Food Policy, 44(0), 177-189.

Huy Quoc, N., Bao Quoc, T., Hoivik, N., Halvorsen, E., & Aasmundtveit, K. (2013). Carbon nanotube based gas sensor for expiration detection of perishable Food. Proceedings of the 13th IEEE Conference on Nanotechnology, 675-678, Beijing, China, 5-8 Aug. 2013.

Ketzenberg, M. & Ferguson, M. E. (2008). Managing slow-moving perishables in the grocery industry. Production and Operations Management, 17, 513-521.

Lindbom, I. Gustavsson, J., Sundström, B. (2014). Minskat svinn i livsmedelskedjan – ett helhetsgrepp Slutrapport Ingela Lindbom, available at: http://www.sik.se/archive/pdf-filer-katalog/SR866.pdf.

Roth, A, Tsay, A, Pullman, M, & Gray, J. (2008). Unraveling the food supply chain: Strategic insights from China and the 2007 recalls, Journal of Supply Chain Management, 44, 1, p. 22-39.

Russell, D. A. (2014). Sustainable (food) packaging – an overview. Food Additives & Contaminants. Part A: Chemistry, Analysis, Control, Exposure & Risk Assessment, 31(3), 396-401.

Silvenius, F., Gronman, K., Katajajuuri, J., Soukka, R., Koivupuro, H., & Virtanen, Y. (n.d). (2014). The Role of Household Food Waste in Comparing Environmental Impacts of Packaging Alternatives. Packaging Technology And Science, 27(4), 277-292.

Taylor, D. H. & Fearne, A. (2009). Demand management in fresh food value chains: A framework for analysis and improvement. Supply Chain Management, 14(5), 379-392.

Terpstra, M. J., Steenbekkers, L. P. A., de Maertelaere, N. C. M., & Nijhuis, S. (2005). food storage and disposal: Consumer practices and knowledge. British Food Journal, 107(7), 526–533.

Van der Vorst, J.G.A.J., Beulens, A.J.M., and Van Beek, P. (2005). Innovations in logistics and ICT, in food supply chain networks, In: W.M.F. Jongen and M.T.G. Meulenberg, eds. Innovation in agri-food systems, product quality and consumer acceptance. Wageningen, Neherlands: Wageningen Academic Publishers, 245–292.

Van Donk, D. P. (2000). Customer-driven manufacturing in the food processing industry. British food journal, 102(10), 739

Van Donk, D. P., Akkerman, R. & Van Der Vaart, T. (2008). Opportunities and realities of supply chain integration: The case of food manufacturers. British Food Journal, 110(2), 218-235.

Van Donselaar, K., van Woensel, T., Broekmeulen, R., & Fransoo, J. (2006). Inventory control of perishables in supermarkets. International Journal of Production Economics, 104(2), 462-472.

Verdouw, C. N. & Wolfert, J. (2010). Reference process modelling in demand-driven agri-food supply chains: a configuration-based framework. IN TRIENEKENS, J., TOP, J., VAN DER VORST, J. & BEULENS, A. (Eds.) Towards effective food chains; models and applications. Wageningen, Wageningen Academic Publishers.

Watson, M., & Meah, A. (2013). Food, waste and safety: negotiating conflicting social anxieties into the practices of domestic provisioning. The Sociological Review, 60(2), 102–120.

Wikström, F., Williams, H., Verghese, K., & Clune, S. (2014). The influence of packaging attributes on consumer behaviour in food-packaging life cycle assessment studies - A neglected topic. Journal of Cleaner Production, 73, 100-108.

Wikström, F., & Williams, H. (2010). Potential environmental gains from reducing food losses through development of new packaging - a life-cycle model. Packaging Technology And Science, 23(7), 403-411.

Williams, H., Wikström, F., Otterbring, T., Löfgren, M., & Gustafsson, A. (2012). Reasons for household food waste with special attention to packaging. Journal Of Cleaner Production, 24, 141-148.

Whitehair, K. J., Shanklin, C. W., & Brannon, L. A. (2013). Written Messages Improve Edible Food Waste Behaviors in a University Dining Facility. Journal of the Academy of Nutrition and Dietetics, 113(1), 63–69.

Wolford, E. J. (2014). Our industry's important role in lessening food waste. Flexible Packaging, 16(3), 16-17.

WRAP (2013). Consumer Attitudes to Food Waste and Food Packaging.
WRAP (2014). Household food and drink waste: A product focus: Project code: CFP204.