Imperial College London

Sainsbury's

Sustainable Energy Futures Conference 2014

19th September 2014

Developing Sustainable Food Supply Chains
Decarbonising the Strawberry Supply Chain

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INTRODUCTION

Supermarkets are one of the largest commercial energy consumers. However, the costs and emissions arising from their supply chain are significantly higher compared to their customer facing retail activities. It is argued that the food supply chain in the UK is responsible for 195MtCO_2e per year and 15Mt of food waste, which accounts for more than 30MtCO_2e [1]. Energy consumption in the food chain is estimated to be 367TWh annually, which is almost equal to 18% of UK's overall final energy use [1]. Hence, there is a great need and opportunity for companies to reduce costs and emissions in their supply chain and especially their food supply chain, due to additional costs and emissions arising from food waste and refrigeration.

OBJECTIVE

Minimisation of cost and carbon emissions in the strawberry supply chain of Sainsbury's (from farms to stores)

Formulation of a mathematical optimisation model which integrates the cost and energy consumption at all stages of the strawberry supply chain (growers, transportation from growers to depots, depots, transportation from depots to stores, stores)

The model developed incorporates
- **The seasonality of production**
- **Waste across all stages of the supply chain**
- **Quality deterioration of strawberries as a function of time and temperature**

METHODOLOGY

Figure 1 depicts the strawberry supply chain that was modelled.

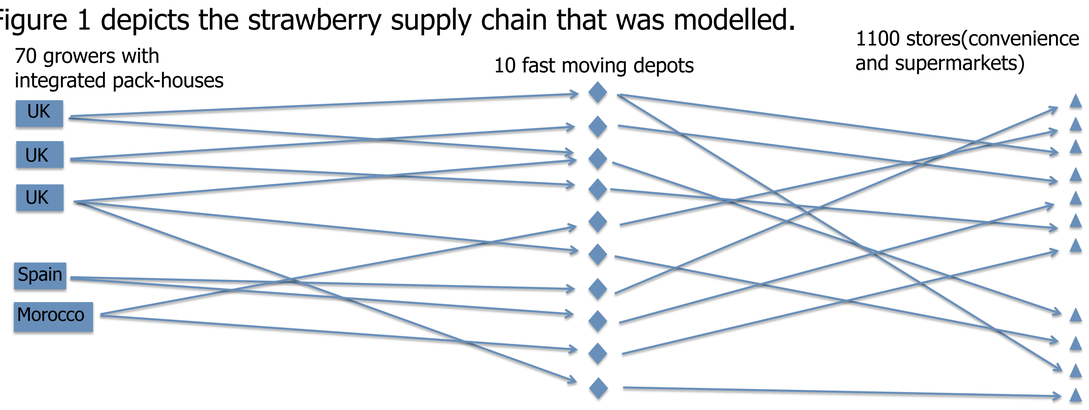

Figure 1. Boundaries of the strawberry supply chain

Figure 2 shows the most important characteristics of the model developed.

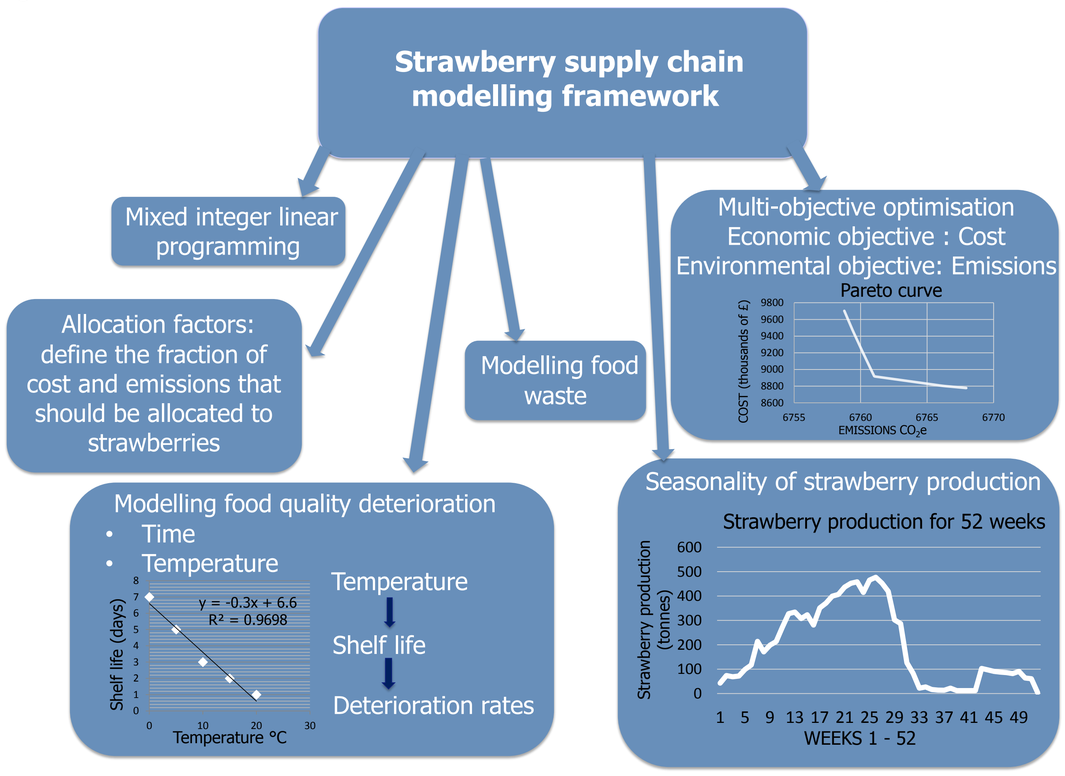

Figure 2. Strawberry supply chain modelling framework

RESULTS

Figures 3 and 4 show the distribution of costs due to **energy consumption** for the strawberry supply chain.

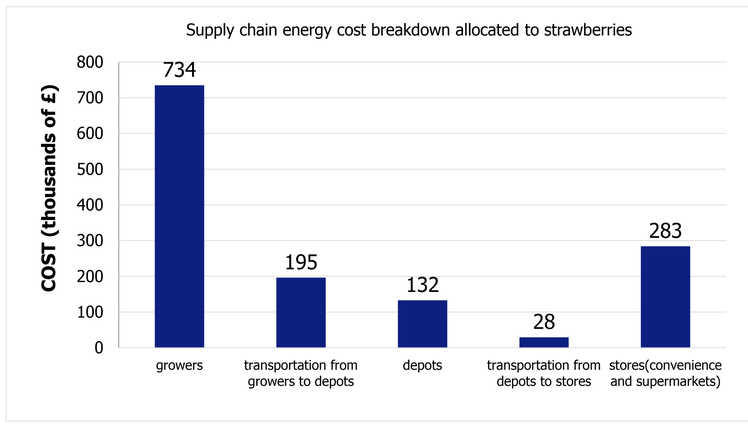

Figure 3. Energy cost breakdown (thousands of £)

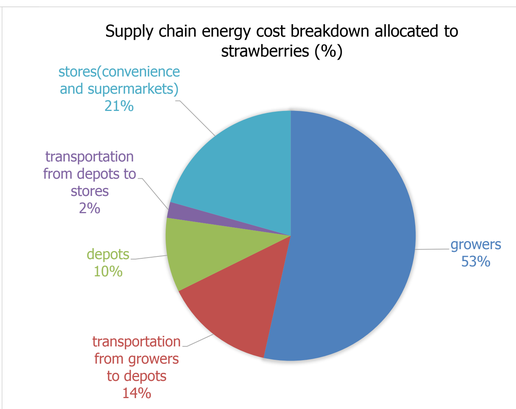

Figure 4. Energy cost breakdown (%)

Figures 5 and 6 show the distribution of emissions due to **energy consumption** for the strawberry supply chain.

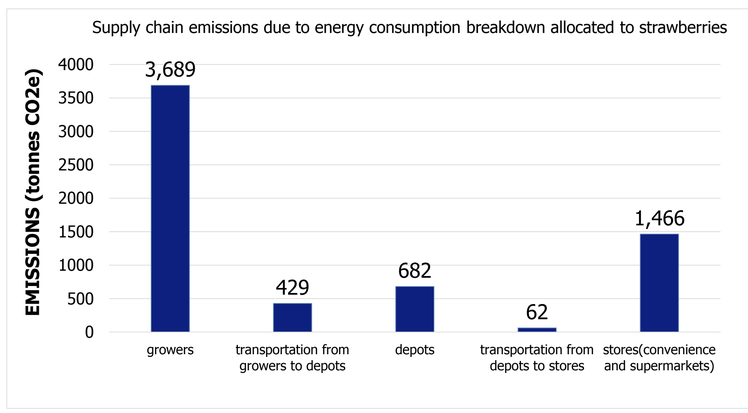

Figure 5. Emissions from energy consumption breakdown (tonnes CO_2e)

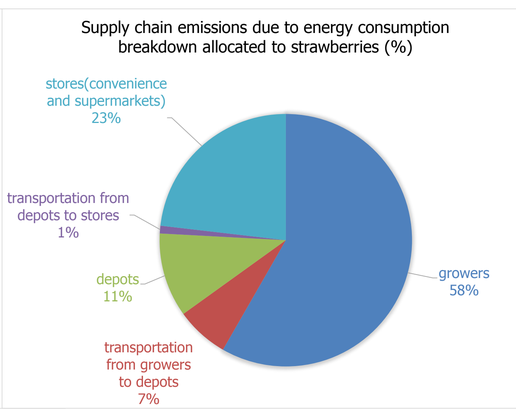

Figure 6. Emissions from energy consumption breakdown (%)

Figures 7 and 8 depict the comparison of transportation stages in terms of **cost** between the BAU case and the optimised case.

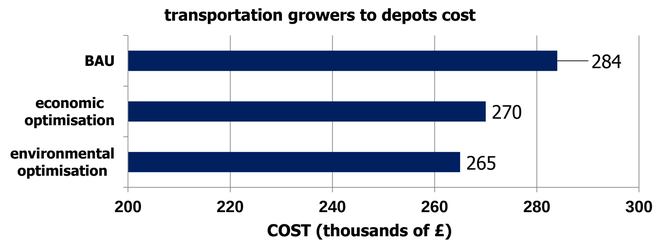

Figure 7. Transportation from growers to depots: cost

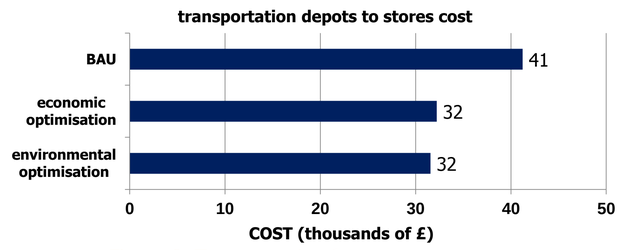

Figure 8. Transportation from depots to stores: cost

Figures 9 and 10 depict the comparison of transportation stages in terms of **emissions** between the BAU case and the optimised case.

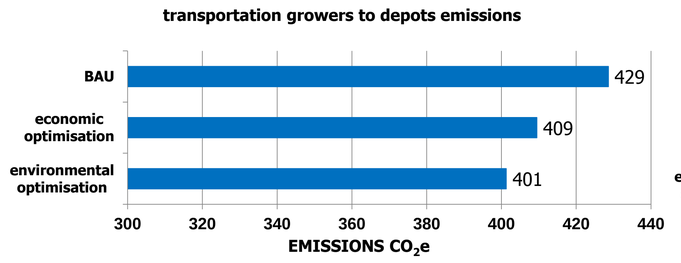

Figure 9. Transportation from growers to depots: emissions

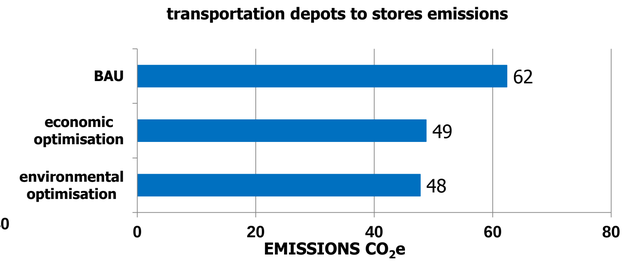

Figure 10. Transportation from depots to stores: emissions

Figure 11 shows the relative improvement in terms of cost and emissions of the optimised case compared to the BAU case.

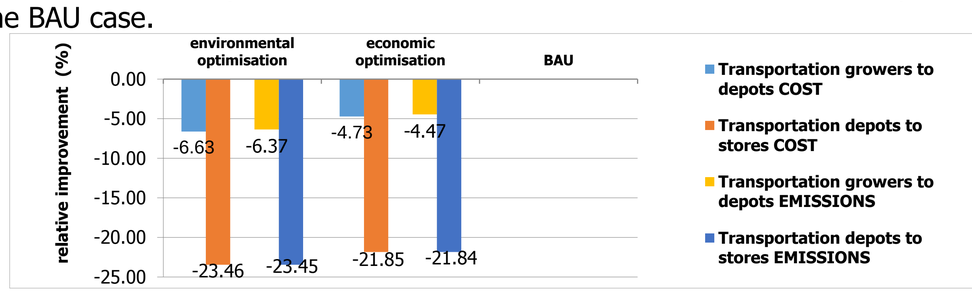

Figure 11. Relative improvement (%)

CONCLUSIONS

- Optimisation of the supply chain can have significant impact on the minimisation of cost and carbon emissions at the transportation stages of the strawberry supply chain.
- Food waste is a huge contributor to cost and carbon emissions. Hence, even a small reduction can result in significant amount of savings.
- Temperature during storage and transportation is the key factor that ultimately determines the final quality of strawberries in the stores.
- Refrigeration accounts for the majority of cost and emissions allocated to strawberries. Implementation of more efficient refrigeration technologies is essential at all stages of the strawberry supply chain.

REFERENCES

[1] Tassou, S., Azapagic, A. & Bakalis, S. (2013) *The National Centre for Sustainable Energy Use in Food Chain.* [Online] Available from: http://sites.brunel.ac.uk/__data/assets/pdf_file/0005/351581/CentreLaunch-05-09-13-2-Savvas-Tassou-Intro-to-CSEF.pdf [Accessed 03/08/2014].

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