

# Economic Returns of Using Brewery's Spent Grain in Animal Feed

U. Ben-Hamed, H. Seddighi and K. Thomas

**Abstract**—UK breweries generate extensive by products in the form of spent grain, slurry and yeast. Much of the spent grain is produced by large breweries and processed in bulk for animal feed. Spent brewery grains contain up to 20% protein dry weight and up to 60% fiber and are useful additions to animal feed. Bulk processing is economic and allows spent grain to be sold so providing an income to the brewery. A proportion of spent grain, however, is produced by small local breweries and is more variably distributed to farms or other users using intermittent collection methods. Such use is much less economic and may incur losses if not carefully assessed for transport costs. This study reports an economic returns of using wet brewery spent grain (WBSG) in animal feed using the Co-product Optimizer Decision Evaluator model (Cattle CODE) developed by the University of Nebraska to predict performance and economic returns when byproducts are fed to finishing cattle. The results indicated that distance from brewery to farm had a significantly greater effect on the economics of use of small brewery spent grain and that alternative uses than cattle feed may be important to develop.

**Keywords**—Animal Feed, Brewery Spent Grains, cattle CODE, Economic returns.

## I. INTRODUCTION

**B**REWERY by-products can be potentially valuable resources for agriculture. Spent barley grain, hops and surplus yeast are the major by products. Spent grain has the most value because of its high levels of sugars and proteins [1]. As these are by products rather than waste products, they can be recycled and reused in the food and agricultural industries. As a result, the brewing industry tends to be more environmentally friendly compared to other industries [2].

Wet Brewery spent grain (WBSG) is the material that is remaining after grains have been mashed to extract starch and sugars during the beer making process. These materials can be fed to cattle in the wet form (wet brewer's grains) or dried (dried brewers grains). Breweries generate more than 250 million tons of spent grains every year in the UK.

Traditionally spent grain is used to feed cattle feed being a valuable supplement to existing feed due to its high protein content. In addition it is a good source of dietary fiber [1]. Large scale brewing can provide large quantities of spent grain with up to 10 tons being produced per brew. Efficient breweries may now produce 12 brews per day allowing a continuous supply of spent grain to be available. The economics of bulk transport allow this to be delivered

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regularly to large dairy farms and command a reliable price to the brewery.

However, small scale production may only produce between 0.25 and 2 tons per brew inconsistently often just 2 to 4 times per week. Such supplies are inappropriate for large farms and most is collected by small farms often for no charge and using farm transport. Although the brewery loses payment for the grains it does removing the grain and prevent spoilage. In particular it avoids the brewery paying a landfill charge which would be charged if disposed of by standard waste handling.

With the development of more small breweries in the UK disposing of spent grains may pose difficulties in the future. This is particularly so for urban breweries with poor access to farms and where distance and transport costs make collection uneconomic. This study has analyzed the economics of using brewery spent grain in animal feed and used the Co-product Optimizer Decision Evaluator (cattle CODE) a model designed by the University of Nebraska to estimate profit and loss from feeding by-products in feedlot diets and to assess factors such as type of by-products, dietary inclusion level, moisture content, trucking costs, feeding costs and price relationship between by-products and corn price all affect cattle feeding profit or loss when using by-products [3].

TABLE I

	DBSG	WBSG	CGF	CGM
DM (%)	92	29	90	91
CP (%)	28	27	26	45
EE (%)	7.5	6.5	3	2.5
Ash (%)	4	4.8	7	4
CF (%)	15	15	9	5
NFE (%)	45.8	46.7	55	43.5

**Abbreviations:** DBSG, dried brewer spent grain; WBSG, wet brewer spent grain; CGF, corn gluten feed; CGM, corn gluten meal; DM, dry matter; CP, crude protein; EE, ether extract(fat); CF, crude fibre; NFE, nitrogen-free extract.

**Source:** From Crampton, E. W. and Harris, L. E., *Atlas of Nutritional Data on United States and Canadian Feeds*, National Academy of Sciences, Washington, 1972; Hubbell, C. H., *Feedstuffs*, 1985; Preston, D. R., *Feedstuffs*, 1986.

## II. METHOD AND MODEL

The model used in this study is Co-product Optimizer Decision Evaluator (cattle CODE) model which evaluates economic returns for feeding by-products to feedlot cattle compared to a control diet with no by-products. In other words, Cattle CODE is a model developed to predict performance and economic returns when by-products are fed to finishing cattle. In addition, Cattle CODE not only shows the relative advantage of feeding spent grains over corn or other feeds, but also shows overall profitability.

Type of by-products, dietary inclusion level, moisture content, trucking costs, feeding costs and price relationship between by-products and corn price all affect cattle feeding profit or loss when using by-products. Transportation, additional handling or mixing are some of the factors that can reduce profits [3].

The model calculates dietary dry matter, DM, content with the inputs of feed ingredient DM and % inclusion, which is important for calculating feeding yardage costs. By-product hauling costs were calculated with load size, cost/loaded mile, and miles delivered to the feedlot. Table I and table II show the assumptions for the model inputs.

TABLE II  
ASSUMPTION INPUTS FOR CATTLE CODE FROM PREVIOUS STUDY

Inputs
Initial weight 336 kg
Finished weight 590 kg
Fat cattle price £1.279/kg
Feed conversion (F:G) 6.5
Processing and Medical costs £ 8 /head*day
Death loss 1.5 %
Cattle loan 8.1 %
Yardage costs £0.23/head*day
Dry rolled corn price £94.7/ton
High moisture corn price £85.7/ton
Supplement £123/ton

Notes: - All prices shown in this table converted from \$ to £ to suit this study.

- All weights converted from Pounds to tones and kilograms.

Source: Buckner. et al., 2008..

Only one by-product was evaluated for this study which is wet brewers spent grains, WBSG, the material remaining after grains have been mashed during the beer making process. These grains are assessed as 29 % DM and priced at 0% the price of corn on a DM basis since on small scale collection the farmer receives the spent grains from the brewery for free with no cost. However, farmers will be responsible for transporting spent grains to their farms. For the cost of transporting spent grains three sizes of vehicles were assessed in terms of their load capacity at 1 ton load, 2 ton and 4 ton respectively [4]. This study considered three different transportation costs in terms of the brewery size and its production (small, medium and large scale). Table 2 shows transportation inputs for the model.

A Sensitivity Analysis was Conducted for;

- 1) Changing WBSG cost from £0/ton to £38/ton (assuming that the farmer would be charged for WBSG).
- 2). Changing the distance between the breweries and the feedlot.

Analysis was conducted to assess the optimal level of inclusion of WBSG in cattle feed ranging from 10% to a maximum of 50% and the economic return for this inclusion. The analysis indicated the effect of distance whereby a greater distance of delivery would increase the cost and so reduce the economic benefit.

TABLE III  
TRANSPORTATION INPUTS FOR CATTLE CODE ANALYSIS

Inputs	Small breweries (Vehicle 1)	Medium breweries (Vehicle 2)	Large breweries (Vehicle 3)
The cost of load per mile.	£1.37 (£/loaded mile)	£1.61 (£/loaded mile)	£1.16 (£/loaded mile)
Average load.	0.646 ( ton/load)	1.397 (ton/load)	2.630 (ton/load)
Distance between the feedlot and the brewery	5 (Miles.)	5 (Miles)	5 (Miles)

Source: Ben-Hamed et al., 2010.

### III. RESULTS

Feeding WBSG priced at 0% of the price of corn and transported from breweries by three different vehicles in terms of their load (vehicle1, vehicle 2 and vehicle 3), increased economic returns and the optimum inclusion level of WBSG compared to feeding corn alone (Fig 1). When the feedlot was at 5miles of the breweries and the vehicle loads (Vehicle1, Vehicle 2 and Vehicle 3) were 0.646 ton/load, 1.397 ton/load and 2.630 ton/load respectively, the optimum inclusion of WBSG for the three scales of breweries (small, medium and large) was 50% of diet DM and returns were £76.4, £89.3 and £141.2 respectively more/head compared to feeding corn alone (Fig 2).

#### A Sensitivity Analysis

1) Economic returns for feeding WBSG when the farmer buys WBSG from breweries at £38/ton (market price) instead of £0/ton.

This analysis determined the sensitivity of WBSG price at £38/ton {priced at 130% of corn price (DM basis)}, as 5 miles hauling distance for WBSG and corn price at (£94.7/ton) remaining constant. Economic returns were sensitive to the price of WBSG relative to corn, as the optimum inclusion of WBSG decreased from 50% to 10% and economic returns decreased from £119.2/head to £46.7/head when the vehicle 1 load was 0.646 ton/load. The optimum inclusion of WBSG decreased from 50% to 20% when the vehicle 2 and vehicle 3 loads were 1.397 t/load, 2.630 t/load respectively, and economic returns decreased to £50.7/head, £54.3/head respectively ( Fig. 3). If the inclusion level of WBSG was more than 20% in the vehicle 1 case, the results were not economic compared to feeding corn alone. For vehicle 2, feeding WBSG were not economic if the inclusion level exceeded 30% compared to feeding corn alone. Feeding WBSG would not be economic compared to feeding corn alone if the inclusion level of WBSG was more than 40% in the case of vehicle 3 (Fig 4)

Pricing WBSG at 130% (%DM basis) of the corn price (£38/ton) had a larger impact on economic returns as inclusion levels of WBSG decreased.

2) Economic returns for feeding WBSG when the distance between the breweries (small, medium and large brewery) and the feedlot increased.

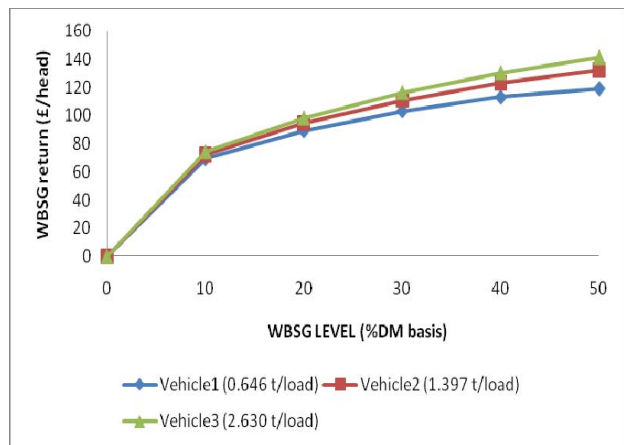


Fig. 1 Economic returns for feeding WBSG at 0% the price of corn (£94.7/ton) at 5 miles from breweries, 0.646 ton/load (vehicle 1), 1.397 ton/load vehicle 2), and 2.630 ton/load (vehicle 3).

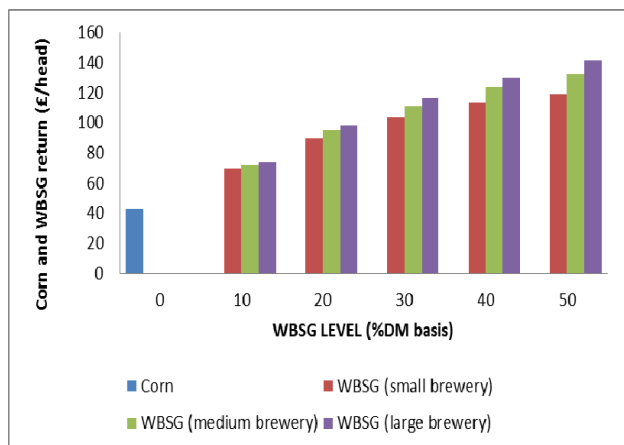


Fig. 2 Economic returns and the advantage for feeding WBSG received from breweries at 0% the price of Corn at 5 miles compared to corn diet.

A) Economic returns were assessed for feeding WBSG from small breweries at 0, 20, 40 and 60 miles distance from the brewery.

When the feedlot was located at the source WBSG with no transport required (small breweries), the optimum inclusion level was 50% of diet DM and returns were £146.9 /head. As the distance from the breweries to the feedlot increased from 0 to 20 miles, the returns decreased to £55.8/head and the optimum inclusion decreased to 20%. When the distance increased more than 20 miles there would be losses for feeding WBSG compared to corn alone. The optimum inclusion of WBSG decreased as distance increased from the brewery to the feedlot.

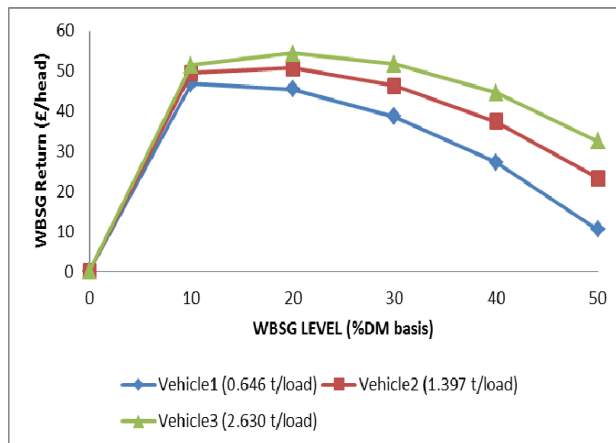


Fig. 3 Economic returns for feeding WBSG at 130% the price of corn [(£94.7/ton) %DM basis], at 5 miles from breweries, 0.646 ton/load (vehicle1), 1.397 ton/load vehicle2), and 2.630 ton/load (vehicle3).

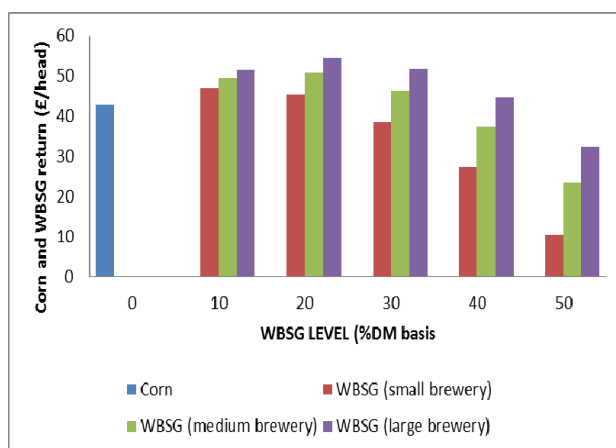


Fig. 4 Economic returns and the advantage for feeding WBSG received from breweries at 130% the price of Corn at 5 miles compared to corn diet.

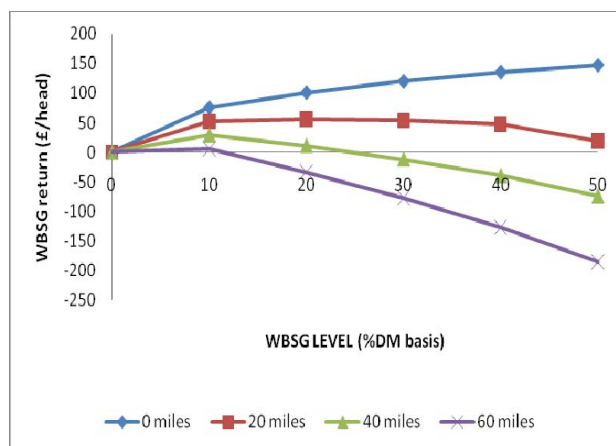


Fig. 5 Economic return for feeding WBSG received from small breweries 0.646 ton/load (vehicle1) at 0% the price of corn at 0, 20, 40 and 60 miles.

*B) Economic returns for feeding WBSG received from medium breweries at 0, 20, 40, 60 and 100 miles.*

When the feedlot was located at the source WBSGS with no transport required (medium breweries), the optimum inclusion level was 50% of diet DM and returns were £146.9 /head. As the distance from the breweries to the feedlot increased from 0 to 40 miles, the returns decreased to £55.8/head and the optimum inclusion decreased to 40%. When the distance increased more than 60 miles there have been losses for feeding WBSG compared to corn alone. The optimum inclusion of WBSG decreased as distance increased from the brewery to the feedlot (figure 6).

*C) Economic returns for feeding WBSG received from large breweries at 0, 20, 40, 60 and 100 miles.*

When the feedlot was located at the source WBSGS (large breweries), the optimum inclusion level was 50% of diet DM and returns were £146.9 /head. As the distance from the breweries to the feedlot increased from 0 to 60 miles, the returns decreased to £101.2/head and the optimum inclusion level of WBSG remained 50%. When the distance was 100 miles, economic returns decreased to £80.8/head and the optimum inclusion decreased to 40% (Fig.7).

Overall, Vehicle 3 with load of 2.630 t/load recorded positive economic returns for feeding WBSG when the distance increased from 0 miles to 100 miles between the breweries to feedlot, which means the load of the vehicle has a large impact on economic returns when WBSG are fed.

In summary, Based on this analysis feeding wet brewery's spent grain increased cattle economic returns compared to feeding corn alone. However, returns were impacted by inclusion level in the diet, distance from the brewery to feedlot, average load of the vehicle, the cost of loaded spent grain per mile and brewery's spent grain price relative to corn.

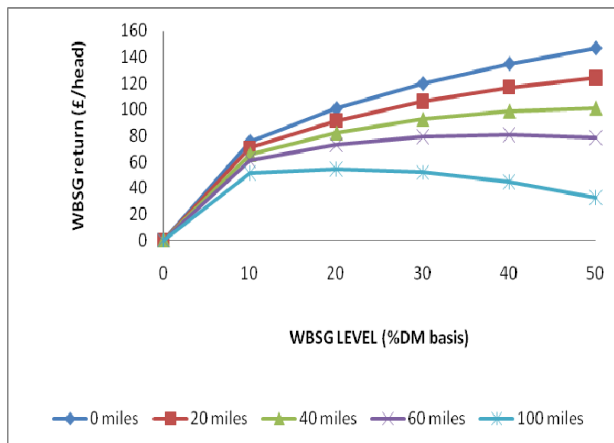


Fig. 7 Economic return for feeding WBSG received from large breweries 2.630 t/load (vehicle3) at 0% the price of corn at 0, 20, 40, 60 and 100 miles.

IV. CONCLUSION

By-product feed ingredients can provide an economical alternative to traditional grains and forages used in cattle operations. Animal performance can be maintained or even improved if brewery's spent grains are used within nutrition and feed management guidelines. Brewery spent grain were transported by farmers from three scales breweries in terms of their production (small, medium and large) to their farms and paid for transportation cost. The average load of the vehicle affected the cost per loaded mile and that would increase the hauling cost to yard per head. Moreover, the distance between the brewery and feedlot affected the cost of transportation and if the farmer pays for spent grain that would increase the cost too. As results of that, economic returns would be affected by these factors and then Feeding brewery spent grain might not be economic compared to feeding traditional grains such as corn.

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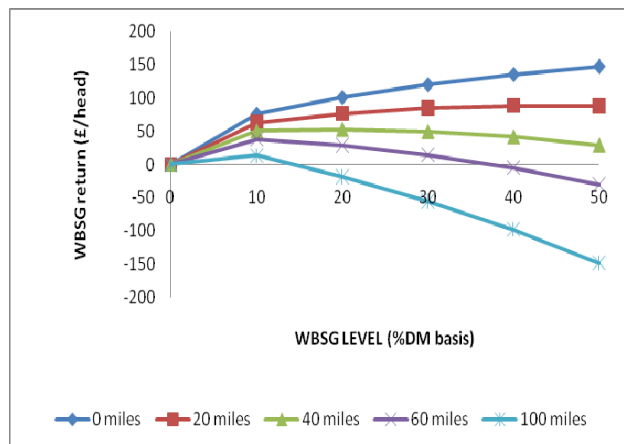


Fig. 6 Economic return for feeding WBSG received from medium breweries 1.397 ton/load (vehicle2) at 0% the price of corn at 0, 20, 40, 60 and 100 miles.