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The development and application of a simulation model of dairy calf-to-beef production systems

Key external stakeholders:

Beef and dairy farmers, beef industry, research organizations, consumers.

Practical implications for stakeholders:

- Maximising the proportion of grazed grass in the diet and live weight gain from grazed grass and maintaining a high carcass output per hectare are important to maximise net margin.
- Changes in beef, calf and concentrate price can have a major effect on net margin; however, there are a number of strategies that can be taken to mitigate these effects.
- Cash flow can vary greatly between different dairy calf-to-beef production systems and is, therefore, an important consideration when deciding on the appropriate system for a farm.
- Due to the large number of cattle farms where the farmer and/or spouse have an off farm job, labour requirements and labour availability for the different systems need to be taken into account, especially at peak periods as they can vary greatly between the different systems. Labour requirements are directly related to the number of animals on the farm, therefore, selecting systems that have lower numbers of animals (older ages at slaughter) could help reduce labour requirements.
- The economics of exploiting compensatory growth in steer systems was exemplified in this research. Compensatory growth will not occur in animals under 3 months of age or animals approaching maturity. This study indicated that a restriction period of four months and a live weight gain no lower than 0.4 kg/day results in the greatest economic advantage from compensatory growth.

Main results:

A whole farm, static, deterministic simulation model called the Grange Dairy Beef Systems Model (GDBSM) was developed and used to analyze a number of research questions in four sets of studies. Results indicated that: 1) finishing animals outdoors on grazed grass-based diets resulted in a higher net margin than indoor finishing, 2) the most profitable live weight gain during the restriction period was 0.6 kg/day for animals finished at 24 months of age and 0.4 kg/day for animals finished at 28 or 30 months of age, 3) steer systems were found to be more profitable than bull systems, 4) bull systems were more sensitive than the steer systems to variation in prices and, 5) the most profitable systems were finishing steers at 28 months of age with the least profitable being finishing bulls at 16 months of age. In general, cash flow, financial risk and labour requirements and costs were also found to be important issues when deciding on an appropriate system.

Opportunity / Benefit:

With the increase in the number of dairy cows in Ireland, there will be opportunities for beef farmers to increase output from their dairy calf-to-beef enterprises. The selection of beef sires for using on dairy cows is driven by the requirements of the dairy farmer and thus shorter gestation length and lower incidence of calving difficulty will be most important. This would favour the use of early maturing rather than late maturing sires. Based on the profitability of the different systems found in this study, increasing numbers of early maturing beef crossbred calves from the dairy herd should not have a negative effect on farm margins and particularly where a bonus price structure for early maturing animals exists would increase profitability.

Collaborating Institutions:

UCD

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1. Project background:

In Ireland beef production is the main activity on 57% of all farms and the beef industry is a major contributor to the agri-food industry and the local economy as a whole. However, the profitability of beef farms is low and mainly negative when subsidies are removed. Beef production from the dairy herd contributes approximately 50% of all animals used for beef production in Ireland. There are a large number of different dairy calf-to-beef production systems possible in Ireland due to the permutations of different breeds, genders and finishing ages. Mathematical modelling can be used to analyse the complex interactions that can occur within systems, however, there is a paucity of whole farm dairy calf-to-beef production system models for temperate grass land areas such as Ireland. Therefore, a whole farm model of dairy calf-to-beef production systems practiced in Ireland was developed to help understand the complex interactions and factors affecting profitability of these systems.

2. Questions addressed by the project:

The objectives of the study were to:

- Develop a bioeconomic simulation model of dairy calf-to-beef production systems in Ireland for animals born in the spring.
- Assess the potential of compensatory growth to improve the profitability of dairy calf-to-beef production systems by optimising growth pathways and thus, identifying the most profitable live weight gain during indoor winter feeding and summer grazing periods.
- Simulate the interaction between monthly grass growth and demand to determine the profitability of male Holstein-Friesian animals finished as bulls at 16, 19 and 22 months of age and steers at 24 months of age.
- Under a fixed set of assumptions, determine the profitability of a range of dairy calf-to-beef systems differing in breed, gender and finishing age.

3. The experimental studies:

The GDBSM was developed to facilitate the technical and economic evaluation of temperate grass-based dairy calf-to-beef production systems of the type that operate in Ireland. The simulation model is a whole farm systems model that integrates the various components of beef farming systems into a single framework. These components consist of the animal groups in terms of breed, gender and finishing age, the feed demand and supply (grazed grass, grass silage and concentrate) on the farm and input and output prices. It adopts a single year approach operating on a monthly time step. This means that the model represents the farm in 1 month blocks over a 12 month period from January to December. It uses a static, deterministic methodology and was developed in Microsoft Excel. Macro routines are used to maximise the number of animals carried on a fixed area of land while also taking into account limitations on stocking intensity due to the Nitrates Directive. The model consists of four sub-models; the farm systems, animal nutrition, feed supply and financial sub-models. The farm systems sub-model defines the dairy calf-to-beef production system and calculates animal numbers, individual animal live weight, slurry production and accommodation for animals during the indoor period on a monthly basis. The animal nutrition sub-model determines the energy demand and feed requirements (grazed grass, grass silage and concentrate) of the modelled herd. The feed supply sub-model determines the forage production systems used to produce grazed grass and grass silage on the farm. The financial sub-model is used to calculate the costs and receipts generated from the system being modelled. In the analysis profitability is measured by the net margin per farm excluding imputed charges for the famer's own labour and owned land. This assumption reflects the dominant farm structure in Ireland comprising owner-operated holdings where the proprietor is remunerated through drawings from the business rather than a wage. Moreover, in order to focus on the market-based returns that dictate longer-term financial viability, SFP is also excluded as this payment is decoupled from the level of farm production. Therefore, the net margin figures reported can be interpreted as the market-based farm business income representing the financial return to unpaid family labour and the capital invested in the farm business including land and buildings. During the model development stage systems researchers at the Animal & Grassland Research and Innovation Centre, Teagasc, Grange were consulted to ensure appropriate

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biological relationships were specified.

4. Main results:

Study 1

A whole farm system bioeconomic model was developed (GDBSM) that can be used to evaluate dairy calf-to-beef production systems in temperate grassland conditions of the type found in Ireland. Evaluation of the model was conducted using expert opinion and it was found to appropriately represent dairy calf-to-beef production systems. Results showed that finishing animals outdoors on grazed grass resulted in the net margin being on average €8,667 higher than finishing indoors on grass silage and concentrate. Changes in beef and concentrate price were found to have the largest effect on net margin.

Study 2

The GDBSM was improved/modified by using linear regression equations derived from a series of experiments carried out at Teagasc, Grange to calculate the live weight gain during the compensation period based on the live weight gain during the restriction period. Maintenance requirements were also reduced by 20% for the first 90 days of the compensation period as reported by NRC (2000). The developments to incorporate the effects of compensatory growth enhanced the ability of the model to accurately and effectively simulate Irish dairy calf-to-beef grass-based systems. The most profitable live weight gain during the restriction period was 0.6 kg/day for animals finished at 24 months of age and 0.4 kg/day for animals finished at 28 and 30 months of age. The reduction and duration of maintenance energy requirements during compensation had a modest impact on net margin. Therefore, although the literature is equivocal in terms of the extent and duration of maintenance reduction its overall effect on net margin is low.

Study 3

The GDBSM was further adapted to more accurately simulate the interaction of grass supply and demand balancing the grazed grass grown and grazed grass demand on a monthly basis. The hypothesis was that the combining of systems could make better use of the grass grown on the farm by better matching supply and demand. However, there was no advantage to the combining of production systems. This was because October was the month that had the lowest animal carrying capacity for each of the systems and this dictated the animal carrying capacity of the farm. There were variations in labour requirements per farm during the calf rearing period between the systems. The bull systems required more labour than the steer system because of the greater number of calves purchased in the bull systems. Furthermore, despite greater live weight gain, carcass gain, feed conversion ratio, conformation score and kill out proportion for bulls when compared to steers net margin was lower due to the high level of concentrate in the diet.

Study 4

The purpose of this study was to provide a thorough comparative analysis with a common set of input and output prices for the different breeds, genders and finishing ages that can occur in dairy calf-to-beef systems in Ireland. Twenty-eight month steer production systems were the most profitable and16 month bull systems were the least profitable. Variations in beef, calf and concentrate price were found to have a large effect on net margin with reranking of some of the systems where extreme price deviations occur. Cash flow needs to be considered when comparing the different systems. In particular, the 16 month bull system had a very poor cash flow which would clearly represent a significant and unacceptable liability for many farmers. The labour requirement for the different systems was calculated and there were considerable differences found between them with the 28 month steer systems having the lowest labour requirements.

5. Opportunity/Benefit:

The aim of this research was to develop a model of dairy calf-to-beef production systems that could simulate the wide range of systems found in Ireland. This model was used to determine the most profitable dairy calf-to-beef production systems and the main drivers of profitability for these systems. The originality of the GDBSM lies in its ability to model a wide range of dairy calf-to-beef production systems under temperate grassland conditions and the evaluation of the results to allow greater understanding of the systems and causes of failure of systems. The model incorporates most of the dairy calf-to-beef production systems practiced in Ireland. Although the performance parameters are based on production data from the Animal & Grassland Research and Innovation Centre, Teagasc, Grange, the parameters can be modified to reflect other temperate grassland situations, where animal performance and/or feeding strategies differ from those assumed in this study. The model takes into account the main feedstuffs used on Irish beef farms (grazed grass, grass silage and concentrate), thus, allowing the user to better understand the relationship between feed supply from home produced feed (grazed grass and grass silage) and nitrogen application rate. Economic analysis permits the evaluation of the profitability of the different systems studied. New production systems can be tested to determine their profitability in comparison to current systems. The model provides a

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framework for analysing the economic impact of alternative policy, market and production conditions on profitability.

6. Dissemination:

Peer reviewed journal publications

- Ashfield, A., Crosson, P. and Wallace, M. (2012) Simulation modelling of temperate grassland based dairy calf to beef production systems. Agricultural Systems 115, 41-50.
- Ashfield, A., Wallace M., McGee, M. and Crosson, P. (2014) Bioeconomic modelling of compensatory growth for grass-based dairy calf-to-beef production systems. Journal of Agricultural Science, volume 152, issue 05, 805-816.
- Ashfield, A., Wallace M. and Crosson, P. (2014) Economic comparison of pasture based dairy calf to beef production systems under temperate grassland conditions. International Journal of Agricultural Management, 3(3), 175-186

Conference proceedings

- Ashfield, A., Crosson, P. and Wallace, M. (2011) Simulation model of Irish dairy calf to beef systems. In: Proceedings of Agricultural Economics Society of Ireland, Young Researcher Seminar, p.15. Dublin, Ireland.
- Ashfield, A., Crosson, P. and Wallace, M. (2012) Description of a simulation model of dairy calf to beef systems in Ireland. In: Proceedings of Farm Level Modelling Workshop, p.86. Dublin, Ireland.
- Ashfield, A., Crosson, P. and Wallace, M. (2012) Modelling the economics of dairy calf to beef production systems. In: Proceedings of the Agricultural Research Forum, p.48. Tullamore, Ireland.
- Ashfield, A., Crosson, P. and Wallace, M. (2012) Modelling the effect of turnout date to pasture in spring of yearling dairy bred cattle. In: Proceedings of the 63rd Annual Meeting of the European Federation of Animal Science, p.141. Bratislava, Slovakia.
- Ashfield, A., Crosson, P., Wallace, M. and McGee, M. (2012) Modelling compensatory growth using the Grange Dairy Beef Systems Model. In: proceedings of Agricultural Economics Society of Ireland, p.30. Dublin, Ireland.
- Ashfield, A., Crosson, P., Wallace, M. and McGee, M. (2013) Incorporating compensatory growth into a whole-farm model of dairy calf-to-beef production systems. In: Proceedings of the Agricultural Research Forum, p.47. Tullamore, Ireland.

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