Research Stimulus Fund

Final Report

'Profitable production of bull beef to market specification while ensuring optimum quality for the consumer (BullBeef)'

DAFM Project Reference No: 11/SF/322

Start date: 01/11/2012

End Date: 30/09/2018

Principal Coordinator and Institution: Dr. Aidan Moloney, Teagasc

Email: aidan.moloney@teagasc.ie

Collaborating Research Institutions and Researchers:

Teagasc: Dr. Aidan Moloney, Dr. Edward O'Riordan, Dr. Mark McGee, Dr. Robert Prendiville, Dr. David Kenny, Dr. Paul Allen, Dr Paul Crosson, Dr. Lara Moran (Post-Doctoral Fellow)

University College Dublin: Prof. Frank Monahan, Dr. Alan Kelly

University College Cork: Dr. Joe Kerry, Dr. Maurice O’Sullivan

Institute National Research Agronomique (France): Dr. Brigitte Picard

Irish Cattle Breeding Federation: Dr. Andrew Cromie, Dr. Stephen Conroy

Please place one "x" below in the appropriate area on the research continuum where you feel this project fits

<table>
<thead>
<tr>
<th>Basic/Fundamental</th>
<th>Applied</th>
<th>Pre Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise* (NRPE) report:

| Priority Area(s) | H Food for Health
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sustainable Food Production and Processing</td>
</tr>
</tbody>
</table>

Key words: Bulls, production systems, beef quality
1. **Rationale for Undertaking the Research**

Approximately 910,000 male cattle are slaughtered annually in Ireland and more than 90% of Irish beef is exported. Beef from late maturing suckler-bred animals is generally exported to higher-priced European markets, beef from early maturing breed crosses has a significant role in premium niche markets and beef from the dairy herd is primarily exported to UK markets. A wide range of beef systems are operated with the two predominant systems today being the grass-based dairy and suckler calf-to-beef. Male animals are generally produced as steers at ca. >24 months of age, on grass-based systems. Grass-fed steer is a point of difference for Irish beef in many high-value EU markets. The superior growth and feed conversion efficiency of bulls compared to steers however make bulls attractive to producers. The proportion of the male slaughter represented by young bulls varies from year to year (e.g. 13% in 2008, 22% in 2017 and 23% in 2018 (Department of Agriculture, Food and the Marine, Beef carcass classification and price reporting section, Annual Report, 2018). Traditionally, bulls were reared indoors on a high energy ration which is a relatively expensive production system. Exploiting grazing is one strategy to decrease the cost of production but meeting the abattoir specifications of animal age and carcass fat score and weight is likely to be a challenge. In addition the impact of modifications of the traditional production system on the appearance and eating quality of bull beef were largely unknown. This large, multi-institutional project addressed novel production systems for bulls, the impact on beef quality and whether current abattoir specifications are valid from a meat quality perspective.

2. **Research Approach**

The over-arching tasks concerned the modification of production systems for sucker and dairy-origin bull beef to increase profitability and the assessment of the resulting beef for market-relevant quality characteristics and environmental impact. Bull production data were collected and analysed. Detailed compositional analysis (proximate, fatty acids, collagen, texture) of beef samples was undertaken. Sensory analysis of beef was carried out. Large data sets were statistically analysed. Underpinning research tasks focused on elements from “farm to fork” that limit achievement of market specifications. Since carcass fat score is a key market specification, the underlying biology of fat deposition was explored.

In the course of the project and in consultation with stakeholders, the following modifications were approved:

- A comparison of bulls and steers was introduced for both dairy and suckler bull beef production systems.
- Meat quality assessment was expanded form the striploin to sirloin and rump muscles.
- An under 16 months of age slaughter point for suckler bulls was added.
- Carcass hanging of dairy origin bulls and steers was examined.
3. **Research Achievements/Results**

- When finished from pasture at the same age, ca. 19 months, carcasses from spring-born, suckler-bred early-maturing breeds were lighter, fatter, and had poorer conformation than late-maturing breeds; bulls had greater growth, live weight, better kill-out proportion, a heavier carcass, better carcass conformation score and a lower carcass fat score than steers.
- Carcasses of early-maturing breed bulls slaughtered at 19 months of age from pasture were lighter but adequately finished, with or without concentrate supplementation during the latter half of the grazing season (i.e. ca. 4.0kg daily for 95 days), whereas the heavier, late-maturing breed bull carcasses were only adequately finished when supplemented.
- Carcasses of both early- and late-maturing breed suckler bulls were inadequately finished from pasture, with or without concentrate supplementation at 15 months of age.
- For dairy origin bulls, achieving market specifications is challenging when slaughtered under 16 months of age and the profitability of this system is particularly vulnerable to increases in concentrate costs.
- The most profitable production system for dairy origin bulls was finishing as 19 month bulls with supplementation in the final 100 days at pasture. However, the possibility of a price discount due to the animals being older than the 16 months currently required in many markets needs to be considered.
- There was some evidence that production system *per se* may have a small negative effect on eating quality. When suckler bulls from early or late maturing breed sires were slaughtered at 380 kg carcass from an *ad libitum* concentrate diet or grazed prior to finishing on an *ad libitum* concentrate diet, the tenderness rating by trained assessors was lower for the grass-based system. The scale of this decrease is unlikely to be detected by untrained consumers.
- Continental breed-sired bulls and steers were compared within 2 production systems; the striploin from steers was fatter and rated more highly for tenderness and acceptability than the striploin from bulls. The absolute differences in eating quality were however, small.
- There is little commercially important difference in tenderness or overall liking of striploins from continental breed sired suckler bulls slaughtered between 15 and 22 months of age or from dairy bulls slaughtered at 16, 19 or 21 months of age.
- Finishing both dairy beef and suckler beef offspring at younger ages reduced the greenhouse gas emissions of the system.

4. **Impact of the Research**

A wide range of suckler and dairy origin bull production systems and the associated effects on meat quality were examined in this project. The main implications are:

- Grazing can have a significant role in bull beef production.
- Market specifications based on age/weight or carcass fatness are not supported by major differences in eating quality.

The main stakeholders/end users of the information from this project are beef farmers, beef processors, ICBF, Bord Bia, Teagasc advisory service, agri-consultants and scientific community.

4(a) Summary of Research Outcomes

(i) Collaborative links developed during this research

Excellent collaborative links were formed in the course of the project. This was facilitated initially by the formation of a stakeholder advisory group at the start of the project. The stakeholder advisory group included representatives of the meat industry (Meat Industry Ireland), Bord Bia (the Irish Food Board), meat processors and farmer associations. The functions of the advisory group were: (i) to offer advice on work proposed as the project progressed and (ii) to ensure that the project tasks met stakeholder needs. Beef production studies were conducted in two Teagasc locations and involved different abattoirs/meat processors. Samples were transferred around four institutions within the project which required excellent collaboration and co-ordination. Publications from the project were collaborative.

(ii) Outcomes where new products, technologies and processes were developed and/or adopted

The project did not set out to develop a new product per se. New grass-based bull beef production systems were developed and evaluated.

(iii) Outcomes with economic potential

The output of the project is exploitable by the producers and processors of Irish beef. The Irish food sector needs to target high value markets through increased value-added output (Food Harvest, 2020); it is therefore essential that the quality of food products targeted for these markets be well characterised and underpinned by science. The project demonstrates the feasibility of lower cost systems for producing bull beef and provides information to address concerns in some markets about the influence of age at slaughter on the quality of bull beef relative to steer beef. In addition, the data generated facilitates examination of the relevance of meat quality to current market specifications based on age and carcass fatness.

(iv) Outcomes with national/policy/social/environmental potential

The research supports the production of bull beef to meet Irish national and export needs. The data generated facilitates discussion between processors and retailers about
perceived quality issues with bull beef and so can aid marketing strategies for Irish beef. The environmental assessment of the production systems within the project can contribute to the national debate of greenhouse gas emissions.

4 (b) Summary of Research Outputs

(i) Peer-reviewed publications, International Journal/Book chapters.


(ii) Popular non-scientific publications and abstracts including those presented at conferences


7. O’Riordan, E.G., McGee, M, Moloney, A.P. and Crosson, P. TResearch Summer Issue. Producing suckler origin male cattle. 01/05/2016


10. Prendiville, R., Murphy, B., Swan, B. and Crosson, P. TResearch Summer Issue. Male dairy calf to beef systems. 01/05/2016


31. Moloney, A.P., McGee, M., O’Riordan, E.G., Marren, D., Mazgebo, G., Monahan, F. and Richardson, I. Influence of grazing prior to finishing on a high concentrate ration, on colour and sensory characteristics of muscle from early or late maturing bulls slaughtered at a the same carcass weight. Meat Science, 112, 118-119 (2016)


47. Ferguson, N. Kelly, A.K., Moloney, A.P. and Kenny, D.A. Effect of milk replacer fat content during calfhood and cereal type and supplemental saturated fat inclusion in the finishing ration on the performance and carcass composition of


58. Ferguson, N. Kelly, A.K., Dick, J.R., Moloney, A.P. and Kenny, D.A. The effect of milk replacer fat content on the performance and carcass composition of pre-


(iii) National Report

Moloney, A.P. (2020). Technology update, Teagasc

(iv) Workshops/seminars at which results were presented

1. Work Package Leaders. Stakeholder advisory group meeting. Presentation of project, discussion of industry perspectives. 25/06/13

2. Work Package Leaders. Stakeholder advisory group meeting. Presentation of project, discussion of industry perspectives. 05/06/14

3. Work Package Leaders. Stakeholder advisory group (meat sub-committee) meeting. Discussion on modifications to Task 8. 15/05/15


7. O'Riordan, E.G., McGee, M, Moloney, A.P., Crosson, P., Marren, D, McMenamin, K. and Lenehan, C. Beef 2016 (Grange Open Day Book). Male sucker cattle production. 05/07/16


10. McGee, M. Proceeding of Society of Feed Technologists, Ruminants Conference, Coventry. Aspects of feed efficiency in beef production, 21/04/16

11. Prendiville, R. and Murphy, B. Teagasc National Beef Conference, Athlone, Roscommon. Alternative finishing strategies for dairy calf to beef systems. 04/10/16


13. Prendiville, E. AHDB, UK. Dairy calf to beef production systems. 27/06/17

14. Prendiville, E. AHDB, UK. Dairy calf to beef production systems. 28/06/17

15. Prendiville, R. Visitors to Teagasc, Wexford. Dairy calf to beef production systems. Various


17. McGee, M. FETAC accredited Training Course. Ruminant Nutrition. 01/10/17

18. Regan, M. Glanbia (Gain Animal Nutrition) Beef Finishers Conference. Pasture-based finishing of early- and late-maturing breed suckler bulls. 01/10/17


(v) Intellectual Property applications/licences/patents

No intellectual property has arisen from the project.

(vi) Other

N/A

5. Scientists trained by Project

Total Number of PhD theses: 4

- Brian Murphy (UCD). The effects of production system and finishing strategy on male calves from the dairy herd (Submitted 2017)

- Sibhehiiso Siphambili (UCD). An evaluation of the colour, texture and biochemical characteristics of muscle from suckler bulls finished under various modified pasture-based production systems (Submitted 2018).

- Natasha Ferguson (UCD). Novel dietary strategies to manipulate the carcase composition of dairy bred bull under a pasture based production system (anticipated submission, October 2020).


Total Number of Masters theses: 2

- Ciaran Lenehan (UCD). Strategies for growing and finishing suckler-bred male cattle prior to a second winter at pasture, or indoors on rations differing in composition (Submitted 2016)

- Maeve Regan (UCD). Grass-based production systems for suckler-bred male cattle (Submitted 2018)
6. Permanent Researchers

<table>
<thead>
<tr>
<th>Institution Name</th>
<th>Number of Permanent staff contributing to project</th>
<th>Total Time contribution (person years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teagasc</td>
<td>13</td>
<td>7.93</td>
</tr>
<tr>
<td>UCD</td>
<td>2</td>
<td>2.00</td>
</tr>
<tr>
<td>UCC</td>
<td>1</td>
<td>0.25</td>
</tr>
<tr>
<td>ICBF</td>
<td>2</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td><strong>10.48</strong></td>
</tr>
</tbody>
</table>

7. Researchers Funded by DAFM

<table>
<thead>
<tr>
<th>Type of Researcher</th>
<th>Number</th>
<th>Total Time contribution (person years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Doctorates/Contract Researchers</td>
<td>2</td>
<td>4.29</td>
</tr>
<tr>
<td>PhD students</td>
<td>4</td>
<td>15.43</td>
</tr>
<tr>
<td>Masters students</td>
<td>2</td>
<td>3.48</td>
</tr>
<tr>
<td>Temporary researchers</td>
<td>2</td>
<td>1.00</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>24.2</strong></td>
</tr>
</tbody>
</table>

8. Involvement in Agri Food Graduate Development Programme

<table>
<thead>
<tr>
<th>Name of Postgraduate / contract researcher</th>
<th>Names and Dates of modules attended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Lara Moran</td>
<td>Hot topics in the Agri-Food Sector, 11-13 June 2014</td>
</tr>
<tr>
<td>Dr Lara Moran</td>
<td>Innovation in the Bioeconomy, 12-14 November 2014</td>
</tr>
<tr>
<td>Dr Lara Moran</td>
<td>Leadership in the Agri-Food Sector, 21-23 January 2015</td>
</tr>
</tbody>
</table>
9. **Project Expenditure**

Total expenditure of the project: \( \text{€1,257,551.33} \)

Total Award by DAFM: \( \text{€1,328,700.70} \)

Other sources of funding including benefit in kind and/or cash contribution (specify):

Teagasc Walsh Fellowship (Ref: 2012054) \( \text{€81,000} \)

**Breakdown of Total Expenditure**

<table>
<thead>
<tr>
<th>Category</th>
<th>Institution 1 (Teagasc)</th>
<th>Institution 2 (UCD)</th>
<th>Institution 3 (UCC)</th>
<th>Institution 4 (ICBF)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract staff</td>
<td>32943.00</td>
<td>32943.00</td>
<td>45580.00</td>
<td>197579.19</td>
<td></td>
</tr>
<tr>
<td>Temporary staff</td>
<td>1274.43</td>
<td>1274.43</td>
<td>430265.71</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post doctorates</td>
<td>151999.19</td>
<td>45580.00</td>
<td>242294.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post graduates</td>
<td>170586.71</td>
<td>83929.00</td>
<td>242294.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumables</td>
<td>210905.77</td>
<td>16163.60</td>
<td>242294.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel and subsistence</td>
<td>28775.51</td>
<td>9780.50</td>
<td>258.40</td>
<td>43362.78</td>
<td></td>
</tr>
<tr>
<td>Sub total</td>
<td>567430.47</td>
<td>188396.10</td>
<td>258.40</td>
<td>947719.73</td>
<td></td>
</tr>
<tr>
<td>Durable equipment</td>
<td>6294.67</td>
<td>804.42</td>
<td>7099.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>35781.10</td>
<td>35781.10</td>
<td>35781.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overheads</td>
<td>170229.14</td>
<td>57490.43</td>
<td>39153.32</td>
<td>266951.41</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>779735.38</strong></td>
<td><strong>249929.61</strong></td>
<td><strong>227550.42</strong></td>
<td><strong>335.92</strong></td>
<td><strong>1257551.33</strong></td>
</tr>
</tbody>
</table>

10. **Leveraging**

A Teagasc Walsh Fellowship was awarded to fund the PhD work of Kevin McMenamin (award number 2012054) associated with the suckler bull production dimension of the project. To accelerate the progress of the project, an early task in the suckler bull production phase was facilitated by modification of an existing project. The associated costs incurred were borne by Teagasc. Generation of beef samples within this project
allowed linkage with a project within “Sensory Network Ireland” funded by Department of Agriculture Food and the Marine (FIRM: 13SN401), thereby adding value to both projects.

11. Future Strategies

The results of the research have been extensively disseminated through stakeholder engagement, Teagasc Open Days, publications in the popular press, conference presentations and peer reviewed publications as outlined in section 4b. Further work should focus on the relationship between current market specifications for bulls, in particular, age at slaughter and carcass fat classification, and the nutritional value and eating quality of bull beef. Moreover, research on understanding consumer sentiment towards bull beef, particularly grass-fed bull beef, in international markets for Irish beef is warranted.

12. Consent to Publish Final Report on the DAFM Website and/or Through Other Dissemination channels

I consent to this report being made available to the public, through the Department’s website and other dissemination channels.

Yes [x] No [ ]

13. Declaration

I declare that the information contained in this final report is complete and true to the best of my knowledge and belief.

Signed: [Signature] Project Coordinator

Date: April 23, 2020