Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

Research Stimulus Fund

Final Report

Development of an integrated farm and processing sector model for the Irish dairy Industry

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Please tick below the appropriate area on the research continuum where you feel this project fits

BASIC/FUNDMENTAL ⟶ APPLIED/PRE COMMERCIAL

☑		

Key words: *farm, processing, milk, seasonality, processing costs,*

NDP NATIONAL DEVELOPMENT PLAN

1. Rationale for Undertaking the Research

The mid term review of Common Agricultural Policy (CAP) "the Health Check Report (2008)" has changed the landscape for milk production in Ireland. This change came into place in late 2007 with the announcement of the removal of milk quotas in 2015 and gradual increase in milk quotas between 2009 and 2013 with a 1% annual increase and a reduction in the milk quota fat correction for each 0.1% increase in fat concentration from 18 L/1,000 L to 9 L/1000 L of milk quota. These reforms have presented real opportunities for the dairy industry to generate increased milk production and higher returns and ultimately higher industry profitability (farmer and processor alike). However for the Irish dairy industry to truly reap the rewards of this policy change a number of questions needed to be answered: will milk production in Ireland increase when quotas are abolished, if so where will it be produced, is the current structure of the processing sector adequate to process it, should the processing sector continue to process at a peak to trough ratio of 6.5 to 1, should the milk supply profiles be flattened or should there be more plant capacity constructed with expansion, if additional plant capacity is required where should it be constructed? In addition the Prospectus Report (2003) highlighted some inherent weakness in the Irish dairy industry, seasonality which adds significantly to processing costs and the over reliance on commodity type products, all of which may be exacerbated if the industry were to expand. Therefore to help inform the optimal strategy for the industry, that is profitable for both the farmer and processor alike while maintaining international competitiveness, clarity on each of these issues was essential.

The overall objective of this project was to identify strategies to allow the dairy farm and processing sector optimally respond to milk quota policy reform through developing a model that integrates both sectors. The models were to be used to develop milk pricing systems to maximize industry profitability.

Specific objectives;
1. Develop a processing sector model for the Irish dairy processing sector
2. Link the processing and Moorepark Dairy Systems Model to develop a dairy industry model
3. Calculate the optimal milk supply profile for the industry taking cognizance of processing costs, farm costs and the product portfolio.
4. Develop milk pricing systems that facilitate and promote the optimal supply profile
5. Determine the current processing capacity and location of this capacity within the dairy industry in Ireland
6. Develop strategies that could be used by the dairy industry to respond to potential changes in farm level production following policy reform both domestic (transfer policy) and international (arising from EU or WTO agreements).

2. Research Approach

Processing sector model
A milk processing-sector model (Moorepark Processing Sector Model) (Geary et al., 2010) that accounts for all inputs, outputs, and losses involved in dairy processing was developed. The model is a mathematical representation of the process of conversion of milk into dairy products. Within the model the production of cheese, butter, whole milk powder, skim milk powder, fluid milk, and casein is simulated. The model estimates the quantity of products and by-products that can be produced from the available milk pool. Processing costs are simulated, the return from raw milk is calculated and the values per kg of fat, per kg of protein and the milk price paid to farmers based on the product mix and milk composition are estimated. The processing sector model was used to examine the effect of a change on milk volume, milk composition, processing capacities, product mix and product market values on component values and overall milk price.

Industry model
The processing sector model was linked with the Moorepark Dairy Systems Model (Shalloo et al., 2004), which simulates dairy systems inside the farm gate. Outputs from each model were fed into the other

until both models were solved. The objective of carrying out an analysis using both models was to examine the effect of changes at farm level (volume and composition of milk produced) on the processor and changes at processor level (milk price paid) on the farm. There can be conflicts between optimality for the farm sector and optimality for the processing sector, by examining both systems together the net industry effect can be examined. The joint farm and processing sector models were used to determine the optimal seasonal profile within the Irish dairy Industry.

Expansion analysis

The economic value of milk quota was estimated on a national and regional basis for 2008. These values were compared to real milk quota exchange prices in order to assess the functioning of the regional restrictions of the milk quota. This analysis gives insight into whether milk quota is over or under valued in certain regions and provides information where milk production is likely to increase/decrease after the abolition of quotas. This analysis provided estimates of national and regional milk output supply under various policy scenarios which allowed for projections of where milk output is likely to increase after the abolition of milk quotas. Following this the expansion capacity of milk output was simulated on a national and regional level. The model accounted for structural change, on-farm expansion and estimated net margins for 2020. Technical factors to increase milk production were explored. More specifically, the length of the grazing season was assessed as a means to reduce costs of production. The effects of an extended grazing season on farm profitability were quantified and factors affecting the length of the grazing season were also assessed.

Milk transport model

A simulation/optimization milk transport model was developed for the Irish dairy industry. This model allows the examination of a wide range of efficiency factors in milk transport including pumping rates, tanker sizes, size of suppliers, and density of milk supply and frequency of collection. The model also facilitated the investigation of alternative industry development scenarios on milk transport costs. The model integrates capital costs, labour utilisation and running costs. As transportation is a significant contributor to carbon emissions the model also estimates carbon emissions. This model was used to examine (a) the effect of different milk output levels (+30%, +50%) post milk quota abolition on milk transport costs and on carbon emissions from milk transport (b) the effect of different tanker sizes (5000 gallon tankers and 6000 gallon tankers) on milk transport costs and on carbon emissions from milk transport and (c) the effect of different milk supply patterns (moderate reduction in seasonality: peak to trough month ratio of 2.71:1, even milk supply: peak to trough month ratio of 1.26:1) on milk transport costs and on carbon emissions from milk transport. Utilising the projected milk supply in 2020 a scale efficiency model was developed and the milk transport model was used to compare the current processing capacity with the peak milk supply in 2020. The newly developed model was then utilized to determine the optimal site location and scale of the required investment to support milk supply in 2020. Finally the transport model was used to identify the optimum configuration for the Irish dairy processing sector in terms of the number of manufacturing sites, average size of each manufacturing site and the location of each site.

3. Research Achievements

Processing sector model

The processing sector analysis completed using the Moorepark Processing Sector Model highlighted that the processor returns, the milk price paid to farmers and the value per kg or fat and protein is sensitive to product mix, product market values, milk volume, milk composition and processing capacities. Therefore the optimal strategy for the processor sector varies with commodity price and product port folio.

The processing model was used to examine the impact of moving the mean calving date from mid-March to mid-February on the processing returns. This shift in the mean calving date had been demonstrated to be more profitable for the farmer in previous analysis; the research question centred on the effect for the processor. The analysis found that a shift from mid-March to mid-February was more profitable for the processor and generated a higher average milk price, a higher value per kg of fat

and an equivalent value per kg of protein. This analysis was repeated assuming different cheese and casein processing capacity constraints with similar results. By moving the mean calving date from mid-March to mid-February processor returns could increase by an estimated €18 million per annum (assuming current industry processing capacities) and milk output of 5 billion litres.

Industry model

The linked farm and processing sector model were used to examine the effect of moving from a mean calving date of mid-February to a less seasonal milk supply profile, attained through 50:50 split Spring:Autumn system characterised by a lower peak and proportionately more milk produced on the shoulders of the season. The analysis examined the impact on farm returns, processor returns and the combined industry returns. From the farm perspective the seasonal milk supply profile generated a farm margin that was €148.8 million higher than the less seasonal milk supply profile. From the perspective of the processing sector net milk value was €65.8 million higher for the less seasonal milk supply profile than the seasonal milk supply profile. Accounting for the returns from both sectors, at industry level the seasonal milk supply profile was more profitable for the Irish dairy industry than the less-seasonal milk supply profile, generating returns that were €83 million higher. Therefore as the Irish dairy industry expands it should retain the seasonal milk supply profile and invest in additional processing facilities to accommodate peak milk supply.

Expansion analysis

The expansion analysis, using the National Farm Survey database, showed that, given the infrastructure that existed on farms in 2008 and the expected gains in productivity per cow, that the existing population of dairy farmers could increase national milk production by 72% by 2020. However, when anticipated farm exits from milk production and costs of expansion are considered, this falls to between 10 and 50% depending on future milk price, increases in productivity per cow and declines in dairy farm numbers. This expansion was also stratified by region and incorporated into the milk transport model.

Milk transport model

The milk transport model was used to examine the impact of expansion by location, optimum plant locations, effect of tanker size and the effect of seasonality on milk collection costs on overall industry profitability. This work evaluated different options around expansion and is directly relevant for the Irish dairy industry and provides quantitative analysis in relation to different aspects of the transport sector of the dairy industry. The milk transport model was used to optimise the locations of new processing facilities and where existing milk processing facilities should be expanded using the locations of current capacity and the locations of where expansion is expected to take place. The analysis found that the optimum location for building new facilities is in the South of the country, with Mitchelstown the most suitable location. The model was used to determine the optimum configuration of the Irish dairy industry. The objective function of the model was set to minimise the overall processing costs and milk transport costs when milk supply increased. Five scenarios were examined, S1-S4 assumed all current plants in Ireland operated at full capacity and the 45% increase in milk supply by 2020 was transported to the optimum location with S5 simulating an overall optimum industry configuration. Each of the five scenarios assumed a different product mix: scenario 1 (S1) and scenario 5 (S5) assumed the average national product mix between 2007-2009, Scenario 2 (S2) assumed that all the additional milk would be processed into cheese; scenario 3 (S3) assumed all additional milk would be processed into WMP and scenario 4 (S4) assumed all additional milk would be processed into butter and SMP. It was found that product mix had a large influence on the optimum configuration of the Irish industry in 2020. Also by co-locating plants on the same site substantial savings could be made. The optimum configuration (S5) in 2020 was 6 integrated sites; located across the country with this configuration resulting in increased profitability for the processing sector of €37 million per annum. This does not take into account current sunk costs.

4. Impact of the Research

Processing sector model & Industry model

The processing sector model is a dynamic simulation model that can be used by processors to investigate the effect of changes in a simulation framework to determine the optimum strategy. This tool coupled with the farm systems model provides the dairy industry with a novel means to examine the implications of strategic changes prior to implementing them to ensure strategies that are optimal for the industry are identified. The processing sector model also incorporated the A+B-C milk pricing system which can support processors in developing seasonal milk payment systems.

Expansion analysis

The expansion analysis is of high value to the dairy industry to help inform strategies for the processors in the future. As milk production increases the dairy industry needs to be primed to process the additional milk, integral to this is having the transport and processing capacity in the optimal locations. To ensure this can be achieved, clear knowledge on where the expansion will occur is essential. Prior to completing this research there was no clarity on this issue, while assumptions could have been made the research now provides the answer to this key question.

Milk transport model

Milk transport has not been previously evaluated for an Irish situation. This study built on a model developed in a previous study, which was calibrated using Irish data for the current industry structure and related this to an expanded industry structure. This analysis found that the optimum configuration for the Irish dairy industry was 6 sites around the country which would generate €37 million per annum in savings relative to the current industry structure. In addition this study shows where the additional processing capacity should be constructed within the dairy industry in Ireland, e.g. expand two additional sites which were located in Mitchelstown and Ballyraggot and to open a Greenfield site in Macroom. This analysis is highly applicable to the Irish dairy industry and would help to inform strategic discussions on the structure of the industry in the future.

5. Exploitation of the Research

There has been no intellectual property, licences or patents developed in this project. The project has developed milk pricing strategies around both seasonal milk payment and the multiple component pricing. This project has quantified the benefits associated with staying with the current seasonal milk supply profile and it demonstrated that the optimum strategy for the dairy industry centres around remaining with the seasonal milk supply profile and expanding milk output through building additional processing capacity at a number of optimum sites. The identification of locations where expansion will occur nationally has helped the decision making process around building additional processing capacity.

6. Summary of Research Outputs

(a) Intellectual Property applications/licences/patents

None

(b) Innovations adopted by industry

Prior to this work processors' were beginning to implement component milk pricing systems (A+B-C) however since completing this work the uptake has been more widespread. The research carried out in this project clearly demonstrated the power of component milk pricing systems and how rapidly such systems can act as a signal to farmers. Over the duration of this project numerous one to one meetings with processors and their boards have been completed examining the A+B-C milk pricing systems and how these systems could be implemented. The Authors are responsible for methodologies for most processors in Ireland around the A+B-C systems of milk payment. They also have developed seasonal milk payment systems for various milk processors.

(c) Number of companies in receipt of information

Arrabawn, Dairygold, Kerry, Carbery, Tipperary, Wexford, Glanbia

(d) Outcomes with economic potential

The development of milk pricing systems that encourage high solids milk at the correct time of the year will increase the profitability of the Irish dairy industry. The strategy that has been identified to increase milk output nationally in the seasonal nature will result in the maximum industry profitability. While there will be a requirement for increased processing capacity, the expenditure on this capital will be more profitable than flattening the milk supply profile.

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

None

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

1. Geary, U., Lopez-Villalobos, N., Garrick, G. and Shalloo, L. The effect of calving seasonality on overall profitability of the Irish dairy industry and its component farm and processing sectors. *Journal of Agricultural Science*, Cambridge (Accepted)
2. Geary, U., Lopez-Villalobos, N., Garrick, G. and Shalloo, L. 2012. An analysis of the implications of a change to the seasonal milk supply profile in the Irish dairy industry utilising a seasonal processing sector model. *Cambridge Journal of Agricultural Science*, **150:** 389-407
3. Geary, U., Lopez-Villalobos, N., Garrick, G. and Shalloo, L. 2010. Development and application of a processing model for the Irish dairy industry. *Journal of Dairy Science,* **93**: 5091–5100.
4. Heinshinck K., Shalloo L. and Wallace M. 2012. Development of an optimization model for analyzing production seasonality in the Irish milk processing sector. *International Journal of Agricultural Management*, Volume 1, pp. 6-18(13)
5. Hennessy, T., D. Lapple, Shalloo, L and Wallace, M. 2012. An economic analysis of the Irish milk quota exchange scheme. *International Journal of Agricultural Management* **1:** 10-18.
6. Läpple, D., Hennessy, T. and O'Donovan, M., 2012. Extended Grazing: A Detailed Analysis of Irish Dairy Farms, *Journal of Dairy Science* **95:** 188-195
7. Lapple, D. and Hennessy, T. 2012. The Capacity to Expand Milk Production in Ireland Following the Removal of Milk Quotas. *Irish Journal of Agriculture and Food Research*. In Press
8. Quinlan C., Shalloo L., Keane M., O' Connor D., Lapelle D. and Hennessey T. 2012. Expansion strategies for the Irish Dairy Industry. *Agribusiness.* (In Press)
9. Quinlan, C., Shalloo L., Keane, M., O'Connor, D., Enright P. and Geary U. 2012. The interaction between economies of scale and transport costs in the Irish dairy industry. *Journal of Dairy Science* (Accepted)
10. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2012. Milk Transport Costs under differing seasonality assumptions for the Irish Dairy Industry. *International Journal of Dairy Technology* **65:** 22-31
11. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2010. The Transport Implications for Ireland of the Elimination of the Milk Quota Regime in 2015. Irish Transport Research Network conference September 2010, available online. http://www.itrn.ie/uploads/Part%209.pdf

(g) Scientific abstracts or articles including those presented at conferences

1. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2010. Seasonality of Milk Production-Implications for Irish Milk Transport Costs, presented at the AESI conference
2. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2011. Modelling the Impact of changes in Regional and National Milk Supply on the Irish Dairy Processing Sector. AESI Young Researcher Conference
3. Geary, U. and Shalloo, L. 2011. Irish dairy processing model. Moorepark Open Day
4. Quinlan, C., Shalloo L., Keane, M. and O'Connor, D. 2011. Expansion Strategies post Milk Quota. ICOS Dairy Digest, September 2011.

5. Quinlan, C., Shalloo L., Keane, M. and O'Connor, D. 2011. Milk Transport Options for an Expanded Dairy Industry Post Milk Quota Abolition in 2015. AESI conference November 24th 2011
6. Heinshinck K., Shalloo L. and Wallace M. 2012. Irelands dairy processing sector: Seasonality profitability and product mix. Austrian Society of Agricultural Economics (ÖGA) was presented at the ÖGA conference in Bolzano, Italy, in October
7. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2011. Expansion Strategies for the Irish Dairy Industry. IDF World Dairy Summit conference October 2011
8. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2011. Co-operation among co-operatives to ensure the overall competitiveness of the Irish dairy sector. UCC Doctoral conference June 21st
9. Heinschink, H., Shalloo, L. and Wallace, M. 2011. Seasonality in the Irish dairy processing industry. Agricultural Economics Society annual conference in Coventry, UK in April 2011.
10. Hennessy, T., Läpple, D. and Newman, C. 2011. The Economic Returns to Membership of a Discussion Group: Evidence from the Irish National Farm Survey, Paper presented at the 85th Annual Conference of the Agricultural Economics Society, Warwick, UK.
11. Geary, U and Shalloo, L. 2011. The impact of seasonality on dairy industry returns. Agricultural Research Forum March 14th
12. Quinlan C, Keane M, O'Connor D. 2010. Optimisation of Milk Transport, Processing and Dairy Product Distribution using an Integrated Model Submitted presentation to Department of Agriculture, Food and Fisheries "2020 Strategy" in March 2010.
13. Läpple, D., and Hennessy, T. 2010. The Capacity to Expand Milk Production: The Evidence from the National Farm Survey, paper prepared for the Food Harvest 2020 Implementation Committee.
14. Läpple, D., Hennessy, T., Wallace, M and Shalloo, L. 2010. An Economic Analysis of the Irish Milk Quota Scheme, paper presented at the Agricultural Economics Society of Ireland Annual Conference, Dublin, Ireland.
15. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2010. A transportation model for estimating milk transport costs and carbon emissions from milk transport. Presentation at IRSS conference in August 2010.
16. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2010. The Transport Implications for Ireland of the Elimination of the Milk Quota Regime in 2015" presented at the IRSS conference on 31st August and at the ITRN conference on September 1st.
17. Heinschink, H., Shalloo, L. and Wallace, M. 2010. Modelling strategies for the Irish dairy industry: The processor's perspective. Agricultural Economics Society annual conference, Dublin.
18. Geary, U., Shalloo, L., Garrick, D.J. and Lopez-Villalobos, N. 2010. Development of a milk processing sector model. IDF World Dairy Summit
19. O'Connor, D., Keane, M. and Barnes, E. 2009. Measuring volatility in dairy commodity prices, , 113th European Association of Agricultural Economists (EAAE), Mediterranean Agronomic Institute of Chania (MAICh), Chania, Greece, 03 – 06 September, 2009
20. Heinschink, H., Shalloo, L. and Wallace, M. 2009. Ensuring a sustainable Irish dairy industry in a post-quota environment. IDF World Dairy Summit in Berlin
21. Geary, U., Shalloo, L and Lopez-Villalobos, N. 2010. Development of a dairy processing sector model for the Irish dairy industry. British Society of Animal Science and Agricultural Research Forum, Belfast, 12-Apr-2010, p. 335
22. Heinschink, H., Shalloo, L. and Wallace, M. 2010. Seasonality and sustainability in Ireland's dairy industry. AES conference, Edinburgh, March 2010.
23. Quinlan, C., Keane, M., O'Connor, D. and Shalloo, L. 2010. Planning for the future of the Irish dairy Industry post milk quota elimination. UCC Doctoral Showcase

(h) National Report

None

(i) Popular non-scientific publications

1. Geary U and Shalloo L. Mastitis and farm profitability. *TResearch*, Vol 6: Number 4. Winter 2011

2. Geary U and Shalloo L. A milk processing sector model for Ireland. *TResearch*, Vol 5: Number 4. Winter 2010
3. Geary U, Shalloo L and Hennessy T. Milk processing, utilisation and pricing. *TResearch*, Vol 4: Number 2. Summer 2009
4. Läpple, D., Hennessy, T. and O'Donoghue, C. 2010. Farm Demography and the Opportunities for Dairy Expansion in Food Harvest 2020, *Irish Farmers Journal*.
5. Hennessy, T., Kinsella, A., Moran, B. and Läpple, D. 2010. Benefits of Extending the Grazing Season, *TResearch* Vol. 5(4), pp. 26-27.
6. Hennessy, T., Kinsella, A., Moran, B. and Läpple, D. 2010. Benefits of Extending the Grazing Season, *Irish Farmers Journal.*

(j) Workshops/seminars/ open days at which results were presented (excluding those in (g))

1. Geary, U. 2009. Development of an integrated farm and processing sector model for the Irish dairy industry: Processing Sector Model, Rural Economy Research Centre in Athenry, July 15th
2. Geary, U. 2010. Development of an integrated farm and processing sector model for the Irish dairy industry: Analysis and results to date. Massey University, New Zealand
3. Heinschink, H., Shalloo, L. and Wallace, M. 2009. Modelling strategies for the Irish dairy industry: The processor's perspective. AESI conference
4. Shalloo, L, Geary, U. 2011. An oral presentation was made at a farmers conference which was entitled "Expansion in the dairy industry". The costs and benefits of flattening the supply profile were presented as well as the possible options to fund expansion.
5. Heinschink, H., Shalloo, L. and Wallace, M. 2011. Seasonality in the Irish dairy processing industry. Coventry, UK in April 2011.
6. Geary, U., Shalloo, L. 2011. Economic analysis of the Irish dairy industry. Moorepark Open Day
7. Shalloo, L. 2012. Presentation to Dairygold on milk pricing strategies in relation seasonality (January 2012)
8. Shalloo, L. 2011. Presentation to Glanbia on milk pricing strategies in relation to seasonality (December 2011)
9. Shalloo, L. 2012. Presentation to Carbery on milk pricing strategies in relation seasonality (July 2012)
10. Shalloo, L. 2012. Presentation to Tipperary Co Op in relation to the implementation of the multiple component milk pricing system of milk payment (A+B-C) (June 2012)
11. Shalloo, L. 2012. Discussions with Wexford creameries in relation to the implementation of the multiple component milk pricing system of milk payment (A+B-C) (July 2012)
12. Shalloo, L. 2012. Presentation on the A+B-C system of milk payment at Irish Farmers Association (IFA) meeting in Kilrush, Co Clare in July 2012
13. Lapple, D. and Hennessy, T. 2012. The Capacity to Expand Milk Production in Ireland Following the Removal of Milk Quotas. Presentation at the Teagasc Lunchtime Briefing on the Medium Term Outlook for Agri-food markets. Buswells Hotel July 24th 2012
14. Hennessy, T. 2012. The Capacity to Expand Milk Production in Ireland Following the Removal of Milk Quotas. Briefing at the Department of Enterprise, Trade and Employment. June 21st 2012.

7. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (months)	Average time contribution per permanent staff member
Teagasc Moorepark	2	21	10.5 months
Teagasc RERC	1	2.6	2.6 months
UCC/CIT	2	5.4	2.7 months
UCD	1	2.7	2.7 months
Total			

8. Researchers Funded by RSF

Type of Researcher	Number	Total Time contribution (months)	Average time
Post Doctorates	0	0	0
Contract Researchers	2	48.7	24.35 months
PhD postgraduates	1	36	36 months
Masters postgraduates	0	0	0
Temporary researcher	0	0	0
Other	0	0	0
Total			

9. Postgraduate Research

Total Number of PhD theses: 1

Karin Heinschink, University College Dublin, Development and application of an optimisation model for analysing economic implications of seasonality and milk quota removal on Ireland's milk processing sector, August 2013

Total Number of Masters theses: 0

10. Project Expenditure

Total expenditure of the project:	€ 410,530.12
Total Award by RSF	€ 415,477.44
Other sources of funding (specify) Walsh Fellowship	€63,000

Breakdown of Total Expenditure

Category	Teagasc Moorepark	Teagasc RERC	UCD	UCC	CIT	Total
Contract staff	171,883.43	56,291.25	-	-	-	228,174.68
Temporary staff						
Post doctorates						
Post graduates			64,649.96			64,649.96
Consumables						
Travel and subsistence	12,080.94	2,393.85	6,215.39	7,674.56	6,643.77	35,008.51
Sub total	183,964.37	58,685.10	70,865.35	7,674.56	6,643.77	327,833.15
Durable equipment						
Other	62.76	528.18				590.94
Overheads	46,006.78	148,03.32	17,716.32	1,934.40	1,660.94	82,106.03
Total	**230,033.91**	**74,016.60**	**88,581.67**	**9,593.21**	**8,304.71**	**410,530.12**

11. Future Strategies

The dairy processors have been made aware, through publications and industry consultation, that the processing sector model has been developed and is available to support individual processor as well as industry analysis. The linked models have been utilised (1) to complete a carbon emissions analysis for Carbery dairy products and (2) to complete an analysis of the cost of mastitis to the Irish dairy industry (farm and processor) (RSF 10 714). The processing sector model is a dynamic tool that can support GHG, animal health as well as processing analysis for the Irish dairy industry. It is the aim of the researchers to utilise this model in the completion of tasks in other research studies and to answer other pertinent Industry related research questions. The milk processing sector model is currently been used to develop economic values for the economic genetic selection index for dairy cattle in Ireland.

12. Industry Collaboration

Throughout this project we have consulted and collaborated with the dairy industry. This collaborative relationship began at an ICOS board meeting early in the project whereby we presented to the board the project objectives and sought their input in the completion of one of the project tasks. We also had one to one meetings with a large majority of the dairy processors in relation to this task (Dairygold, Kerry, Glanbia, Arrabawn, Tipperary, Centenary Thurles, Newmarket, Carbery). Throughout the project we have consulted with processors on a number of data points and demonstrated the model capabilities utilising their own specific data. Through this collaboration we have ensured that the model is built using Irish specific data and we have also validated the models ensuring they are fit for purpose. In addition we have worked with the Irish Dairy Board throughout the project, we have consulted on the project objectives, potential industry strategies and various data gaps.