

## Research Stimulus Fund

### Final Report

#### Review of factors impacting on the processing quality of raw milk produced in Ireland

**DAFM Project Reference No:** 10/RD/AAQUALITYMILK/TMFRC/713

**Start date:** 10/05/2012

**End Date:** 09/05/2013

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Name: Dr. Sinead McParland, TEAGASC

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Name: Professor Alan Kelly, UCC

Name: Dr. Karina Pearce, UCD

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

Basic/Fundamental		→		Applied		→		Pre Commercial	
1	2	3	4 X	5	6	7			

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

<b>Priority Area (s)</b>	Priority Area I - Sustainable Food Production and Processing  Priority Area H - Food for Health
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**Key words:** (max 4) Milk Quality, Processability, Residues,

## **1. Rationale for Undertaking the Research**

*This section should outline the rationale for carrying out the research and identify the need / problem to be addressed*

In the future, milk of the highest standard in terms of milk composition and processability, bacteriological status, and residue levels will be required in order to be at the forefront of competing markets e.g. trichloromethane (TCM) levels of < 0.03mg/kg in butter and < 250 µg/kg of iodine in milk intended for use as a raw material for infant feed formula. There is also a preference by the Russian market for milk of <200,000 cells/ml.. New research is required to deal with 'harder to attain' current and future quality standards as well as impediments to achieving optimum milk quality from modern, expanded farm systems that need to be profitable and sustainable.

This research project needed to be put in place to establish the position of milk quality currently and to establish what were the key areas that needed special attention in future.

## **2. Research Approach**

*Specify the research methodologies employed, emphasising novel techniques and also outline any modifications from the original approved project proposal*

The research approach included (i) an examination of milk quality criteria in other countries with a view to establishing how they attain good milk (e.g. through payment systems); (ii) using existing data of ICBF and processors to define the quality of milk in the country in terms of composition and somatic cell count and total bacterial count, as these are the key quality criteria - the trends for these criteria were described within and between years; (iii) reviewing recent research studies and thus clearly identifying the knowledge accumulated, the relevant problems, unanswered questions and critical gaps in the knowledge that need to be addressed.

### **1. Comparison of both milk quality criteria between Ireland with those across EU and other countries**

A questionnaire was designed (see Appendix 1) and sent to colleagues in other countries, and colleagues in the International Dairy Federation. Seventeen questionnaires were distributed and 9 returned. So the information on milk quality parameters was obtained through IDF contacts and other international researchers

### **2. Using milk recording data, i.e. composition (fat, protein, lactose) and SCC to establish associations between cow factors (genetic and management imposed) and milk quality characteristics**

Milk recording data on 58,659,604 test day records from 2,789,000 individual cows across 8,669,464 lactations were obtained from ICBF. Data were categorised into spring calving and mixed season calving herds. A univariate analysis of age at calving within parity was performed. Records obtained between 2007 and 2011 from Holstein, Friesian, Jersey, Montbelliarde and Norwegian Red animals, as well as crosses between these breeds were retained. Somatic cell count (SCC) was normalised to somatic cell score (SCS) using the transformation:  $SCS = \log_{10} (SCC * 1000)$ .

**3. Updating the national trends in SCC, TBC and milk composition (2005-2010) using data from milk processors**

Bulk tank milk quality data were requested from individual milk processors across the Republic of Ireland. Bulk tank milk quality data were supplied by ten individual milk processors representing 11,824 individual milk suppliers from across the Republic of Ireland. Data were supplied from 2006 to 2011, inclusive, by eight processors, two processors provided data from 2007 to 2011, inclusive, and 2008 to 2011, inclusive, respectively. Trends in SCC and TBC across year, across month and across herd size were quantified using mixed models in ASReMl. All models included the fixed effects of milk processor, monthly milk volume, year and month and the random supplier effect. Interactions between fixed effects were tested. Where the herd size was tested in the model (as an individual or interacting effect) volume was not included in the model.

**4. Reviewing the influence of cleaning and sanitizing of milking machines, milk cooling and milk storage in terms of microbiological pathogen status especially in relation to thermophilic, *Bacillus cereus* and sulphite reducing clostridia**

A review of studies published in this work area was conducted, the results of a questionnaire on milking hygiene completed by seventy one dairy managers were recorded and considered

**5. Establishing the issues surrounding the occurrence of residues in commercial milks, i.e. flukicides, trichloromethane**

A review of studies published in this work area was conducted – this mostly concentrated on research studies and peer reviewed publications.

**3. Research Achievements/Results**

*Outline main results achieved*

**Under the headings 1-5 above:**

1. Detailed information on milk quality criteria requested by milk purchasers in other countries was not as forthcoming as originally thought. This information was difficult to obtain from both milk purchasers and farm advisory consultants. This may have been due to different structures the industry to that in Ireland.

Information on the milk quality payment systems in different countries was obtained. Only one country has a national payment system. The payment systems are confidential to the different processors and not publically available. This gives flexibility to the processors to pay for quality parameters they require for their product portfolio.

2. All animal and herd factors tested had a significant effect on somatic cell count. Older animals, animals which were younger at calving than contemporaries and Holstein animals have higher somatic cell count than younger alternative breed or animals who calve at the median age at calving. In addition, mixed calving production systems and herds in Connaught had higher somatic cell count than spring calving herds in the other regions of Ireland.

3. There was no consistent trend in either SCC or TBC across years to demonstrate that milk quality is either improving or disimproving. Lowest SCC and TBC were observed in the summer months and in the largest herds. Poor weather appears to have an adverse effect on SCC, however further research is required to quantify the association between rainfall and increased SCC.

4. Recent microbiological data on Irish milk was collated, and state-of-the-art methodologies for studying biodiversity were investigated. As a consequence of the farm survey, experimental studies were conducted to test the effectiveness of a number of milking machine wash routines on the hygienic quality of milk. Clear guidelines have now been published in the form of four defined milking machine wash routines.

5. A comprehensive review was carried out of the residues that may be of concern for the dairy industry. The task identified priority residues that may be of concern at present and in the future including, banned substances (i.e. recombinant bovine somatotropin), cephalosporin antibiotics, anti-parasitic agents, biocides (quaternary ammonium compounds, chlorinated disinfectants, aflatoxins M1, plant toxins, plasticisers and persistent organic pollutants (PCBs and brominated flame retardants).

#### **4. Impact of the Research**

*A summary of the tangible impact of the research project should be provided under the 'outcomes' and 'outputs' heading below. In addition, please provide a short narrative synopsis of the benefits / improvements the research has made to the area under investigation particularly as regards end users, e.g. industry, consumers, regulatory authorities, policymakers, the scientific community, etc*

#### **Under the headings 1-5 above:**

1. As the information on payment for quality is confidential, the results of this task are of limited value, except to know that other countries don't have a national payment system.

2. Recent recommendations have promoted calving animals at a younger age, however this study has shown that animals that are younger than the average age of their contemporaries at calving have higher somatic cell count. The regional differences observed in somatic cell count indicate that further effort is required in Connaught to reduce somatic cell count and may require greater education or a revision of recommended practices to deal with somatic cell count in production systems in Connaught. This study has provided the first estimates of differences in the somatic cell count across geographical regions of Ireland and the first estimates of differences in somatic cell count amongst breeds of cattle nationally. Results from this study indicate that a follow-up study investigating the greater somatic cell count of animals which are younger at calving than their contemporaries should be initiated.

3. This study provided the first quantification of the somatic cell count and total bacterial count across the majority (66%) of the national herd. The results from this study indicate that SCC and TBC are not improving in the national herd. However in order to quantify

improvements baseline figures are required such as were provided by this study. The national statistics for somatic cell count and total bacterial count quantified by this study indicate that weather has a strong effect on somatic cell count. However, further research is required to disentangle the housing, feeding, weather and individual animal milk volume effects on reduced somatic cell count observed in the summer months.

4. The microbiological data will be used to inform future research. As a consequence of the farm survey, experimental studies were conducted to test the effectiveness of a number of milking machine wash routines on the hygienic quality of milk. Clear guidelines have now been published in the form of four defined milking machine wash routines. The wash routines are freely available and should be widely used.

5. This succinct report identified key residues that are of concern to the dairy industry. This included residues that should be monitored on an ongoing basis and new emerging residues that warrant further research. The latter may become an issue for the industry in the future due to improvements in analytical detection.

#### **4(a) Summary of Research Outcomes**

(i) Collaborative links developed during this research

No new links but improved links with UCC and UCD in this area

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

None

(iii) Outcomes with economic potential

No direct economic potential BUT indirect economic potential associated with improved milk quality

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

Potential national outcome associated with improved image of Irish milk quality in export markets

#### **4 (b) Summary of Research Outputs**

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

*McParland, S., O'Brien, B., McCarthy, J. (2013). The relationship between herd- and cow- level factors and somatic cell count of Irish dairy cows. Irish Journal of Agricultural and Food Research 52, 151-158.*

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

- Animal and herd factors associated with somatic cell count of Irish Holstein-Friesians. In: Agricultural Research Forum, Tullamore Court Hotel, 12-Mar-2013
- Efficacy of post-milking teat disinfection products in reducing bacterial numbers on teats. In: Agricultural Research Forum, Tullamore Court Hotel, 12-Mar-2013
- The association between udder hygiene score and the bacillus cereus count in raw bulk tank milk. In: Agricultural Research Forum, Tullamore Court Hotel, 12-Mar-2013
- Investigation of the persistence of triclabendazole residues in bovine milk following lactating-cow and dry-cow treatment. In: Agricultural Research Forum, Tullamore Court Hotel, 12-Mar-2013
- Investigation of the persistence of rafoxanide residues in bovine milk and fate during processing. 2012 IDF World Dairy Summit, Capetown
- Triclabendazole residues in bovine milk following milking-cow and dry-cow treatments. 2012 IDF World Dairy Summit, Capetown
- Strategy for the reduction of trichloromethane in milk. 2012 IDF World Dairy Summit, Capetown

(iii) National Report

(iv) Workshops/seminars at which results were presented

- O'Brien, B., Gleeson, D. and Jordan, K. Report on research work conducted on various aspects of milk quality. Milk and Product Quality FORUM. Heritage Hotel, Portlaoise. 24/04/13.
- O'Brien, B. Milk Quality lecture. IMQCS technicians (Group 1). Teagasc Animal and Grassland research and Innovation Centre, Moorepark. 23/04/13.
- Gleeson, D. Milk Quality lecture. IMQCS technicians (Group 2). Teagasc Animal and Grassland Research and Innovation Centre, Moorepark 24/04/13.
- O'Brien, B., Gleeson, D. and Jordan, K. TCM in Irish milk. Irish Dairy Board TCM meeting. Teagasc Animal and Grassland Research and Innovation Centre, Moorepark. 31/07/12.
- O'Brien, B., Gleeson, D. and Jordan, K. Improving Quality of Irish Milk. Milk Quality Workshop. Teagasc Animal and Grassland Research and Innovation Centre, Moorepark. 04/12/12.
- O'Brien, B., Gleeson, D. and Jordan, K. Improving Quality of Irish Milk. Milk Quality Workshop. Slieve Russel Hotel, Ballyconnell, Co. Cavan. 06/12/12.
- O'Brien, B. and Gleeson, D. web page: <http://milk quality>. 01/05/13.

(v) Intellectual Property applications/licences/patents

(vi) Other

## 5. Scientists trained by Project

Total Number of PhD theses:   0  

Please include authors, institutions and titles of theses and submission dates. If not submitted please give the anticipated submission date

Total Number of Masters theses:   0  

Please include authors, institutions and titles of theses and submission dates. If not submitted please give the anticipated submission date

## 6. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (person years)
Teagasc Animal & Grassland Research and Innovation Centre	2	0.23
Teagasc Food Research Centre, Moorepark	1	0.07
Teagasc Food Research Centre, Ashtown	1	0.00
University College Cork	1	0.00
University College Dublin	1	0.00
<b>Total</b>		<b>0.30</b>

## 7. Researchers Funded by DAFM

Type of Researcher	Number	Total Time contribution (person years)
Post Doctorates/Contract Researchers	1	1.00

PhD students	0	0.00
Masters students	0	0.00
Temporary researchers	0	0.00
Other	0	0.00
<b>Total</b>		<b>1.00</b>

## 8. Involvement in Agri Food Graduate Development Programme

Name of Postgraduate / contract researcher	Names and Dates of modules attended
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## 9. Project Expenditure

Total expenditure of the project: € 75,112.44

Total Award by DAFM: € 75,112.44

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

Breakdown of Total Expenditure

Category	Name Teagasc Animal & Grassland Research and Innovation Centre	Name Institution 2	Name Institution 3	Name Institution 4	Total
Contract staff	58,372.85				58,372.85
Temporary staff					
Post doctorates					
Post graduates					
Consumables					
Travel and subsistence	4,573.59				4,573.59
<b>Sub total</b>					
Durable equipment					
Other					
Overheads	12,166.00				12,166.00
<b>Total</b>	<b>75,112.44</b>				<b>75,112.44</b>

## 10. Leveraging

Summarise any additional resources'/funding leveraged by this award from other sources e.g. Additional Staff, National/EU funding secured, EI Commercialisation Fund, etc.

None

## 11. Future Strategies

*Outline development plans for the results of the research.*

These results will have impact in Connaught where greater education or a revision of recommended practices is required to deal with somatic cell count in production systems there

- The results indicate that SCC and TBC are not improving in the national herd. However in order to quantify improvements, baseline figures are required such as were provided by this study
- The microbiological data will be used to inform future research. The wash routines are freely available and should be widely used by milk producers
- key residues have been identified that will be of concern to the dairy industry requiring improvements in analytical detection.

From an overall perspective, the different aspects of the project have identified a number research areas that need to be focused on in a strategic manner:

- a research study on farm factors influencing environmental and cow hygiene specifically during the spring and autumn time when SCC and TBC has been observed to be at their highest

- research on extended milk storage time and temperature needs to be conducted in order to elucidate the factors affecting the high TBC, observed when milk volumes are low at the start and end of lactation
- an evaluation of the dissemination of knowledge on SCC and TBC, since levels have not improved significantly between 2006 and 2011
- there are major gaps in knowledge with respect to *B. cereus*. Data is needed on the factors affecting the transfer of *B. cereus* from the farm environment to the milk and on the factors that affect toxin production by *B. cereus*.
- a more rapid and reliable test for *B. cereus* is needed to allow decisions on milk product destination
- a survey of the major pathogens in the same milk sample is currently being undertaken by the FSAI, and following this, continuous monitoring of pathogens is required from a public health risk perspective and to verify that on-farm hygiene practices are effective
- milk biodiversity is poorly understood as indicated in the study. Application of new technologies to the study of biodiversity will add to the understanding of biodiversity in milk and will add to information on milk quality and contribute to maintaining quality
- development of intervention strategies to reduce the occurrence of thiouracil and semicarbazide in food
- chemical tests for measuring residues of key antibiotic residues, including cephalosporins, aminoglycosides and polypeptides in milk
- studies to investigate impact of residues in dairy product manufacture and produce new knowledge to inform risk managers
- studies should be carried out to measure exposure to PBDEs from milk and dairy products
- robust methodologies to detect QACs in various dairy products with satisfactory accuracy and precision
- knowledge on causes of QAC contamination in dairy products and the migration of QACs between various products during dairy product manufacture.