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Water footprinting of dairy, beef and sheep farms in Ireland

Key external stakeholders:

Dairy processors, beef, sheep and dairy farmers, Irish Cattle Breeding Federation (ICBF), Bord Bia, consultancy agencies

Practical implications for stakeholders:

- Quantified the water footprint of dairy, beef and sheep farms in Ireland using farm specific data
- Identified mitigation strategies to improve sustainability on farms in the area of water use efficiency
- Developed low cost, low data requirement solutions to aid the deployment of water footprinting technologies to the wider farming community

Main results:

- The production of milk consumed on average 690 L water/kg FPCM (fat and protein corrected milk), ranging from 534 L/kg FPCM to 1,107 L/kg FPCM.
- The average WF of the beef farms was 8,391 L/kg carcass weight (CW) of which 8,222 L/kg CW was green water and 169 L/kg CW was blue water; water for the production of pasture (including silage and grass) contributed 88% to the water footprint (WF), concentrate production, 10% and on-farm water use, 1%.
- The average WF of the sheep farms was 7,672 L/kg CW of which 7,635 L/kg CW was green water and 37 L/kg CW was blue water; water for the production of pasture contributed 87% to the WF.

Opportunity / Benefit:

This project showed that the demand for grass as a source of feed had a large influence on the total water footprint of all systems studied, as well as how pasture based systems in Ireland are capable of producing livestock products far beyond our domestic needs which can be exported to meet the global demand for livestock products. This study also evaluated the sustainability of recent intensification initiatives in Ireland and found that increases in productivity were supported through an increase in green water use and higher grass yields per hectare on dairy, beef and sheep farms.

Collaborating Institutions:

Irish Cattle Breeding Federation, Bord Bia, UCD, Wageningen University, Cork Institute of Technology

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1. Project background:

A central requirement within the Food Harvest 2020 and Food Wise targets is that output is increased in a sustainable manner. The Food Harvest and Food Wise reports call for the development of a sustainability audit system that uses recognized international standards to benchmark the overall sustainability of Irish farms, locally and globally. To realise the Food Harvest 2020 vision this project developed new models and metrics according to international standards to enable Ireland's producers to verify their "green" credentials and help promote "Brand Ireland". The methods recommended to evaluate farm water consumption are based around cradle to farm gate and whole farm systems analysis. This project created water footprint models to feed into an assurance scheme, which will help support national food production objectives ad inform policy around water consumption in the future

2. Questions addressed by the project:

• This project answers industry and consumer questions around quantifying the water footprint of Irish dairy, beef and sheep production
• It addressed the requirements of stakeholders to develop a sustainability audit system that can benchmark Irish farms performance over time and offers the potential to carry out this monitoring through an assurance scheme or system

3. The experimental studies:

A group of 75 beef, dairy and sheep farms were selected to participate in this project over a two-year period. Information was collected for several sustainability metrics through direct measurement, surveys and websites. Water was measured on-farm after installing monitoring equipment. The information from these measuring devices was remotely transferred to Moorepark via the mobile phone network at 15 minute intervals or manually read. Farm facilities were also surveyed e.g., cubicles per slatted unit to determine farm infrastructure levels, area of yards washed, water recycling strategies etc. Animal number and activity information for the farms along with monthly milk volumes supplied to dairy processors was transferred by technicians from the Irish Cattle Breeding Federation website to the Moorepark Oracle database. Data that could be not captured directly or indirectly (e.g. cattle or sheep housing dates) was provided by farmers using detailed on-line monthly surveys.

Detailed industry specific water footprint models were developed to international best practice standards to quantity the water footprint across the different industries. These models applied holistic systems approaches to quantify water resources used from cradle to farm gate and the resultant water stress index adjusted footprint was computed from raw-material acquisition through to production of the farm product. Subsequently a regression model based solution was developed and published which would allow roll out of a water footprint to the broader industry through computation of farm specific water footprints based on readily available farm data. This version of the water footprint will be adopted into the Board Bia quality assurance scheme.

4. Main results:

- The production of milk consumed on average 690 L water/kg FPCM (fat and protein corrected milk), ranging from 534 L/kg FPCM to 1,107 L/kg FPCM. Water required for pasture production contributed

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85% to the water footprint, 10% for imported forage production (grass in the form of hay and silage), concentrates production 4% and on-farm water use ~1%.

- The average stress weighted water footprint was 0.4 L/kg FPCM across the farms, implying that each liter of milk produced potentially contributed to fresh water scarcity equivalent to the consumption of 0.4 L of freshwater by an average world citizen.
- The average WF of the beef farms was 8,391 L/kg carcass weight (CW) of which 8,222 L/kg CW was green water and 169 L/kg CW was blue water. Water for the production of pasture (including silage and grass) contributed 88% to the WF, concentrate production, 10% and on-farm water use, 1%.
- The average stress-weighted WF of beef was 91 L H_2O eq/kg CW, implying that each kg of beef produced in Ireland contributed to freshwater scarcity equivalent to the consumption of 91 L of freshwater by an average world citizen.
- The average WF of the sheep farms was 7,672 L/kg CW of which 7,635 L/kg CW was green water and 37 L/kg CW was blue water; water for the production of pasture contributed 87% to the WF, concentrate production, 12% and on-farm water use, 1%.
- The average stress-weighted WF was 2 L H_2O eq/kg CW for sheep.

5. Opportunity/Benefit:

This project demonstrated that intensification of Irish animal production systems through high utilisation of rain water resources for the production of milk, beef and sheep meat are sustainable from a water use perspective. Rain water for the production of grass made up 85% of the total water footprint in dairy systems, 88% in beef systems and 87% in sheep production systems. This is a key competitive advantage for Irish agriculture in terms of sustainable food production since the majority of these products are exported to less water rich regions. Utilising green water resources that are plentiful in Ireland for the production of milk, beef and sheep meat indicates that recent intensification measures in Food Harvest 2020 and Food Wise 2025 are sustainable from a water use perspective.

6. Dissemination:

Main publications:

Murphy, E., I. J. M. de Boer, C. E. van Middelaar, N. M. Holden, L. Shalloo, T. P. Curran, and J. Upton. 2017. Water footprinting of dairy farming in Ireland. J. Clean Prod. 140, Part 2:547-555.

Murphy, E., I. J. M. de Boer, C. E. van Middelaar, N. M. Holden, T. P. Curran, and J. Upton. 2017. Predicting freshwater demand on Irish dairy farms using farm data. J. Clean Prod. 166(Supplement C):58-65.

Shine, P., T. Scully, J. Upton, L. Shalloo, and M. D. Murphy. 2017. Electricity & direct water consumption on Irish pasture based dairy farms: A statistical analysis. Applied Energy.

International conferences

Results were presented at numerous conferences such as the Lifecycle assessment food conference in Dublin, Engineers Ireland conference on Process Water Recovery in the Food & Beverage and Pharma & Biopharma Industries; Opportunities, Challenges, International Manufacturing conference in Belfast, Northern Ireland, Global Science Conference in France and the Agriculture Engineering Conference in Switzerland.

National conferences and seminars

Presented at national dairy, beef and sheep conferences and at the Agricultural Research Forums throughout the duration of the project as well as presenting to Dairy Degree students that undertake their undergraduate programmes at Teagasc Moorepark.

Open days:

Presented at Moorepark and Grange open days, as well as at a number of open days that were held on individual farms throughout the country.

Industry consultation

Different industry groups were collaborators on this project and therefore got first-hand knowledge of the projects findings. For other national industry groups there were many other meetings at different points throughout the project.

Farmer discussion groups

Results were presented and discussed at several farmer discussion groups and seminars. There were also intensive sessions completed with the farmers involved in the overall study on a number of occasions

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throughout the project to provide feedback on an on-going basis.

7. **Compiled by:** Dr. John Upton