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# A slacks-based Data Envelopment Analysis framework to identify differences in sustainability patterns between four contrasting dairy systems

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## ► To cite this version:

Andreas Diomedes Soteriades, Philippe Faverdin, M. March, A.W. Stott. A slacks-based Data Envelopment Analysis framework to identify differences in sustainability patterns between four contrasting dairy systems. 11. European IFSA Symposium: Farming systems facing global challenges: Capacities and strategies., Apr 2014, Berlin, Germany. IFSA Europe, 2014, Farming systems facing global challenges: Capacities and strategies. hal-01210739

**HAL Id: hal-01210739**

**<https://hal.science/hal-01210739>**

Submitted on 2 Jun 2020

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**Workshop 2.7: Sustainability of Dairy Farms - Concepts, Measurements and Empirical Results**Convenors: **Ludwig Theuvsen, Birthe Lassen, Monika Zehetmeier****A slacks-based Data Envelopment Analysis framework to identify differences in sustainability patterns between four contrasting dairy systems**AD Soteriades<sup>1</sup>, P Faverdin<sup>2,3</sup>, M March<sup>4</sup>, AW Stott<sup>1</sup><sup>1</sup>Scotland's Rural College, UK, <sup>2</sup>INRA, UMR1080, St-Gilles, France, <sup>3</sup>Agrocampus Ouest, UMR1080, Rennes, France, <sup>4</sup>Scotland's Rural College, UK, [Andreas.Soteriades@sruc.ac.uk](mailto:Andreas.Soteriades@sruc.ac.uk)

World food production must increase to meet greater future demand without exacerbating climate change and despite dwindling resources. More efficient dairy farm production is therefore essential if farms are to become and remain economically, socially and environmentally sustainable. Data Envelopment Analysis has been increasingly used to measure dairy farm efficiency. However, all studies identified have used radial models that do not account for the farms' slacks, i.e. overused resources for a given production level. This study used a slacks-based measure of efficiency (SBM) in order to identify relationships between the technical, environmental and economic efficiencies of Scottish dairy farms by using data from a long-term genetic line × feeding systems experiment comprising of 4 distinct systems. The slacks allowed for the calculation of resource-specific efficiency patterns for each system. Results supported the assumption that technically efficient units were also environmentally efficient. Additionally, there was no clear relationship between economic and environmental efficiency. Notably, technically efficient units did not always manage to reduce their costs to the lowest possible level, compared with their peers. Further inspection revealed that systems on high forage tended to be more cost-efficient than systems on low forage. Furthermore, resource-specific efficiency patterns suggested that systems selected for increased milk fat + crude protein yield were better in minimizing their greenhouse gas emissions and nitrogen and phosphorus surpluses, compared to systems selected to remain close to the average UK genetic merit. Moreover, systems on high forage required a larger reduction in land use and fertilizer use than systems on low forage. A further step will be to test the hypothesis that the 'best' system is not necessarily the most efficient one, but the least variable one, i.e. further step will be to account for the experiment's temporal nature.

**Keywords:** *dairy farm experiment, contrasting systems, slacks-based Data Envelopment Analysis, efficiency analysis, resource-specific savings potentials, sustainability patterns*