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► To cite this version:

Mathieu Vigne, Philippe Faverdin, Jean-Louis Peyraud. Energy analysis of agricultural systems: uncertainty associated with energy coefficients non-adapted to local conditions. 8. International Conference on LCA in the Agri-Food Sector, Oct 2012, Saint-Malo, France. INRA, 2012, Proceedings 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012). <hal-01210840>

HAL Id: hal-01210840

<https://hal.science/hal-01210840v1>

Submitted on 3 Jun 2020

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180. Energy analysis of agricultural systems: uncertainty associated with energy coefficients non-adapted to local conditions

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Among studied impacts in Life Cycle Analysis, fossil energy use has been widely considered. But choice of energy coefficients from the literature and their ability to express accurately local conditions is questioned for territories where references for inputs life-cycle are lacking. This study measured fossil energy use in dairy farms and assessed uncertainty associated to energy coefficients in order to improve energy analysis methodology of agricultural systems.

Fossil energy use for forty two dairy farms from Poitou-Charentes (PC) and thirty from Reunion Island (RI) have been analysed using PLANETE for PC (Bochu, 2002) and PLANETE MASCAREIGNES for RI (Thevenot et al., 2010). Uncertainty analysis and sensitivity analysis has been conducted through the SIM-LAB tool (Saltelli et al., 2004). Uncertainty analysis consisted in a Monte-Carlo methodology: 30,000 sets of energy coefficients have been randomly drawn from a uniform law between minimum and maximum values found in the literature for each energy coefficients. Uncertainty is expressed by 95% confidence interval of average fossil energy use in megajoule per litre of milk produced (MJ.l⁻¹). Estimation of sensitivity of energy coefficients is based on similar drawn and has been studied through the calculation of the Standardised Regression Coefficient (SRC).

Estimated probability distribution is reported in Fig. 1. Minimum and maximum values for 95% confidence interval are respectively 3.6 and 5.0MJ.l⁻¹ for PC and 5.8 to 8.2MJ.l⁻¹ for RI. The corresponding variabilities from mean were $\pm 16\%$ and $\pm 17\%$ respectively for PC and RI. Whereas they could appear low, these values question comparison of systems from different territories. Among the set of coefficients chosen, difference between the territories could appear large or conversely equal when considering higher values for PC and lower values for RI. This results highlights need for a common methodology for calculation of energy coefficients. This could enable to calculate energy coefficients adapted to local conditions and to produce accurate values of energy use of agricultural systems. Such method should concern clear definition of system boundaries in indirect energy assessment and promote precise investigation of the technology used in the different processes.

SRCs obtained for the different energy coefficients (Table 1) showed that the most sensitive energy coefficients are not the same in the two territories. Energy coefficient for concentrate feeds is mainly responsible of this uncertainty for RI farms whereas it is a combination of several energy coefficients for PC farms (electricity, concentrate feeds, animal buildings, fuel, N fertiliser). Calculation of adapted energy coefficients could be associated to a preliminary sensitivity analysis through minimum and maximum values of energy coefficients found in the literature in order to focus on the most influential energy coefficients and to fit an appropriate value for them. This will avoid adapting all energy coefficients which could be time-consumer.

Nonetheless, energy coefficients do not represent the only source of uncertainty in energy analysis. Uncertainty related to inputs data could be decrease as done in our study with large surveys of real farms and individual economic follow-up surveys based on representative years. Uncertainty related to the methodology could be decrease, in addition to common methodology for energy coefficients, by common choice of allocation method.

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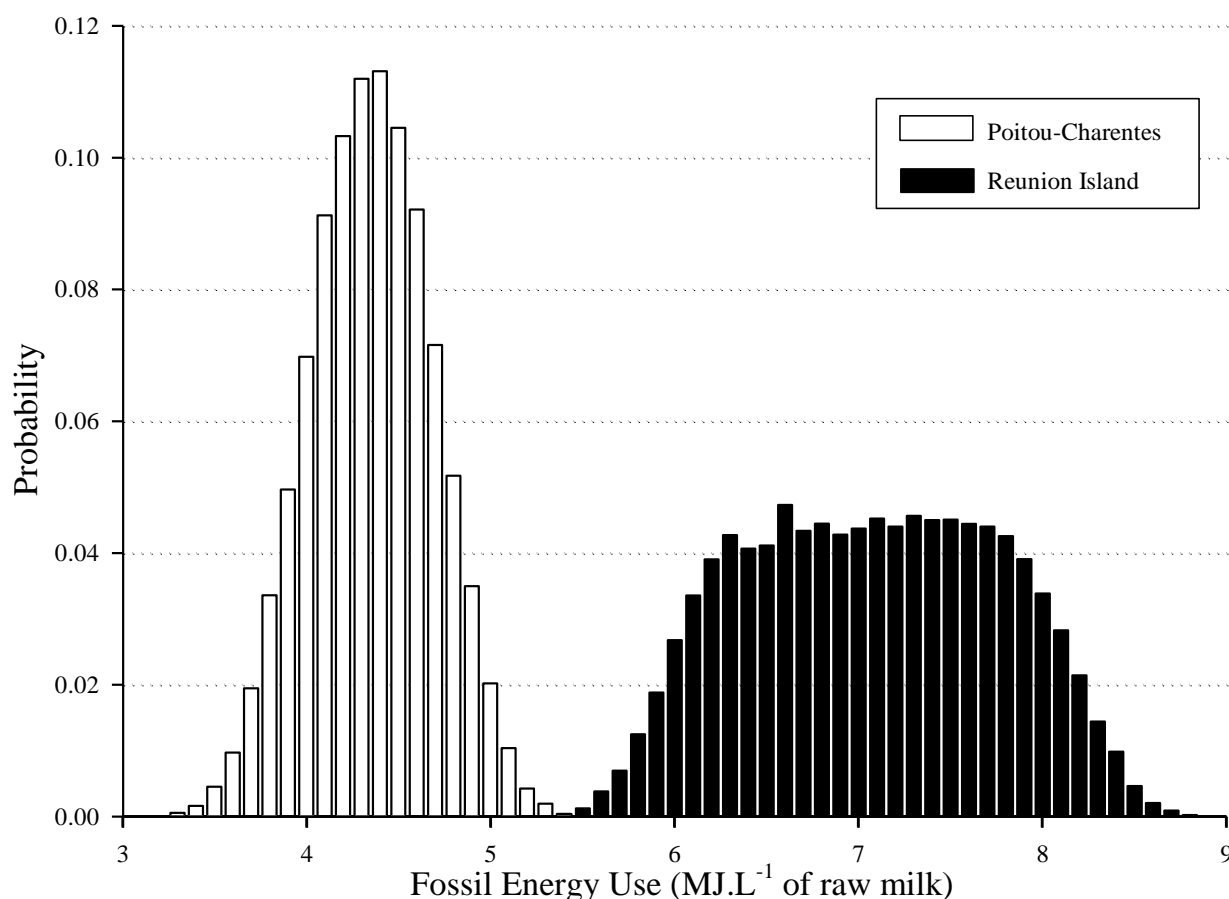


Figure 1. Probability distribution of energy use for dairy farms from (a) Poitou-Charentes and (b) Reunion Island calculated with the 30,000 sets of energy coefficients

Table 1. Standardised Regression Coefficients (SRC) of the five most influential energy coefficients for Poitou-Charentes and Reunion Island dairy farms

Poitou-Charentes		Reunion Island	
Energy coefficients	SRC	Energy coefficients	SRC
Electricity	0.53	Concentrate feeds	0.91
Concentrate feeds	0.51	Tractor	0.25
Animal buildings	0.47	Fuel	0.17
Fuel	0.38	Electricity	0.15
N fertiliser	0.27	Animal buildings	0.14