Jilg, T., Herrmann, K., Hummler, T. and Elsaesser, M., 2014: Energy consumption and greenhouse gas emissions of DAIRYMAN farms in South-West-Germany. Grassland Science in Europe, 20,634-637.

Energy consumption and greenhouse gas emissions of DAIRYMAN farms in South-West-Germany

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Abstract

The EU Interreg IVb NWE project DAIRYMAN was established in 2009 with the aim to enhance the sustainability of dairying in North-West Europe by improving the competitiveness and ecological performance of dairy farming. Therefore economic, ecological and social farm information were collected from a pilot farm network of 127 dairy farms in 10 regions of North-West Europe from 2009 - 2011 in order to evaluate and compare farm performances. 14 farms in South-West Germany (Baden-Wuerttemberg) participated in this network. Additionally to the data, that were collected for the whole network, the LAZBW Aulendorf determined energy consumption and greenhouse gas emissions of these German farms in 2010 and 2011. This was made with the AgriClimateChange Tool (ACCT), a new developed EXCEL-based tool , with which energy in- and output, energy efficiency,nitrogen balances and greenhouse gas emissions can be calculated. This tool is suitable to indicate the correlations of influencing factors and to clearly visualize the farmers' efforts of adapting their farm management to climate-friendly systems.

Keywords: nitrogen balance, greenhouse gases, energy consumption, dairy farm system

Introduction

DAIRYMAN was an EU Interreg IVb NWE project which was established in 2009 with 14 partners under the lead of the University of Wageningen (Aarts, 2012). The project ended in August 2013. The main objective of DAIRYMAN was the investigation of dairy farming systems with regard to ecological, economic and social performances. This was realized by establishing a pilot farm network of 127 dairy farms. In Baden-Wuerttemberg, the German Dairyman partner, 14 farms participated in that network. At the beginning of the project special development plans were worked out for each farm, so that the initial farm values could be compared with the values reached at the end of the project. With the AgriClimateChange Tool (ACCT), developed by 4 partners of the LIFE funded project Agriclimate Change (Solagro, Bodensee Stiftung, Región de Murcia, Communità Montana and Fundacíon Global Nature (Solagro, 2013)), there is now a tool available which can be used throughout the European Union in order to show energy consumption and greenhouse gas emissions on farm scale. In 2010 and 2011 such measurements with ACCT were made on the 14 German dairy farms. Especially the influence of the used concentrates and the nitrogen input on the global energy efficiency should be investigated.

Material and Methods

As basic information the ACCT (Solagro, 2013) uses the direct energy input (fuel, electric energy, water) and the indirect energy input (concentrates, fertilizer, machines, buildings, agricultural pesticides, seeds, animals and other synthetic materials). Products leaving the farm like milk, meat and crops are used for calculating the energy output. The 14 selected

farms were not representative for the average of dairy farms in Baden-Wuerttemberg, but they stand for typical farms in the region with successful milk production. Farms from four typical milk regions and different climate conditions were regarded: Swabian Alb, Black Forest, Oberschwaben and Allgaeu. The selected farm types were divided in dairy farms with grass feeding, dairy farms with maize feeding and dairy farms combined with biogas production. Details are reported in table 1.

Table 1: Mean values, standard deviation, minimum and maximum values of selected farms

Attributes	Unit	μ	±s	min	max
Agricultural area	ha	**123,9**	56,5	54,6	265
Agricultural area (AA)	ha	**92,6**	31,4	45,5	159,9
ECM	kg cow^{-1} y^{-1}	**8757**	932	6999	10150
Milk per farm area	kg ha^{-1}	**10106**	3656	5226	17346
Livestock units (LU)		**180,9**	67	79,1	280,6
Concentrate use in % of roughage	%	**25**	10	10	60
Fuel consumption	GJ ha^{-1}	**7,6**	2,3	4,2	11,2
Electricity per kg milk	kJ kg^{-1}	**10,3**	4,5	4,7	20,1
Feed purchase	GJ ha^{-1}	**8,5**	4,5	3,6	18,8
Fertilizer	GJ ha^{-1}	**5,5**	2,7	0	11
Input total	GJ ha^{-1}	**37,1**	10,3	20,3	55,4
Milk	GJ ha^{-1}	**26,8**	11,8	11,3	47,5
Meat	GJ ha^{-1}	**2,8**	1,3	1	5,7
Cultures	GJ ha^{-1}	**35,2**	45,1	0	133,7
Output total		**64,9**	38,4	22,7	147,5
Global energy efficiency (GEE)		**1,71**	0,8	1	3,4
t CO_2	ha AA^{-1} y^{-1}	**9,8**	3,3	5,8	15,7
t CO_2	LU^{-1} y^{-1}	**6,3**	1,2	4,5	9,3
Energy efficiency dairy branch		**1,07**	0,1	0,8	1,2
N balance	kg ha^{-1}	**80**	44,9	-5	170,5

Results and discussion

The energy consumption for fuel, fertilizer and feed purchase varied widely between the farms. Focusing on the global energy efficiency (GEE), which includes the branches milk, crop and biogas production, the differences between farms were remarkable. Dairy farms with biogas production had a 2 - 3 times higher GEE than dairy farms without biogas production. Only farms with biogas reached GEE values higher than 2,0. The energy efficiency for the dairy branch ranged between 0,8 and 1,2. It is remarkable, that there is no close relation between GEE and nitrogen fertilization respectively the use of concentrates (fig. 1, 2). The percentage of fertilizer use in energy input was only 15 %. Obviously the energy consumption from feed, electricity and fuel had more influence on the total energy input. Nevertheless fig. 2 shows, that increasing amounts of concentrates reduced the GEE.

Regarding only the dairy branch of the farms, it seems that the amounts of concentrates are positively correlated to the energy efficiency (fig. 3). This may be due to a more efficient milk production with higher amount of concentrates. Energy efficiency is increasing until a milk performance of 4000 kg milk from roughage. More milk from roughage seems to have no further benefits in terms of energy efficiency.

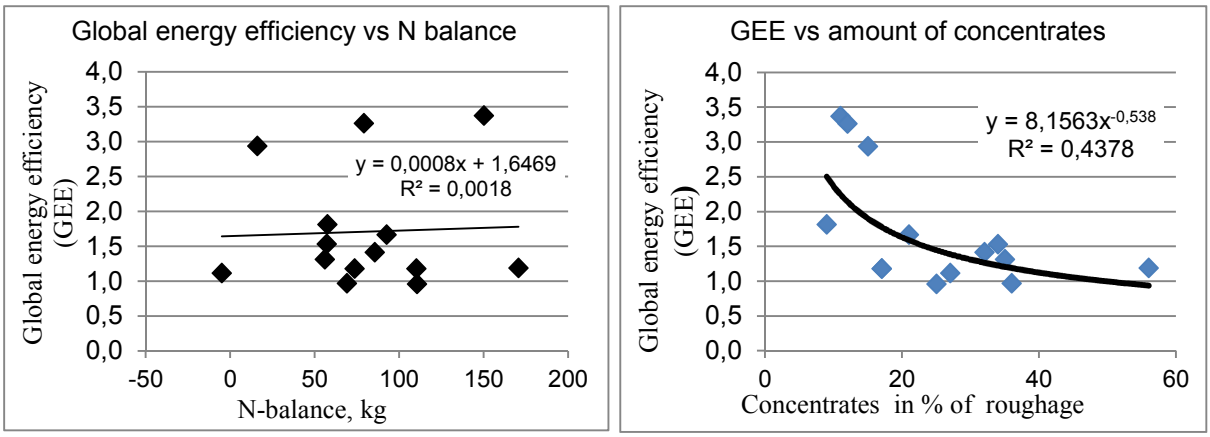

Figure 1, 2: Relation between global energy efficiency and N balance respectively portion of concentrates in roughage

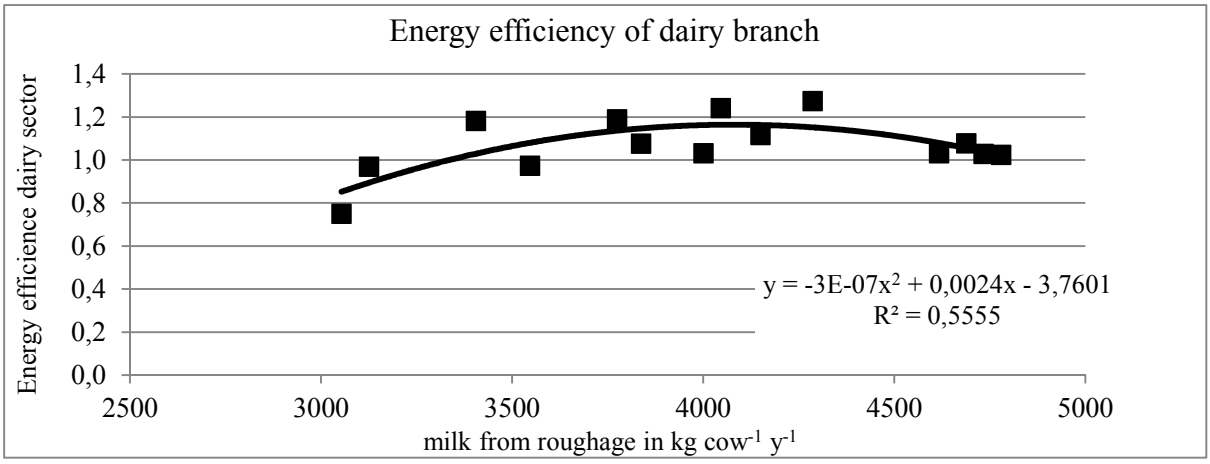

Figure 3: Energy efficiency of dairy sector related to milk performance from roughage

Conclusions

The dairy branches of the investigated farms largely differ in energy input, output and efficiency. This gives potential for improvements in individually optimizing the management of the farms and it shows that intensive as well as extensive farms can be managed efficiently. So the use of ACCT might be a helpful tool for farmers and extension services by showing strengths and weaknesses in terms of energy consumption of the individual farm.

Acknowledgements

The authors thank their partners in the DAIRYMAN project, especially Dr. Jacques Neeteson and Dr. Frans Aarts, Wageningen for the friendly collaboration and the EU Interreg-Programm IVb NWE and the Ministry of Laendlicher Raum and Verbraucherschutz in Baden-Wuerttemberg for the financial support.

References

Aarts, F. (2012) DAIRYMAN for a more efficient use of resources by dairy farms. Grassland science in Europe, 17, 753-755.
Solagro (2013) Manual to Agriclimatechange, www.agriclimatechange.eu