Wulfmeier, Kirsten; Dettmer, Tina and Harms, Hans-Heinrich

Efficient agricultural technology for a sustainable biomass production

The Biomass-electricity-sustainability Ordinance demands for fluid bio energy sources to be produced sustainably. Corresponding methods of evaluation so far consider only ecological, social and economical criteria. Thus it is not apparent how the sustainability of biomass cultivation and harvest is influenced by agricultural operating processes. However, operating agricultural technology causes emissions and consumes resources and therefore offers room for improvement. An increased efficiency of the processes has effects on the sustainability of both the agricultural implement and the biomass production. To visualise these effects it is necessary to particularly include the operating processes into the sustainability evaluation.

Keywords
Agricultural engineering, sustainability, biomass, process efficiency

Abstract
Wulfmeier, Kirsten; Dettmer, Tina and Harms, Hans-Heinrich

Landtechnik 65 (2010), no. 2, pp. 111-113, 1 figure, 3 references

Biomass for electricity has to be produced in conformity with the criteria of good agricultural practice and of Cross Compliance. Beginning with August 24, 2009 the German Biomass-electricity-sustainability Ordinance commenced and bio electricity production additionally has to meet the criteria of sustainability. With this new ordinance the federal government puts the European Renewable Energy Directive into legislation. Fluid bio energy sources will hereafter only be subsidised by the Renewable Energy Law if the used biomass is produced sustainably. Using bio energy sources for electricity production is only subsidised if at least 35 % less greenhouse gases are released than with fossil sources.

Starting position

The first site to prove the sustainable production and to calculate the greenhouse gas reduction is not the producer of the biomass but the first instance of acquisition (e. g. cooperations). All following interfaces from here up to the feed-in of the subsidised electricity need to provide and pass on a proof of sustainability. These certificates for bio energy sources can be generated with evaluation methods such as RISE (Response Inducing Sustainability Evaluation), KSNL (Criteria System of Sustainable Agriculture) or “Sustainable Agriculture for the Future” of the DLG. These evaluation methods consider numerous factors of the known three dimensions of sustainability: economy, society and environment. [1] But theses evaluations of sustainability take only indirect account of the agritechnology used for cultivation and harvest of the biomass, for example in form of averaged consumption and emission values within energy, cost and emission balances. In these approaches it stays concealed which actual influence a single agritechnological process has on the sustainability of the production of biomass.

Thesis

The implied agricultural machines have only minor influence on the total eco-balance of a bio energy source in terms of percentage. Other process steps – from cultivating over processing up to generating energy and handling residues – affect the environment more. However, the life cycle of bio energy sources is crossed by the life cycles of agricultural machines (**figure 1**) in which the single process steps (e.g. chopping corn) consistently recur and therefore show a more important potential for economies. Many agricultural processes are energy inefficient, providing a high, so far widely unused, potential for optimisation. To explicitly consider the process efficiency in sustainability evaluation is an approach that offers good starting points to advance not only biomass production but particularly the herein used agritechnology.

National effects of one process

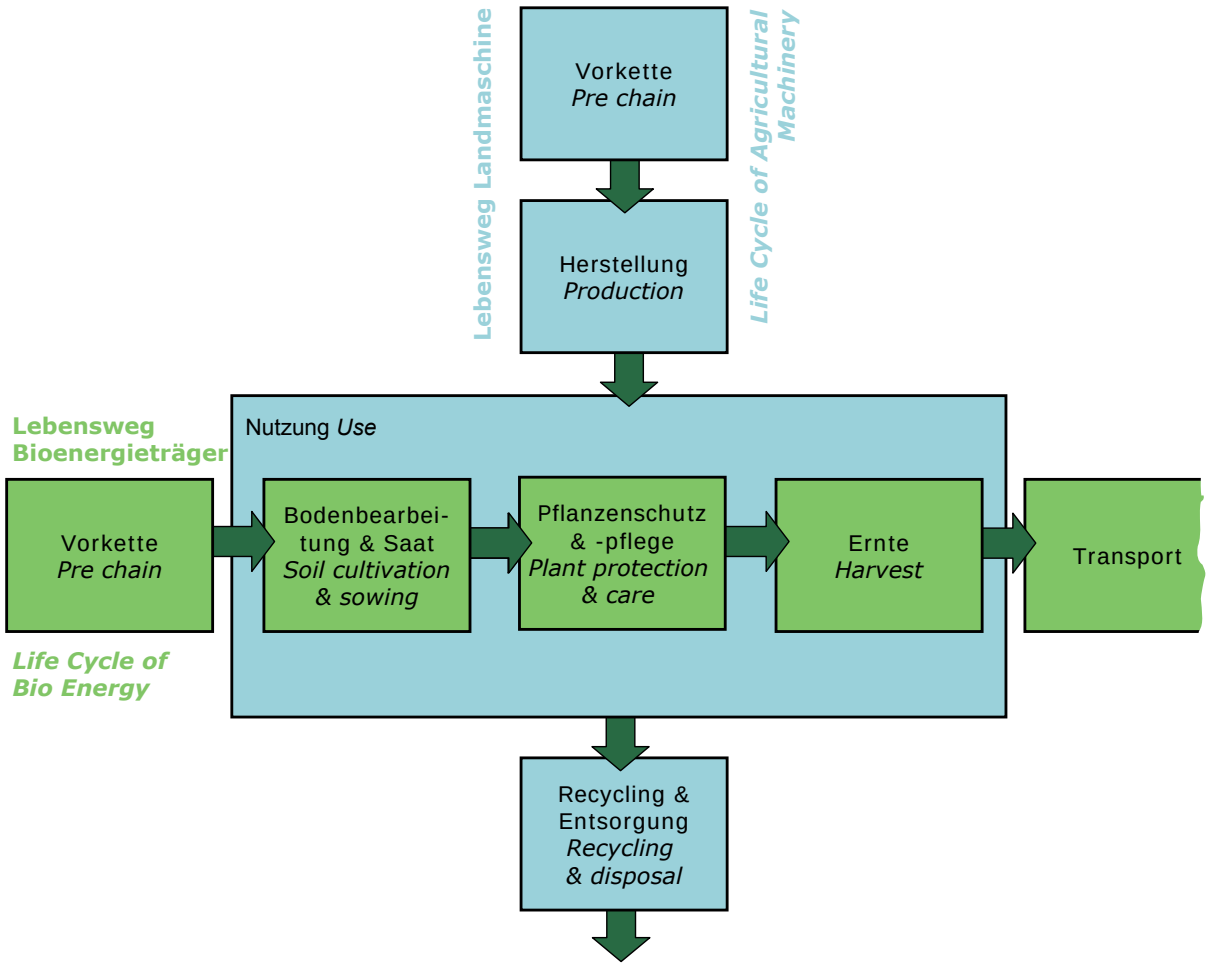
Here the power analysis of a disk mower is taken as an example for an energy inefficient agricultural process. This analysis proves that only 35 % of a disk mower's total drive power are required for the actual cutting performance. 65 % of the input power are lost by friction (25 %), power losses in the drive (20 %) and wind resistance of the rotating parts (20 %). [2]

This process could be made more efficient for example by modifying the drive train, the cutting and transport principle or the rotational speed (wind resistance). Already a 5 % efficiency improvement of the mowing process could effect annual power savings of more than 2.7 GWh on the German roughage acreage [3]. This would mean savings of more than 690,000 litres diesel per year. (Assumptions: two cuts, mower width 3 m, speed 11.5 km/h, drive shaft's power demand 20 kW, efficiency of diesel engine 40 %)

Results

A farmer would perceive only little of the impact that such an improvement of the biomass harvesting technology has. But the positive effects of process modification – by retrofitting and gradual replacements even of small components – could

Fig. 1



Crossing Life Cycles of Agricultural Machinery and Bio Energy

become noticeable for example in the fleets of large contractors. The process efficiency is directly linked to its environmental effects by its power consumption. Reducing emissions and fuel consumption furthermore does not only have effects on the environment but also on the economical dimension of a machine's sustainability and therefore on the biomass production. Several other processes offer great potential for modifications because of their high frequency or degree of inefficiency. For example the chopping device in a forage harvester performs a process which is energy-intensive and often used, as well as the straw chopper in a combine harvester. Agritechnology for biomass production is used in several production lines. Possible improvements would therefore also benefit the sustainability of other production lines, like those for food and fodder. When dealing with agricultural processes it has to be considered that the goods to be processed, the ground and the weather have significant influence on the processes with their mass and energy flows. The impact of agricultural processes on the sustainability of biomass production cannot yet be examined, because of these dynamic factors and because the evaluation includes the processes only indirectly.

Conclusions

Already small improvements of a process can have visible effects on the sustainability of biomass production when accumulated nationally. Therefore it is sensible to take the used agritechnology into account when evaluating biomass production environmentally, economically and socially. Being basis of the production process the agritechnology impacts the production's sustainability. In many cases improving process efficiency would have noticeable influence on the eco-balance of agricultural machines. Sustainability evaluations need to be explicitly oriented towards the processes in order to be able to display this influence.

Literature

Books are signed with ●

[1] ● Zapf, R., U. Schultheiß, R. Oppermann et al.: Bewertung der Nachhaltigkeit landwirtschaftlicher Betriebe. KTBL, Darmstadt, 2009

[2] Niemöller, B., H.-H. Harms und N. Erasmy: Leistungsanalyse eines Scheibenmähwerkes. Landtechnik 63 (2008), H. 2, S. 86–87

[3] Statistisches Bundesamt (Hrsg.): Ernte: Feldfrüchte – Anbauflächen, Hektarerträge und Erntemengen (2008). URL: http://www.destatis.de/jetspeed/portal/cms/Sites/destatis/Internet/DE/Content/Statistiken/LandForstwirtschaft/Ernte/Tabellen/Content75/FeldfruechteAnbauflaechenErntemengen.psml Zugriff am 11.02.2010

Authors

Dipl.-Wirtsch.-Ing. Kirsten Wulfmeier is research associate at the Institute of Agricultural Machinery and Fluid Power of the TU Braunschweig (Director: **Prof. Dr.-Ing. Dr. h. c. H.-H. Harms**), Langer Kamp 19a, 38106 Braunschweig, E-Mail: k.wulfmeier@tu-bs.de

Dr.-Ing. Dipl.-Geoökol. Tina Dettmer is research associate at the Institute of Machine Tools and Production Technology, department Product and Life Cycle Management of the TU Braunschweig (Directors: **PD Dr.-Ing. Christoph Herrmann, Prof. Dr.-Ing. Dr. h. c. Jürgen Hesselbach**), Langer Kamp 19b, 38106 Braunschweig, E-Mail: t.dettmer@iwf.tu-bs.de