Available online at www.sciencedirect.com

ScienceDirect

Agriculture and Agricultural Science Procedia 7 (2015) 292 – 300

Agriculture and Agricultural Science
Procedia

Farm Machinery and Processes Management in Sustainable Agriculture, 7th International Scientific Symposium

# The effects of energy contributions into subsidiary processes on energetic efficiency of biomass plantation supplying biofuel production system

Andrzej Wasiak*, Olga Orynycz

*Bialystok University of Technology, Department of Production Management, Wiejska str. 45A, PL-15-351 Bialystok, POLAND*

**Abstract**

A number of technologies of biofuel production from various biomass crops are already in use, and many studies on new ones are carried out. Biomass production, like any other production processes, involves a number of necessary processes that facilitate subsequent production steps. Those subsidiary processes (e.g. tillage or logistic operations) are connected with consumption of energy. It is therefore important to assure that the sum of energy inputs into those technological steps does not exceed the energy output from the system. Obviously, large energy gain is desired. The paper is devoted to the estimation of energy inputs made into the subsidiary processes occurring in the agricultural subsystems in which various topological structures of plantations as well as for various technologies of tillage, and different requirements for transportation are allowed. Mathematical model describing above mentioned dependencies is derived, and appropriate algorithm elaborated for numerical computations, that have been performed for rapeseed plantations. The results demonstrate evident effects of the choices of technology, and organization of work onto efficiency of plantation as measured by EROEI - type indicator.

© 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the Centre wallon de Recherches agronomiques (CRA-W)

*Keywords:* biofuel; energy balance; modelling; rapeseed; biodiesel.

* Corresponding author: Tel. 48857469840; fax: 48 85 663 19 88.
E-mail address: a.wasiak@pb.edu.pl

2210-7843 © 2015 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Peer-review under responsibility of the Centre wallon de Recherches agronomiques (CRA-W)
doi:10.1016/j.aaspro.2015.12.050

## 1. Introduction

Emission of carbon dioxide, due to use of fossil fuels, is considered as one of the most important factors affecting global warming. Exhaust of the fossil resources, especially of crude oil, that might lead to petroleum shortages in relatively short time scale, and that of coal – leading to problems in more distant future - appears as the other problem of today's global economy. Mathews (2009) indicated that biofuels derived from biomass are considered the main remedy that can be offered. This situation motivates the search for various biomass resources and for the most effective technologies of cultivation as well as conversion of biomass to energy. In recent years a number of papers have been published concerning cultivation of several plants e.g. Abnisa at al. (2011) or Painuly at al. (1995) as well as various aspects of cultivation and processing cf. Juliszewski and Zajac (2007), Jasinska and Kotecki ((1999), Igilinski at al. (2009). Expectation that biomass derived fuels may substitute fossil fuels imposes natural expectation that biomass as energetic resource should provide a real gain of energy. It is well known that industrial processing of any fuel requires some inputs of energy in order to facilitate conversion processes. In terms of biomass it is equally related to both: agricultural as well as industrial processes occurring in production of biofuel. Already established characteristic called EROI or EROEI – „energy return on energy invested" cf. Pickard (2014) is defined as follows:

$$\varepsilon = \frac{\sum_{p=1}^{P} \left(E_{out}\right)_p}{E_{cr} + \sum_{p=1}^{P} \left(E_{in}\right)_p + E_{rem}} \tag{1}$$

where $E_{out}$ – is total usable energy delivered by energy gathering system during the $p$-th year of its existence, $E_{in}$ – represents total energy expended during that year, $E_{cr}$ – is energy needed for creation of that system, and $E_{rem}$ – is energy needed for remediation of that system after the end of its life at $P$-th year.

This quantity can be used as a measure of efficiency of production processes.

It should be pointed out that this is different than energy conversion efficiency that is expressed as:

$$\eta = \frac{E_{out}}{E_{in}} = \frac{E_{out}}{E_{out} + E_w} \tag{2}$$

where $E_{in}$ and $E_{out}$ – represent input and output energy to and from converter, while $E_w$ – corresponds to energy wasted (dissipated) by that converter.

Despite similar form of both equations their meaning is different. The energy $E_{in}$ introduced to the production system is not directly converted into output. This is only energy that is needed to maintain production process. $E_{in}$ in some cases might be very small, while in the other cases - very large as compared to $E_{out}$, consequently the range of variation of this measure might extend in the limits $-\infty \leq \varepsilon \leq \infty$. The other quantity relates energies being directly converted one into other, and it can be easily proved that changes of this characteristic occur only in the limits: $0 \leq \eta \leq 1$. Recent literature offers a number of papers dedicated to the discussion of perspectives of biofuel production in several countries e.g. Raslavicius and Bazaras (2010), Fontaras et al. (2012), Painuly et al. (1995), Wasiak et al. (2008). Excellent review discussing various approaches to production as well as use of biofuels is given by Russo et al. (2012). Analysis performed by Talens et al. (2007) indicated low exergy loss in the process of biodiesel production, and also possibilities of further decrease due to possible improvements of technology. Results presented by Liao et al. (2011) for the case of bioethanol indicate, however, that production of this fuel not always fulfills the requirements of sustainability i.e. that bioethanol production is not sufficiently efficient. The mentioned

Download English Version:

https://daneshyari.com/en/article/4492263

Download Persian Version:

https://daneshyari.com/article/4492263

Daneshyari.com