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ASSESSMENT OF PROFITABILITY LEVELS OF AGRICULTURAL BIOMASS PRODUCTION FOR PURPOSES OF THE PROFESSIONAL ENERGY SECTOR

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Abstract. Economic analysis of selected power plants cultivation was carried out. It was concluded that present prices in many cases do not cover production costs.

Key words: biomass, costs, production profitability.

INTRODUCTION

An increasing demand in the professional energy sector for agricultural biomass requires a rise of biomass production especially with use of perennial energy plants. Contemporary biomass gained from perennial plantations covers only 2.2% of the energy sector's demand in the year 2010 [Internet1]. A lot more farmers should get interested in biomass production in order to enlarge its supply.

It will be possible only when a level of biomass purchase price allows to cover its production costs. Therefore there is a necessity to determine a profitability threshold of plants cultivation for power purposes with taking into account present conditions of the natural and economic environment. It is also essential to know present biomass production costs.

Information concerning biomass production costs and a minimal price ensuring covering production costs can be used both by entities purchasing biomass in order to determine a purchase price and by farmers deciding on starting biomass production.

AIM AND SCOPE OF RESEARCH

The aim of the research was the economic analysis of selected plants cultivation for power purposes taking into account cultivation costs, income from biomass selling as well as a determination of the minimal price ensuring the coverage of production costs.

The scope of the research includes the mentioned economic analysis of two cereal plants (winter wheat and rye) as well as three perennial energy plants: willow, Virginia fanpetals, miscanthus. In the case of cereal plants there was an assumption that grain is sold on a market and straw for power plants.

RESEARCH METHODOLOGY

The cereals' production cost was calculated on the basis of the relationship worked out according to literature [Kalkulacje kosztów... 1998, Klepacki, Gołębiewska 2003]:

$$K_{ZBOZ} = 1.1 \cdot \left(K_{NAW} + K_{SOR} + K_{NAS} + \sum_{i=1}^{n} K_{ei} + K_R \right), \quad (1)$$

where: K_{PROD} – production cost [zl·ha^{-1}], K_{NAW} – fertilization cost [zl·ha^{-1}], K_{SOR} – cost of plant protection chemicals [zl·ha^{-1}], K_{NAS} – cost of grain purchase for sowing [zl·ha^{-1}], K_R – labour cost [zl·ha^{-1}], K_{ei} – cost of the use of a unit performing particular treatment [zl·ha^{-1}], n – a number of treatments in a particular cultivation.

Cultivation cost of energetic willow, Virginia fanpetals and miscanthus was calculated according to the relationship determined with taking into account technological processes presented in literature [Borkowska and Styk 1997, Szczukowski and Budny 2003, Stolarski *et al.* 2008, Dubas *et al.* 2004, Podleśny 2005]:

$$K_{WIELENERG} = \frac{1}{n} \cdot \left[K_{ZAL} + K_{LIKW} \right] + K_{PMZB} + K_{ZBIOR}, \quad (2)$$

where: $K_{WIELENERG}$ – cultivation cost of willow, Virginia fanpetals, miscanthus [zl·ha^{-1}], K_{ZAL} – cost of setting up a plantation [zl·ha^{-1}], K_{LIKWID} – cost of plantation liquidation [zl·ha^{-1}], n – years of plantation use [years], K_{PMZB} – costs of treatments and means of production in the period between crop (this cost concerns energetic willow cropped in the cycle of 2 or 3 years) [zl·ha^{-1}], K_{ZBIOR} – costs paid in a year of harvest [zl·ha^{-1}].

Particular kinds of costs were calculated from the presented relationship used for calculations of cereal cultivation, of course without these elements of costs, which should not be taken into calculation.

Necessary data for calculations were taken from market reports (Rynek rolny, 2005-2009) and literature [Harsim 1994, Niedziółka i Zuchniarz 2006, Lipski *et a.l* 2006, Faber *et al.* 2007, Stolarski *et al.* 2008]. Costs calculations make allowances also for subsidies and financial support paid by the Agency for Restructuring and Modernisation of Agriculture (ARMA).

Costs of tractors and machines use, which are elements of production costs, were calculated from the relationship based on the method of the Institute for Building Mechanization and Electrification of Agriculture [Muzalewski 1999]:

$$K_{e_i} = \left(\frac{C_{m_i} \cdot W_{R_i}}{T_{h_i}} + K_{UB_i} + 0.02 \cdot C_{m_i} \right) \Big/ W_{R_i} + \frac{\left(k_{n_i} / 100 \right) \cdot C_{m_i}}{T_{h_i}} + 1.2 \cdot Z_{p_i} \cdot C_p, \quad (3)$$

where: K_{ei} – cost of i-th machine use (tractor) [zl·h^{-1}], W_{Ri} – use of i-th machine per year [h·year^{-1}], C_{mi} – price of i-th machine (tractor) [zl], K_{ubi} – insurance cost of i-th machine (tractor) [zl·year^{-1}], k_{ni} – coefficient of repair costs (percentage value of a new tractor's price) [%], T_{hi} – normative use of a tractor (machine) in a period of lasting [h], Z_{pi} – use of fuel for i-th tractor (self-propelled machine) per hour [l·h^{-1}], C_{pi} – fuel price [zl·l^{-1}].

Profit from biomass sell was calculated as follows:

$$Z = P - K, \quad (4)$$

where Z – profit on biomass sale [zl·ha^{-1}], P – income from sale [zl·ha^{-1}], K – cultivation cost [zl·ha^{-1}].

Income from biomass sale was calculated on the basis of prices offered by entities purchasing biomass registered in ARMA. On the basis of an interview with a questionnaire with representatives of purchasing entities it was determined that it is 80-150 zl·t^{-1} for cereal straw, miscanthus and Virginia fanpetals and 100-200 zł·t^{-1} for willow pellets (directly after crop).

In the case of cereal, income was calculated as a sum of income from grain sale and income from straw sale. Because of changeable grain prices and the fact that minimal prices for straw do not have to be the same as minimal grain prices, a purchase price of straw was assumed at the average level (115 zł·t^{-1}).

The minimal sale price of biomass from Virginia fanpetals, willow and miscanthus, whose value does not cause financial loss, was calculated according to the relationship:

$$C_{BIOM} = \frac{K}{Q_{BIOM}}, \tag{5}$$

C_{BIOM} – price of biomass purchase [zl/t], Q_{BIOM} – biomass yield [t·ha^{-1}].

The minimal price of straw sale was calculated from the following relationship

$$C_{SLOM} = \frac{K - C_Z \cdot Q_Z}{Q_S}, \tag{6}$$

C_{SLOM} – price of biomass purchase [zl/t], C_Z – price of grain sale, Q_Z – grain yield [t·ha^{-1}], Q_S – straw yield [t·ha^{-1}].

The minimal price of purchase of biomass from willow, Virginia fanpetals and miscanthus was calculated for three levels of yields. They were assumed on the basis of average values noted in the research presented in literature [Sczukowski, Tworkowski 2000, Szczukowski *et al.* 2000, Faber *et al.* 2007]. Yields at the levels of 10, 15 and 20 tones of dry mass·ha^{-1} were assumed for miscanthus, 14, 20 and 21 tones of dry mass ·ha^{-1} for Virginia fanpetals and 26, 34, 48 t·ha^{-1} for willow (one crop per three years). In the case of willow there was used yield of wet mass (directly after crop) because it is often purchased in such a form by power plants.

The minimal price for straw purchase was calculated for two levels of yield. It was estimated on the basis of the relationship of straw yield to grain yield [Harsim 1994]. Grain yield was assumed on the basis of own experiences and observations of cereal yields gained on a farm in the region of Warsaw. There was an assumption of grain yield at the levels of 1.8 and 4.5 t·ha^{-1} (straw yields after calculation: 3.5 and 5.6 ha^{-1}) for rye as well as 2.5 and 5.0 t·ha^{-1} (straw yields after calculation: 2.25 and 4.5 ha^{-1}) for wheat. Additionally, calculations were prepared for two variants of the purchase price of grain. In order to do this there were distinguished the highest and the lowest average purchase prices of grain on the basis of reports from the Institute of Agricultural and Food Economics from the period 2004-2008 (Rynek rolny 2004-2008). They were, respectively, 353.5 and 726.1 zł·t^{-1} for rye and 455.1 and 861.2 zł·t^{-1} for wheat.

The calculated values of the minimal price were referred to the range of biomass purchase prices offered by entities buying biomass.

RESEARCH RESULTS

The calculated costs and financial results of production of the analysed plants are presented in Table 1.

Contemporary prices of biomass purchase make its production unprofitable in many cases. Profits on production can be gained only in the situation of very high yields and attractive purchase prices.

Table 1. Costs and financial results of the analyzed plants' cultivation

		wheat	rye	willow	Virginia fanpetals	miscanthus
Cultivation cost [t·ha^{-1}]		3372.8	1845.66	2734.56	1720.54	2136.06
Profit/loose [zl·ha^{-1}]	min. yield-min. prices*	-1976.70	-920.45	-44.85	-600.54	-1336.06
	max. yield -min. prices *	-579.80	468.70	2065.44	-120.54	-40.54
	min. yield -max. prices *	-961.05	-249.77	821.81	379.46	-636.06
	max. yield -max. prices *	1450.70	2145.40	6865.44	1279.46	1429.46

* in the case of cereals minimal and maximal purchase prices concern grain purchase.
Source: own calculations.

Comparison of present purchase prices with required minimal prices allows to conclude that in many cases they are too low and ensure covering production costs practically only in the situation of high yields. Cereals' cultivation costs are covered by sale of only grain in the situation of high grain yields accompanying by high grain prices whereas straw sale even with present prices additionally increases profit on production. That is why the minimal price for straw can be 0 zl in the last columns of the table 3, which means that in this variant even if farmer give straw for free, he will gain profit on cereal production.

Table 2. Minimal prices for biomass from the analyzed plants [zl·t^{-1}]

	willow	Virginia fanpetals	miscanthus
Yield-variant1	105.18	122.90	213.61
Yield -variant2	80.43	86.03	142.40
Yield -variant3	56.97	81.93	106.80

Source: own calculations.

Table 3. Minimal prices for straw from cereals [zl·t^{-1}]

	min. yield – min. prices*	max. yield – min. prices *	min. yield – max. prices *	max. yield – max. prices *
Wheat	993.36	542.13	243.84	0
Rye	480.26	214.11	40.60	0

* minimal and maximal purchase prices concern grain purchase
Source: own calculations.

CONCLUSIONS

Prices for biomass offered by purchasing entities in many cases do not allow to cover production costs. That is why this production becomes unprofitable. It takes place especially in the situation of low yields of plants. Prices for biomass must be higher than present ones in order to make power plants cultivation profitable. It concerns particularly cereal straw, however entities purchasing biomass must not make up effects of low grain prices.

Purchasing entities should take into account not only cultivation costs of energy plants in the case of determination of biomass prices but also the level of minimal prices allowing to cover costs concerning volume of plants yields possible to achieve in a particular region.

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OCENA POZIOMÓW OPŁACALNOŚCI PRODUKCJI BIOMASY ROLNICZEJ NA POTRZEBY ENERGETYKI ZAWODOWEJ

Streszczenie. Dokonano analizy ekonomicznej uprawy wybranych roślin energetycznych. Stwierdzono, że obecnie obowiązujące ceny w wielu przypadkach nie pokrywają kosztów produkcji.

Słowa kluczowe: biomasa, koszty, opłacalność produkcji.