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ASSESSMENT OF FARMERS' POTENTIAL DECISIONS ON SETTING UP PERENNIAL PLANTATIONS OF ENERGY PLANTS

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Abstract. Analysis of farmers' potential decisions on setting up perennial plantations of energy plants were carried out. It was concluded that the system of accounts offered by power plants can be an encouragement to these plants' cultivation.

Key words: biomass, taking decisions.

INTRODUCTION

Farmers' interest in biomass production for purposes of the professional energy sector depends on the profitability coefficient value. As it is presented in the works of Matyka (2008), its present value is lower than 100% in the case of the most popular energy plants (willow, Virginia fanpetals, miscanthus and Jerusalem artichoke), which means that it does not cover production costs. Substantially higher purchase prices of energy plants in comparison to the present ones can be an encouragement to energy plants' cultivation [Internet1], which also means that these prices should be competitive compared to purchase of traditional agricultural goods.

An analysis of market tendencies for traditional cultivation of such cereals as rape or sugar beet after accession to the EU shows considerable changes in purchase prices with simultaneous increase in prices for means of production [Rynek rolny 2005-2009], which is the reason why cereal production, apart from rape, is unprofitable [Matyka 2008]. This situation can induce farmers to resign from traditional cultivation and with increasing demand for biomass (which should generate increase in biomass purchase prices) it can encourage to perennial energy plants cultivation. However, farmers' decisions, which can be the base for assessment of biomass supply for the professional energy sector, will depend on the state of the natural and economic environment whereas this state can have substantially changeable character, which was proven by the example of the cereal market [Rynek rolny 2005-2009].

Knowledge about farmers' potential decisions in the conditions of the changeable natural and economic environment will facilitate preparation of suitable strategies of biomass supply by power plants.

AIM AND SCOPE OF RESEARCH

The aim of the research was to analyse potential decisions which can be taken by farmers in changeable production and price conditions concerning selection of perennial energy plants cultivation.

The most popular traditional cultivation (winter wheat, barley, rye, rape, maize for grain and sugar beet) and three perennial energy plants: willow, Virginia fanpetals, miscanthus were selected as decision variants. In the case of cereal plants there was an assumption that grain is sold on the market and straw as biomass.

Decision variants take into account the situation of crop sale by low and high prices and also the situation of obtaining low and high yields in production determined mainly by weather conditions.

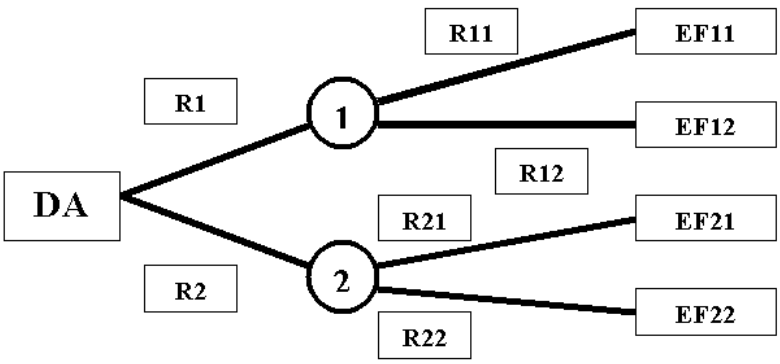
Moreover, the situation that biomass is sold to purchasing firms and power plants, which offer a higher price than purchasing firms, was also taken into account.

RESEARCH METHODOLOGY

Farmers' potential decisions were determined on the basis of a decision tree used in management [Chong, Brown, 2001]. It consists of nodes meaning particular decisions (in this case it is a selection of particular plant). A number of nodes equals the number of analyzed plants.

An example of a decision tree built for the purposes of the analysis was presented on Graph 1.

Graph 1. Branch of one node of a decision tree



There were two nodes (1 and 2) distinguished from each decision signed as D with additional symbols (A, B, C, D, E, F, G, H, I), which means situations of low (1) and high (2) yields of plants. Occurrence of these situations is accompanied by risks of occurrence of low (R1) and high (R2) yields of particular plant. These nodes are next divided into two arms marked with a symbol EF with a numeric index. Thus for the node 1 (low yields) EF11 means profit or loss on particular plant cultivation in the situation of low purchase prices of agricultural goods or biomass whereas EF12 means profit or loss on cultivation in the situation of high purchase prices. These effects are respectively accompanied by risk (R11 – occurrence of low purchase prices and R12 occurrence of high purchase prices). It is similar in the case of arms from node 2.

Selection of the best variants (decisions) is based on the result of expected monetary value (EMV). It is calculated as [Kozlovski *et al.,* 2003]:

$$EMV_i = \Sigma\ EF_{ij} * R_j,$$

where: EF_{ij} – monetary result with selection of i-th variant and in j-th conditions, R_j – risk of occurrence of j-th conditions.

The best variant was pointed out by the maximal value of EMV calculated for particular decisions [Kozlovski *et al.,* 2003].

Profit or loss (referred to 1 ha) for particular states were calculated through subtracting value of production costs from sale income. Production costs were calculated according to the methodology presented in literature [Klepacki, Gołębiewska, 2003]. Costs of perennial energy plants cultivation were calculated in a similar way but there were separate calculations for setting up a plantation and its liquidation next divided into years of plantation use and separately costs paid in years of harvest. Afterwards, the above-mentioned costs were summed up which led to total production cost.

Production costs were estimated for production technologies presented in literature [Borkowska, Styk, 1997, Grzybek, 2004, Podleśny, 2005]. In the case of willow there was the assumption of harvest with use of a chopper and providing moist willow chips directly after harvest for a purchasing firm or power plant which is practiced according to the results of interviews with representatives of power plants or purchasing entities. Unfortunately it is connected with nearly half lower energy value (as it was concluded by representatives of power plants) which was taken into account in the analyses.

Costs of tractors and machines use were calculated according to the methodology and coefficients presented by the Institute for Building Mechanization and Electrification of Agriculture [Muzalewski 1999].

Necessary data for calculations were taken from market reports (Rynek rolny, 2005-2009) and literature [Harasim 1994, Faber *et al.* 2007.

Production costs calculations made allowances also for all subsidies from the Agency for Restructuring and Modernisation of Agriculture (ARMA) accessible for plants cultivation according to their purpose.

Calculations were prepared in variants of low and high plants yields (these levels were determined on the basis of above-mentioned literature and data from the Central Statistical Office – GUS) as well as low and high prices of crop sale. The latest ones were assumed on the basis of minimal and maximal average purchase prices noted by the Institute of Agricultural and Food Economics (Rynek rolny, 2005-2009) in the case of cereal grain, maize and sugar beet. Furthermore, the biomass prices were assumed on the basis of price lists of purchasing firms and power plants. As a consequence, the minimal price of miscanthus and Virginia fanpetals was at the level of 80 $zl \cdot t^{-1}$ and maximal at the level of 150 $zl \cdot t^{-1}$. in the variant of providing for purchasing firms. For willow chips there was the assumption of respectively 100 i 200 $zl \cdot t^{-1}$ of moist mass. In the case of cereals there was the assumption of the average straw price (115 $zl \cdot t^{-1}$) because of the fact that variability of straw purchase prices must not be the same as variability of grain purchase prices.

In the variant of biomass providing directly for power plants there was the assumption of prices according to price lists expressing in $zl \cdot GJ^{-1}$. That is why the minimal purchase price was assumed at the level of 15 zl GJ^{-1} whereas the maximal was at the level of 17 zl GJ^{-1}.

As a result of lack of data on price and production risk there was the assumption of three price risks: sustainable, pessimistic and optimistic. The first one assumes probability of occurrence of low and high prices at the level of 50%. The second one simulates the disadvantageous situation for a farmer with the probability of occurrence of low prices at the level of 70% and high at the level of 30%. Finally, in the third variant there was the adverse assumption of advantageous situation for a farmer with probability of occurrence of low prices at the level of 30% and high at the level

of 70%. Generally, according to literature, selection of probabilities of occurrence of high or low prices aimed at tilting price risk toward one or the second side [Chong, Brown, 2001].

For all variants there was the assumption of probability of obtaining high and low yields at the level of 50%

RESEARCH RESULTS

Expected monetary values calculated according to the above-mentioned relationship are presented in Tables 1 and 2.

Table 1. Expected monetary values (EMV) from production of analyzed plants – sale of biomass to purchasing firms [zl·ha^{-1}]

	Variant I Probability of low prices-50% Probability of high prices-50%	Variant II Probability of low prices-70% Probability of high prices-30%	Variant III Probability of low prices-30% Probability of high prices-70%
Winter what	-516.61	-821.19	-212.04
Winter barley	-166.70	-440.68	107.28
Rye	360.97	126.23	595.70
Winter rape	104.26	-138.58	347.11
Energy willow	1151.96	755.29	1548.63
Virginia fanpetals	4.46	-205.54	214.46
Miscanthus	84.20	-160.80	329.20
Maize for grain	1392.40	858.86	1925.94
Sugar beet	**1776.89**	**1460.69**	**2093.09**

Source: own calculations.

Table 2 Expected monetary values (EMV) from production of analyzed plants – sale of biomass to power plants [zl·ha^{-1}]

	Variant I Probability of low prices-50% Probability of high prices-50%	Variant II Probability of low prices-70% Probability of high prices-30%	Variant III Probability of low prices-30% Probability of high prices-70%
Winter what	-121.74	-445.89	202.41
Winter barley	189.90	-101.05	480.84
Rye	876.94	616.63	1137.26

Winter rape	740.13	478.96	1001.31
Energy willow	708.21	694.72	721.71
Virginia fanpetals	1879.46	1789.46	1969.46
Miscanthus	**3391.70**	**3258.70**	**3524.70**
Maize for grain	1392.40	858.86	1925.94
Sugar beet	1776.89	1460.69	2093.09

Source: own calculations.

The highest values of EMV concern cultivation of sugar beet and maize for grain in the variant of biomass sale to purchasing firms even in the variant of substantial risk of low purchase prices. In the group of perennial energy plants the most advantageous value of EMV is gained in energy willow cultivation.

As far as direct sale of biomass to power plants is concerned, the highest values of EMV concerns miscanthus and Virginia fanpetals cultivation as well as sugar beet cultivation. Next, the cultivation of maize for grain is attractive.

CONCLUSIONS

Analyses carried out by means of the decision tree allow to conclude that in the situation of lower prices of biomass (the variant of providing for purchasing firms) farmers can be more willing to invest in the cultivation of sugar beet or maize for grain than biomass production. Taking into account the European constraints on sugar market resulting in the fact that not all farmers interested in sugar beet production will be allowed to do this, farmers can decide on energy willow cultivation as well as growing maize for grain.

Farmers' decisions on miscanthus and Virginia fanpetals cultivation can be expected in the case of the account system offered by power plants but in the advantageous economic conditions maize or sugar beet cultivation can be competitive for Virginia fanpetals.

In this account system farmers can be more prone to cultivate rape or rye with providing straw for biomass than to cultivate willow. It is connected with the fact that the price of moist biomass from willow in such an account system is lower than the one offered by purchasing firms. On the other hand, higher prices of biomass purchase improving profitability of cultivation of cereals with large straw yield (as for example rye) even in the case of resignation from willow cultivation do not have to disturb biomass supply for the market because the available cereals potential is considerably higher than willow potential [Jadczyszyn *et al.* 2008].

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OCENA POTENCJALNYCH DECYZJI ROLNIKÓW DOTYCZĄCYCH ZAKŁADANIA PLANTACJI WIELOLETNICH ROŚLIN ENERGETYCZNYCH

Streszczenie. Dokonano analizy ocen potencjalnych decyzji rolników dotyczących zakładania plantacji wieloletnich roślin energetycznych. Stwierdzono, że zachętą do uprawy tychże roślin może być system rozliczeń oferowany przez zakłady energetyczne.

Słowa kluczowe: biomasa, podejmowanie decyzji.