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Zsuzsanna Deák, Árpád Ferencz

Pallas Athene University, Kecskemét, Hungary

FINANCIAL FEASIBILITY OF SHORT ROTATION ENERGY CROPS IN HUNGARY: A CASE STUDY

OPŁACALNOŚĆ KRÓTKOROTUJĄCYCH ROŚLIN ENERGETYCZNYCH NA WĘGRZECH – STUDIUM PRZYPADKU

Key words: bioenergy, biomass, SRC, financial feasibility, Hungary

Słowa kluczowe: bioenergia, biomasa, SCR, opłacalność finansowa, Węgry

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Abstract. Biomass is a readily available, renewable and environmentally friendly source of energy. Exploiting renewable organic matter for energy production is showing a growing tendency worldwide including in Hungary. Forest plantations with large numbers of plants (short rotation coppices) that provide a homogeneous, locally available raw material of various fast growing deciduous wood species are broadly supported. In our research we have investigated the financial viability of a short rotation energy forest plantation in the Kunság region of Hungary. Both the EU and Hungary provide economic incentives for the creation and propagation of bio-energy producing facilities. Our results show that the enterprise could not generate profit for the period examined without the help of such subsidies. There are several obstacles that farmers are facing such as the initial high capital outlay, technological shortcomings of the harvesting methods, high logistics costs and suppressed purchasing prices.

Introduction

Bioenergy is any energy derived from the conversion of biomass where it can be utilized directly as fuel, or processed into liquids and gases. In the first case biomass, mostly of dendromass, is burned in specialized energy plants while in the second case biogas is produced from agricultural resources, animal by-products, sewage sludge and municipal organic waste which is then used for electricity production or in-house heating. There is also the possibility to utilize liquid biogas after further cleaning in national gas grids or in CNG powered vehicles.

Renewable energy sources currently represent only 4.9% of Hungary's primary energy consumption (54.8 PJ out of 1000-1100 PJ/year). The target of the Renewable Energy Action Plan (REAP) for Hungary is to increase energy production from renewable resources to 13% by 2020 [INEMAD 2012]. The most important renewable energy source in the country is biomass, accounting for nearly 90% of all renewable energies. Hungary's total biomass resource is estimated to be 350-360 million tons. Out of this amount 105-110 million tons is primary biomass derived from vegetation which is annually regenerated [Czupy et al. 2012]. Presently, only 3% of this is utilized by the energy sector. It is estimated that 65% of the renewable energy sources is used for heat generation, 33% for electric power production and the rest for production of biofuels. Distribution of biomass potential can be seen in figure 1.

One of the most important bioenergy source is energy plantations. In these plantations dendromass can be produced relatively quickly and in large quantities for energy purposes. In Hungary, the area of short rotation energy plantations (also known as short rotation coppice or SRC) has increased steadily in recent years. According to the database of National Food Chain Safety Office (NÉBIH) in 2012 2080 hectares of land was covered by energy plantations which increased to 3268 hectares by 2015 [NÉBIH 2015]. Based on the research of Béla Marosvölgyi [2004] energy plantations' main features are high plant density (8-15 thousand units/ha), a lifes-

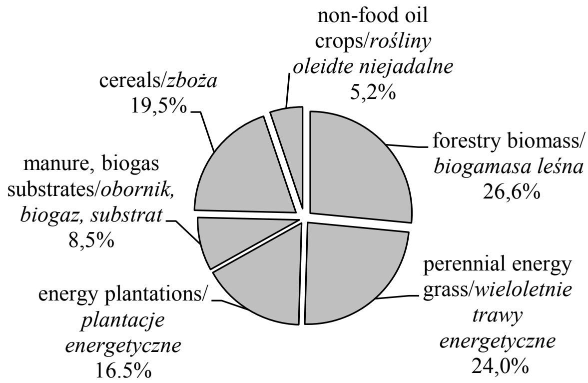

Figure 1. Agricultural Biomass potential of Hungary
Rysunek 1. Potencjał biomasy rolniczej na eęgrzech
Source/*Źródło:* [Hajdú 2012]

pan similar to a bio-power plant (approximately 20 years), it typically is harvested at 3-4 years of age, there are appropriate species even for special site conditions, habitat-specific technology is necessary because of the number of different species, cutting is possible 5-6 times during the lifecycle and 150-250 GJ/ha/year energy output is achievable. From the work of Andrea Vágvölgyi and Imre Czupy [2015] we know that in Hungary poplar (76%), willow (5%) and black locust (9%) represent the biggest area. As for the total consumption of black locust, 55% is utilized for fuel and 45% is used as industrial raw material. In addition, black locust trees are the main basis for Hungarian apiculture and honey production [Rédei et al. 2010]. Chipping of poplar and willow requires less energy and the plantations can be harvested in one go thus more profit can be reached than with locust. Based on experiments conducted with various tree species, yields of 11-20 tons per hectare can be reached annually, out of which 185-330 GJ/ha energy can be produced. The cost of cultivation and expansion of these crops depends mainly on local agro-ecological conditions, the characteristics of their cultivation and proximity to the markets.

Electricity production from renewable resources was given a boost after 2003 when some existing coal-fired power plant capacities were converted into biomass-fired and co-burning facilities. The existing support system only subsidizes electricity production from renewable energy sources thus power plants are not incentivized in utilizing heat, the by-product of power generation, even though a district heating systems in the vicinity could easily harness it. In addition, these high-capacity power plants tend to have high demands of biomass which then often needs to be transported from large distances by rail or road, thus negatively affecting the energy balance of the whole activity.

Our aim was to see if introducing energy forest plantations in areas otherwise not suitable for economical commercial crop production would be a viable alternative for agricultural enterprises located in the Kunsag area of Hungary as additional sources of revenue.

Material and methods

We have set out to examine the financial viability of a short rotation energy forest plantation between the periods of 2009-2016. The plantation was established on an already functioning agricultural site with the explicit purpose of providing additional revenue flows to the investors and exploiting synergies with the existing operations. The Kunsag area of Hungary is well-known for it sand dunes, where black locust trees were originally planted to tie down the shifting sand hills. The project on the plantation started in 2009. We have calculated annual profit margins and repayment periods. For the purpose of assessing the profitability of the plantation initial investment of establishing the plantation and acquiring specialized equipment, annual maintenance and harvesting costs and revenues from sale of energy woods are considered. Opportunity cost of land use was not included in the calculation, as the area to be planted was selected specifically because its use was not economical for other commercial crops. As the area under cultivation is not owned but rented, unlike in other production cost calculations, the cost of land was also included. As renewable energy production is heavily subsidized, we present results both with and without subsidies.

Results and discussion

The 105 hectares to be used for the plantation have been selected in an area where economical crop production even with EU subsidies cannot be achieved. The available options were of two main plant types, the energy willow (*Salix* sp.) and the energy black locust (*Robinia pseudoacacia,* a.k.a. acacia). The company is located in an area where due to the low amount of the annual average rainfall and the number of dry atmospheric days economical cultivation of the water-intensive willow is not possible. Acacia, on the other hand, has ideal characteristics for this technology as with denser deployment high yield per hectare can be attained. It grows even in poor quality sandy soils, with developed root systems, has high drought tolerance and due to its high juvenile growth rate it allows for a quick return on investment. Due to its outstanding regenerating capability harvesting process can be repeated every 2-3 years. The root remains in the soil after the harvest and next spring new sprigs emerge from it (called coppicing). Black locust could grow up to 15-30 meters and develop a crown of 20-40 centimeters in diameter. Based on its physical and mechanical properties it is one of the best tree species in terms of value for money. Moisture content of freshly harvested acacia is about 40-45% thus it can be readily utilized. Due to its favorable flammable properties it is in demand by larger power plants and factories as well.

The main goal was to provide the company with a continuous and calculable revenue source during the year, even through winter, while retaining and better utilizing existing human resources and the possibility of creating new jobs on the long run. In addition, energy costs could be reduced, since the heating of the buildings with woodchips produced in-house is considerably cheaper than with natural gas. As a future goal woodchips can also be utilized for heating the dryer, resulting in further cost reductions.

Establishing an energy forest plantation can only be carried out under license where strict criterions have to be met. The company applied for an EU grant for reclaiming 40% (57 500 Euros) of the installation costs. Given that the main purpose of the grant was to help local businesses, in the first five years the company was not allowed to use its own labor for installation, cultivation and harvesting. As planting had to be financed in advance from own funds, it was done in three rounds. In the first year 20.5 hectares were planted followed by 62 hectares the second year and 22.5 hectares in the third.

Harvesting of black locust trees grown for energy purposes, given its high density and hardness, currently does not have a mature technology. Willow plantations are easily harvested using a special adapter. In this case however, the harvester can only work with adequate performance by reducing the number of blades, resulting in a significant increase in the size of the chips, from to G30 to G50-G60, which causes problems during sale. Contractors do not like to harvest 3-4-year-old mature acacia plantations as their remuneration is per hectare based and the machine is significantly depreciated due to excessive use. In the case of junior plantations (1-3 years) on the other hand, the per-hectare harvest cost of 120-140,000 HUF is not economical for the owner of the plantation as yields are only approximately 13-16 tons of chips per hectare which would not cover the combined cost of harvesting, storage, supplies, loading and transportation. The company produces G30-G50-sized chips which can be sold both to individuals or factories and power plants. However, this is only reasonable, if the customer is located within 50 kilometers, or payment terms are ex works. Because of the large size of the wood chips, specialized trucks with 90 m^3 trailers are needed to economically deliver it to shorter distances.

The smaller the product, the more expensive it is to manufacture. For the efficient and economical use of the chips a boiler developed specially for this purpose is required. The feed-in system of heating plants can easily jam if the product is not homogeneous causing plant shutdowns. Therefore, high-quality, homogeneous wood chips have to be produced without torn fibers. Moisture content of wood chips is also important. With continued rotation by the time the products are sold, a moisture content of approximately 25% can be reached. If the chips get

Table 1. Costs and revenues of the energy plantation with and without subsidies
Tabela 1. Koszty i dochody z plantacji enerietycznej z i bez dotacji

Year/ *Rok*	Harvested area/*Powierzchnia zbioru [ha]*	Yield/ *Plon [t]*	Costs/ *Koszty*	With subsidies/*Z dotacją [EUR}*			Without subsidies/*Bez dotacji [EUR]*		
				revenues/ *przychody*	profits/ *zyski*	cumulated/ *skumulowane*	revenues/ *przychody*	profits/ *zyski*	cumulated/ *skumulowane*
2009	-	-	30 278	15 186	-15 092	-15 092	0	-30 278	-30 278
2010	-	-	91 587	47 576	-44 011	-58 044	0	-91 587	-119 740
2011	13	195	56 184	39 243	-16 942	-73 401	6 655	-49 529	-166 000
2012	-	-	15 174	21 593	6 419	-69 042	0	-15 174	-185 833
2013	-	-	10 316	25 421	15 105	-53 937	0	-10 316	-196 149
2014	28	593	20 674	45 977	25 304	-28 633	20 794	120	-196 029
2015	20	420	16 442	38 655	22 213	-3 859	13 419	-3 024	-181 516
2016	20	420	16 601	38 731	22 130	18 234	13 548	-3 053	-186 326

Source: own study
Źródło: opracowanie własne

wet, fungus appears, the quality decreases and the product will not be suitable for use in food production companies due to the increased health risks.

The largest source of revenue came from area-based aid which represents 59% of all revenues. This is followed by revenues from sales (21%) and planting support (20%). As subsidies are calculated in Euros, an important determining factor is the HUF/EUR exchange rate. From the 2015 financial year on, for example, total aid per hectare increased by more than 10.05% because of favorable exchange rates. In 2013, as a result of a successful application, the company won 50% support for a new, specialized harvester machine with which production became cheaper. Calculations can be seen in table 1.

From table 1 it can be seen that apart from the years of initial plantation the enterprise was profitable when subsidies were included. In the analyzed period, with the given level of subsidies, the investment paid off in year 8. Without subsidies, however, the company generates about 3000 Euros annual loss. The annual break-even point could only be reached if the product was sold for 22.5% more, or at least at a € 40/ton price.

Conclusions

It can be concluded that using black locust as short rotation energy wood is a risky investment as maintenance and harvesting costs are high, sales prices are low, the return on investment is questionable. The technologies employed on short rotation energy forest plantations are not fully developed yet. Several issues and shortcomings have to be resolved before they can be efficiently operated. As the number of power plants in Hungary that produce energy using biomass is limited, the domestic market capacity for dendromass is not reliable enough. Solid biomass consumption, and thereof especially wood energy, is mostly dictated by heating requirements which are climate-dependent and by oil prices which in recent years have been fairly low. The winter of 2016, for example, has been unusually harsh in Hungary which resulted in an overall wood shortage in the country. For the 2009-2016 period, the largest source of revenue in the energy plantation sector came from area-based support. Harvesting of energy acacia under current technology and sales rates is not economical without subsidies and would produce significant losses every year. To cover annual operating costs, a sales price increase of around 20-25% would be necessary (or comparable cost reductions in production would need to be realized). Such cost reduction could be achieved with a one-step harvesting technology instead of the current two step method.

The technology is by no means mature. Technological progress in harvesting, or feeding not only electricity but generated heat directly into the consumer grid would considerably increase the efficiency of energy utilization, decrease production costs and additionally make the whole process more environmentally neutral. On the other hand advancements in bio-methane or bio-hydrogen production, and the tendency of replacing primary biomass (such as forests or energy crops) with byproducts and waste could be detrimental to the marketability of SRC products. Bioenergy, currently, is only competitive with traditional energy sources when analyzed together with all its advantages and benefits to society. Such benefits could be a greater multi-functionality in agriculture providing better financial stability for producers, or increased economic revenues and jobs for rural communities.

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Streszczenie

Biomasa jest łatwo dostępnym, odnawialnym i przyjaznym dla środowiska źródłem energii. Eksploatacja odnawialnych zasobów organicznych do produkcji energii wskazuje na rosnącą tendencję na całym świecie, także na Węgrzech. Głównym źródłem biomasy są lasy, które zapewniają jednorodny, lokalnie dostępny surowiec różnych szybko rosnących drzew liściastych. Przedstawiono wnioski z analiz dotyczących opłacalności krótkoterminowej plantacji leśnej na cele energetyczne, zlokalizowanej w regionie Kunság na Węgrzech. Wykazano, że w badanym okresie przedsiębiorstwo nie mogłoby osiągnąć zysków bez pomocy w postaci dotacji. Istnieje kilka przeszkód w rozwoju tego typu upraw, na które napotykają rolnicy. Wykazano, że są to m.in. początkowy wysoki nakład kapitału, ograniczenia technologiczne związane z pozyskaniem drewna, wysokie koszty logistyczne i zablokowane ceny skupu.

Correspondence address
Árpad Ferencz, PhD, Zsuzsanna Deak, PhD (orcid.org/0000-0001-5074-6765)
Pallas Athene University
Faculty of Horticulture and Rural Development
Mészöly Gyula tér 1-3, Kecskemét 6000, Hungary
e-mail: ferencz.arpad@kfk.kefo.hu,
deak.zsuzsanna@kfk.kefo.hu