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THE EXAMINATION OF THE PROFITABILITY AND COMPETITIVENESS REGARDING THE ENERGY PLANTATIONS OF WOODY PLANTS IN THE REGION OF ÉSZAK-ALFÖLD

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Abstract: Due to the decrease in the quantity of traditional energy sources, in the future an alternative energy production should be sought which provides minimum environmental burden and offers an opportunity to generate energy. The use of biomass provides another option to resolve this problem. The most important features of the biomass are that the quantity doesn't decrease during conversions and are reproduced by natural processes. The main raw materials of the biomass are considered to be the energy plantations, which are economic in areas where the farmer, during the traditional production, can't or with difficulties can cover the expenses, so that profitably sustainable cultivation branches can come to the forefront with less material and energy input. Those cases in which the cultivation of agricultural areas are not economically feasible, there is a possible utilization in our country which is the installation of plantations with energetic aim.

Keywords: alternative energy, energy crop, profitability and competitiveness

Introduction

In agriculture, when designing the production structure such areas should be considered where the farmer, during the traditional production, can't or with difficulties can cover the expenses, so that profitably sustainable cultivation branches can come to the forefront with less material and energy input. Those cases in which the cultivation of agricultural areas are not economically feasible, there is a possible utilization in our country which is the installation of plantations with energetic aim. As *Table 1* shows, energy plantations can be one of the bases of the producing alternative energy.

Table 1: Main energy feedstock

Serial number	Denomination	Example
1.	Biomass from woodfarming	Woodwaste
2.	Energyplants	Locust, poplar, willow
3.	Farmplants grown for energy production	Energygrass
4.	The production for energy making of production plants grown presently for food and feed	Cereals, corn, rapeseed, potato
5.	Basic materials categorized as by-products at present	Cornstalk, straw
6.	Basic materials categorized as waste at present	Waste of slaughterhouse

Source: Tar et al., 2005

It can be read in several agricultural studies (*Erdős – Klenczner, 2000; Gergely, 2000a; Gergely, 2000b; Marosvölgyi, 2004; Erdős, 2007;Kohlheb et al., 2008*) that in the near future, the agricultural strategy doesn't count with sufficient expanse of energy plantation as a possibility for alternative plot usage. One reason for this is that on the low-quality areas with unfavorable relief conditions and tillages producing loss – compared to the rest of the tillage cultures – the farmers do not prefer to set up plantations with high demand for labour. The second group of reasons is that the major proportion of farmers consider the tasks of the agriculture to serve food production, the result and the income cannot be manifested yearly due to the longer production cycle and because of the little information the farmers averse from the wood production. In contrast, a study by *Sulyok – Megyes (2005)* shows that when setting up the plantations a critical point is the profit. Besides the subsidies provided by the European Union, the existence of the state supports would be also important for the investments. This would be necessary because most of the landowners are deterred by the fact that in the first 3–5 years – depending on the variety of species – only expenses occur and this can only partly be counteracted by support for plantations provided by the Union.

The importance of energy tree plantation

The energy tree plantations are plantations with energetic aim set up on fields of agricultural cultivation and fallow areas which provide energetically usable dendromass quickly and in large amount, and in addition to timber production they also serve rational land use. The energy plantations of woody plant with short cutting cycle (for example: energy locust, energy poplar, energy willow) have to be separated from the conventional forests since these are considered arable crops such as corn, wheat, barley and turnsole. The ecological demand of woody vegetation differs significantly from the agricultural plant cultivation's. While the rotation time used by the agricultural field-work is one year, regarding the woody energy plantations with short cutting cycle, the shortest rotational period is from two up to four or five years.

The most important of the basic requirements regarding the energy plantations is that the tree originated from high-yield species should be as cheap as possible (*Rénes, 2008*), its moisture content and bark proportion should be low; it should be available under any circumstances and in proper time; on a long term – 10-15 years – it can be signed on with the lowest risk. So in the course of setting up energy plantations we aim to provide facilities to produce primary energy from unit area as cheap as possible.

According to the categorisation of the plantations we can distinguish two major groups. One of the categories is based on the cutting cycle by which we discern one, two and several years old tree plantations. Another method of classifying is distinguishing the energy tree plantations by installation. On this basis we separate species liable to sprouting and which can be resettled.

The installation of sprouting plantations – compared to the replanting method – uses well sprouting species with larger amount of plant stems (13–15 thousand). Because of the great number of stems, the first cutting happens at the age of 1–3 year. The cut-off plantation resprouts without applying any kind of exterior intervention then after 1–3 years it can be recut. The exploitation can be repeated 5–7 times since the plantation does not lose its ability to grow quickly and to sprout for 15–20 years. In the case of these plantations well budding, high-yielding tree species are beneficial to use. Choosing the tree species depends on the soil quality and water supply. The European Union has set up a method of calculation by which on those areas where the wheat crop can not permanently achieve four tonnes per hectare, and for the exploitation of the produced wood – dendromass – a relevant market is available, it is expedient and more economical to establish energy plantation (*Marosvölgyi – Ivelics, 2004*).

During the replanting procedure – compared to the previous technology – the plantations are set up with the traditional technology, but with a greater number of stems than normally – 5–8 thousand stems – and at the age of 8–15 years they are produced with clearcutting. After the last cut, soil preparation is carried out on the cut area then replanting takes place. Any tree species can be used for installation. Its disadvantage is, however, that the cost of the propagating material is relatively expensive, it is necessary to make a full soil preparation after every harvest, it is difficult to mechanize and has high demand for labour. The resulting end product will be more expensive in comparison to the other technology. So far it has mainly got accustomed in private farms where the aim is to satisfy their own needs. It can be used both on flat and hilly areas. Based on the calculations of *Bai* and his colleagues (2002) we can count with 8-15 tonnes of yield per hectare yearly and approximately 80-150 GJ/ha/year energy.

In our country the most suitable tree species for installing energy tree plantations are the poplar, the willow and the locust.

Among these, specialist consider the locust the most expedient one as it grows fast at young age, its moisture content is low, its budding ability is efficient and it can be used well as fuel even when wet. Besides these, its excellent attributes are that in the first years it grows remarkably quickly, sprouts well, it is resistant to pests and has only a few parasites, it buds well both from tree stump and root, it is a tree species which can be exploited within 4–5 years, it burns well crudely, without drying, it has high calorific value and the offspring generation after the first exploitation will be more than twice as much as the original stock.

It likes the medium dense, sandy, warm soil with sufficient humus content, but grows well in semi-dry, fresh and semi-moist areas too. For the installation saplings are used and put into the soil by sapling planters. The favorable period for plantation is autumn, but spring is also suitable for it.

In the so-called offspring mode 5–7 cuts can be planned. It is important that there is no restocking expense and multiplied yield can be achieved.

Besides the locust the poplar has great importance too (*Hoogeveen et al., 2004*). The species of poplar demands light, warmth, soil air and water. In our country the thermal and light conditions are sufficient to achieve the expected yields. It is important that the topsoil must be at least 80 cms thick but it can be a little bit shallower if the area is under good water management and nutrient replacement is ensured. On drier areas – this is the typical – the thicker topsoil helps a lot to endure the droughty periods in summer also as tender nursing and proper supplementation of nutrients. During the developmental period the plantation is able to cope with short-term floods, nonetheless in areas which lack water desolation is inevitable.

Hungary's soil types and yielding sites are favorable for the agricultural production. However, on the so-called inland water areas – in the region of the rivers Tisza, Körös, Szamos and Bodrog – due to the yearly floods there is no possibility for traditional cultivation. On these areas almost all kinds of „energy willows" can be cultivated effectively *(Szente, 2007*). The areas in the floodplains of the rivers which are currently utilized by arable cultivation play a major role in the production of energy plants. The production values of these sites are usually outstanding, huge yields can be achieved (*Kondor, 2007*) as the willow prefers the periodic floods among other territorial conditions. However, it is necessary to pay attention during harvest so that they can be cropped without any problem. Regarding the conditions of floodplains it is important that the one or two years old plantations – with very short rotating cycle – should be proposed only in limited extent. In contrast to the locust and the poplar, it can beneficial that a lot of cultivated plants can only be produced in limited quantity in the EU based on restrictions so far. However, the energy willow – and the other plants belonging to its category – can be cultivated with support and without limitation. What shows the importance of the willows is that Robertson proved the possibility of producing energy from willow plantations in 1984 (*Robertson – Khalil, 1984*). He marked it beneficial that it is easily propagated by cuttings, resprouts quickly after harvest, in rotation for two-three years it gains high yield over several generations without replanting.

Based on the comparative table – *Table 2* – it can be seen that the woody energy plantations with short cutting cycle assure 120-440 GJ energy yield per hectare yearly.

Table 2: Yields and characteristic data of woody energy plants in Hungary

Wood species	Energy content MJ/kg	Average yield kg/ha/year	Enegy output GJ/ha/year	Moisture content %	Cutting cycle year
Locust	14,8	7900	117	15	3
Poplar	15,1	20000	302	15	2
Willow	14,8	30000	444	15	3

Source: Marosvölgyi, 1998; Bai, 1999; Bai et al., 2002; Marosvölgyi – Ivelics, 2004; Defra, 2007

The yields for specific moisture content are usually given in tonnes/ha/year units. We can only count with a low yield at the first harvest because after the planting, the plants devote almost all their energy into root training. At the following harvest, the yield will significantly increase since the plants can raise more offsprings because of the sprouting.

However, in general we can say that on sandy, relatively dry areas locust can be envisaged, which grows fast, but has a low yield, 5–15t/ha/year. The poplar may bring 13–35 tonnes of tree yield on fresh crop lands per hectare annually. In contrast, on wet, especially floodplain areas, the willows are rather the best because it can produce 30–35 tonnes quantity per hectare annually.

The examination of the profitability of energetics tree plantations

In this chapter, I would like to demonstrate the profitability of the previously described energy plantations. My calculations were prepared for a six-year time interval, because I aimed to compare the tillage crops with these cultures further on.

When calculating the profit contribution, the production value and the production costs must be defined. During the calculation the production values and the changing expenses must be determined for a production period regardless of the calendar year. This period includes the so-called dead period which elapses because of the climatic or technological reasons between two consecutive production periods. In plant production the length of the production period is mostly one year, except for plantation-like production, where a period can even be 20–25 years.

Defining the production values, I took into consideration the realistically achieved yield values, the received support sources and the other incomes. During the designing process, I paid much attention to give accurate estimates to single cultures since the profit contribution can show large differences in case of small-scale estimation mistakes of the planned production value. I defined the yield values based on the product of the crop quantity multiplied by the sales price. I took into account the support levels defined by the current law, and the contracted and estimated prices in marketing. Thus when defining the subsidies I counted with the values of the TOP-UP national complementary and SAPS area-based support. For this source of aid for farmers dealing with growing energy plants may provide further assistance. The calculation of the production values were followed by the calculation of changing expenses, which were difficult to determine because in this category you can't rely safely on statistical data and the databases are also deficient. Textbooks, research institutes and planning aids play important roles. Defining varying expenses mean those costs which can be modified by the change of the size of the sections. I counted with material expenses, personal expenses, the supplementary sector services and with other direct expenses as well. The material expenses, seed-corn expense, cutting expense, chemical fertilizer and pesticide expenses were accounted. The personal expenses were assignable to single sections. Among the supplementary sector service costs, the cost of fuel, maintenance and repair costs got accentuated emphasis. According to one of the studies of Pfau – Széles (2001) regarding the expenses of the maintenance and the repair, we can count with 60–70% material cost, 25–30% a personal cost and 10–15% overhead expenses. In that case if we would like to decide which activities carried out by an agricultural enterprise are considered to be competitive on the terms of profitability, then the value of the profit contribution should be calculated. The values of the planned profit contribution are shown in *Table 3*. When calculating the values of the profit contribution of the energy plants, we should consider that the harvests are not performed every year. In the case of the energy plantations, in those years where the harvest is done I counted with positive profit contribution and in every other occasion I counted with negative. Of course there are exceptions. Since I calculated every year with the amount of the subsidy, in some years, I have received positive profit contribution values when there was no harvest. I calculated 3 years with the locust's and Swedish willow's and 2 years with the poplar's harvesting cycle. I have prepared the multi-annual calculation by defining the value of the profit contribution of the first year and from the second year I used 5 percent income growth and 4 percent cost increase. At the given year the basis of the profit contribution were determined by the data of the expense and income of the previous year.

Table 3: Profit contribution value of energy orchards for one hectare in the examined years

Unit: Ft/ha

Year/Orchard	Locust	Poplar	Willow
Year 1	- 505 335	- 423 674	- 531 170
Year 2	672	134 224	- 2 154
Year 3	352 995	- 184 635	503 738
Year 4	- 160 380	232 401	- 152 955
Year 5	24 745	- 184 635	24 745
Year 5	403 243	232 401	604 233

Source: Own creation

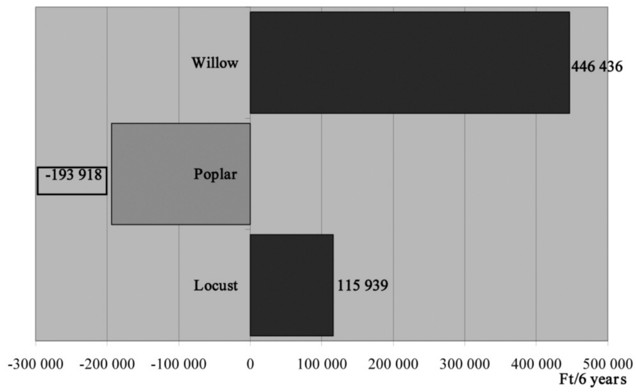


Figure 1: A maximum gross margin in the certain woodplants by the end of the 6th year can reach
Source: Own creation

If we make the arable energy plantations compete in a 6 year interval in terms of the maximum profit contribution, than the Swedish willow would get to the first place (*Figure 1*).

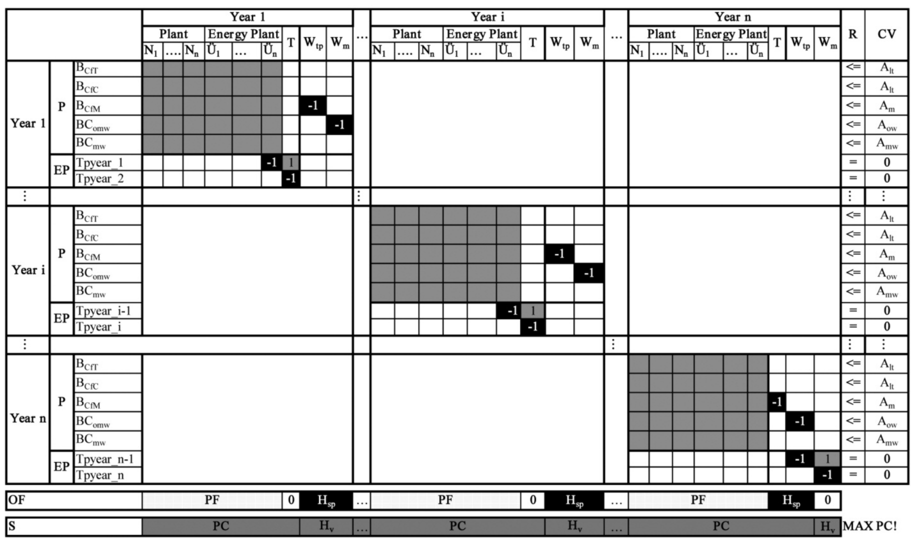
Examining the six years, we would reach 446 thousand forint of profit contribution with the Swedish willow while 115 thousand with the locust. Compared to those, the poplar plantations would only be able to produce loss even after reaching the age for cutting. This means that considering six-year period beside the usage of the given resources and applied plantation technology and the installation of the energy poplar would be lossmaking even with subsidy. This is the main reason why the production structures – unlike the other plants – are not considered competitive.

Because of the region's conditions these values are valid only for the totality of examined economies of Észak-Alföld's region, it is not possible to deduce the inferences on national level.

The examination of the competitiveness of energetics tree plantations

I wish to represent the competitiveness of the energy tree plantations compared to tillage plants'. For my calculations I used a multi-periodic linear programming model. For the database of the linear programming I developed unified cultivation technologies, which are based on the data of 16 crop cultivating company which I examined in the Észak-Alföld region. Based on these, I have developed sample technologies of 100 hectares using the help of Microsoft Excel.

Table 4: Basic scheme of multiperiodical linear programming model



Source: Own creation

V_p	: Plant production variable n=1,2…,k	BC_{omw}	: Balance condition for own mechanic work
V_{ep}	: Energy plant variable n=1,2…,k	BC_{mw}	: Balance condition for mechanic work
W_{tp}	: Time period work (working hour)	T_P	: Transfer condition for plants n=1,2…,k
W_m	: Machinery work (work hour)	OF	: Objective function
T	: Transfer variable	S	: Solution
H_{sp}	: Specific cost of hirework	PS	: Production system (100ha)
H_v	: Volume of hirework (work hour)	R	: Relation (=;<=;>=)
PR	: Power resources	CV	: Capacity vector
P	: Plants	A_{lt}	: Amount of land territory (100ha)
B_{CfT}	: Balance condition for territory	A_m	: Amount of manpower (working hour)
B_{CfC}	: Balance condition for croprotation	A_{ow}	: Amount of own work (working hour)
B_{CfM}	: Balance condition for manpower	A_{mw}	: Amount of machinery work (working hour)

In the basic scheme of the model I have named the signs of the parameters in the following way:

negative sign
negative and positive sign
positive sign

Source: Own creation

After setting up the raw data, it was time to model the sowing structure, which I have done with a multi-periodic linear programming model. The models of the matrix for each year of the production construction are located in the diagonal of the model. The stripping of the technologies is detailed monthly. The interval of the study is six years, which was induced by the more accurate modeling of the perennial energy plantations. The linear programming model involves 60 variables and 160 balance conditions. I built the model of the linear programming with Microsoft Excel. The theoretical structure is shown in *Table 4.*

Of course in the line of the solution – the production structure and the quantity of the lease work– we may only obtain positive values as the negative production structure cannot be defined.

Among the arable crops I chose the wheat, the corn, the turnsole and winter colza because these plants are currently regarded as energetic raw materials that can be produced in large quantity in the agriculture of our country. Whereas among woody energy plantations I chose the earlier presented locust, poplar and Swedish willow.

In the case of the tillage plants, I defined the values of the profit contribution based on the data of 16 agricultural companies, as I prepared sample technologies for the single sections. The applied values of profit contribution used at the tillage plants are shown in *Table 5*. I counted by defining the value of the profit contribution of the first year and from the second year I used 5 percent income growth and 4 percent cost increase. At the given year the basis of the profit contribution were determined by the data of the expense and income of the previous year.

Table 5: Profit contribution value of arable crops for one hectare in the examined years

Unit: Ft/ha

Year/Plant	Corn	Turnsole	Winter wheat	Rape
Year 1	147 811	87 906	128 026	125 147
Year 2	149 289	88 785	129 306	126 398
Year 3	150 782	89 673	130 599	127 662
Year 4	152 290	90 570	131 905	128 939
Year 5	153 813	91 475	133 224	130 228
Year 5	155 351	92 390	134 557	131 531

Source: Own creation

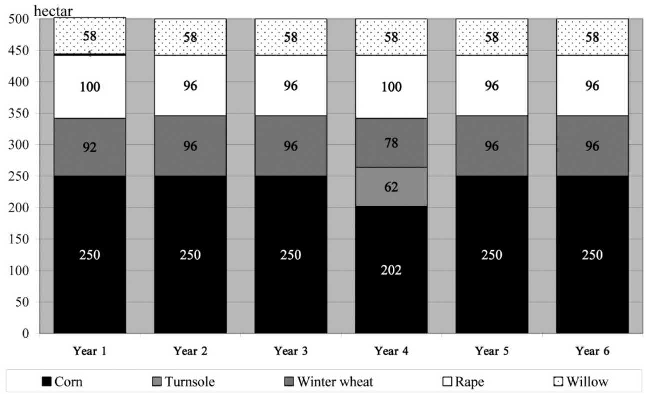


Figure 2: Az alap modell futtatása után kialakult termelési szerkezet 6 évre
Source: Own creation

After building and running the basic model and analyzing the shade prices I prepared three variants: I have modified the profit contributions of the basic model, first the turnsole's, second time the locust's, then the poplar's.

After solving the basic model I received the following production structure for the next six years (*Figure 2*).

The maximum profit contribution which can be achieved by the running of the basic model can approximately be 388 million forint counting with 500 hectares and six years. In the production structure the corn has an unambiguous superiority against the other crops in the six-year period study. The corn took a 100% advantage of the maximum available 250 hectare area every year. The fourth year was an exception, when its sowing area decreased by 48 hectares and the turnsole got into its place with 62 hectares. The winter corn and winter colza stood in second and third place with 92–96 hectares. The minimum area had been submitted to the Swedish willow, with its 58-hectare area.

Table 1: The summarized table of variable cells for the first year's sensitivity analysis of the linear programming model (100ha)

Name	Area under cultivation 100 hectar	Shadow price of the activity eFt/100 hectar	Objective function value eFt/100ha	Lower limit	Upper limit
Corn year 1	2,50		14781,1	12556,5	14781,1
Turnsole year 1		**-3501,94**	**8790,6**	**….**	**12292,6**
Winter wheat year 1	0,92		12802,6	9300,6	13413,7
Rape year 1	1,00		12514,7	11903,6	12514,7
Locust year 1			**-50533,5**	**….**	**-18016,6**
Poplar year 1			**-42367,4**	**….**	**21074,4**
Willow year 1	0,58		-53117,0	-85633,9	-32361,1

Source: Own creation

The turnsole, the locust and the poplar did not get into the production structure. Analyzing the basic model's production structure (*Table 6*) we can see that the turnsole, the locust and the poplar did not get into it. We must analyze the values of profit contribution if we want these crops to be competitive against other field crops. The sensitivity analysis table for variable cells provides us assistance for this. From this table we can read out the shadow prices, marginal costs of the activities. It gives the information about why an activity did not get into the production structure and when it can get into the optimal solution. Besides, it shows that how much the coefficient of an activity's objective function must be increased in order to get into the production structure without the decrease of the objective function's value.

I summarized the table of sensitivity analysis for variable cells in the first year in *Table 6*. It can be seen that the turnsole didn't get in the production structure with its 87.906 forint profit contribution per hectare. If the value of the profit contribution of turnsole would increase from 87.906 forint to 122.926 (*Table 7*), then the maximum use of the existing resources with 100 hectares the Swedish willow would get in the production structure at the expense of the winter wheat and colza (*Figure 3*). Due to this, the role of the willow in the production structure would change.

It can be set out, that the locust and the poplar still didn't get into the production structure.

In the case if we want the locust to get in the production

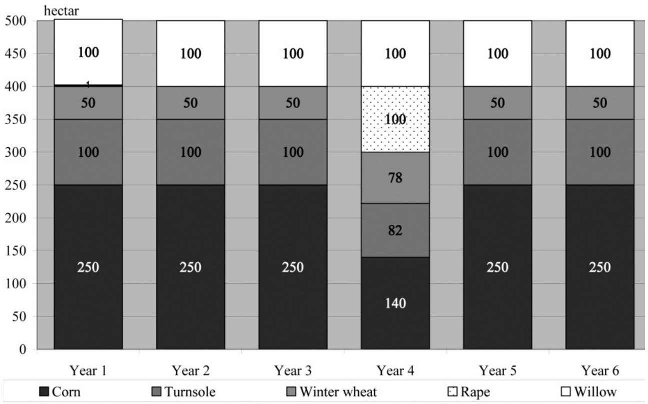


Figure 3: The production system for 6 years counted by the value of the minimal threshold price of the raised coefficient of the objective function of the sunflower
Source: Own creation

structure instead of the turnsole, then the value of the profit contribution for the first year of the locust should be increased from -505.335 forint to -180.166. I have defined this value by that the value of the profit contribution of the base model of the locust was 505.335 forint for 100 hectare and the corresponding increase in allowable value is 325.160 forint. The coefficient of the objective function and the allowable increase must be summed in order to get this value, so in this way we got -180.166 forint per 100 hectares. The lower profit contribution value was determined in this way and the locust would be competitive with other arable crops under these conditions.

However, in the current economics there is no opportunity for the growth of the locust's profit contribution, since the cost of the locust's cutting for one hectare is approximately 288.000 forint. Further costs are the handling, cultivation, material and other cost elements. But in case of this reduce would happen somehow than compared to the basic model the locust and the willow would get into the production structure with 34 and 24 hectares (*Figure 4*).

Returning to the production structure of the basic model we can note that the poplar is not competitive either with

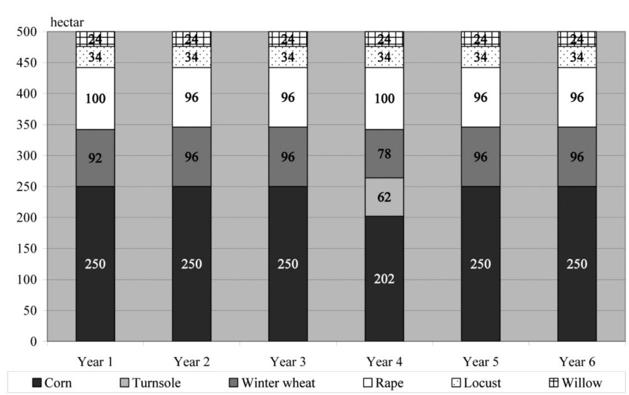


Figure 4: The production system for 6 years counted by the value of the minimal threshold price of the raised coefficient of the objective function of the locust
Source: Own creation

given profit contribution besides the other arable crops. The reason for this is that the whole six-year period has negative balance in the given economics. The profit contribution of the poplar should be a positive value even in the first year in the model (210.744 Ft/ha) so that it can get into the production. Regarding the features of the agriculture it can not occur as the installation of the plantations demands great investment.

However, assuming that the poplar can somehow reach the value of the minimal marginal cost, then besides the poplar's area of 34 hectares the Swedish willow can also integrate into the proposed crop structure (*Figure 5*). The expanse of the areas of other plants in the crop structure is paralleled with the values of the basic model.

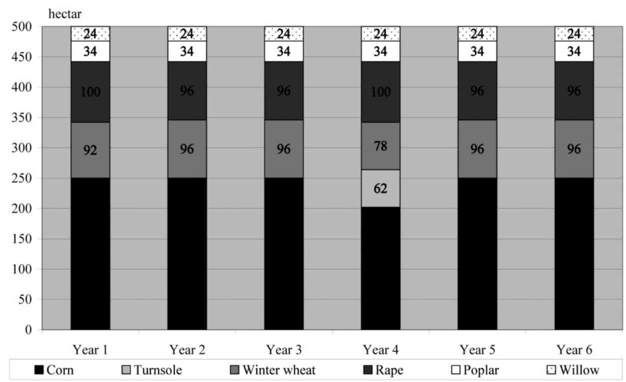


Figure 5: The production system for 6 years counted by the value of the minimal threshold price of the raised coefficient of the objective function of the poplar
Source: Own creation

Result and discussion

The reason why I believe it is important to demonstrate the renewable energy sources is that regarding the estimations of the year 2009, the humanity has used up as much fossil energy sources within a year as the Earth produces within a million years. However, based on the evaluation there will be no global energy crisis in the forecoming years.

During my research I have examined the profitability of the stock of the biomass – the energy tree plantations. Concluding, among the three types of energy plantations based on profit contribution the most competitive is considered to be the Swedish willow. This is followed by the locust with a lower value of profit contribution. Regarding the race condition the worst is turned out to be the poplar since examining the 6-year-old interval this plantation is considered lossmaking (193 thousand forint loss within six years).

References

Bai A. (1999): Az energiaerdő, mint alternatív növénytermesztési ágazat. In.: Tiszántúli Mezőgazdasági Tudományos Napok.

Debrecen. Debreceni Agrártudományi Egyetem. Konferencia kiadvány 125-130. p.

Bai A. – Lakner Z. – Marosvölgyi B. – Nábrádi A. (2002): A biomassza felhasználása. Szerkesztette: Bai A., Szaktudás Kiadó Ház. Budapest

Balogh P. – Kovács S. – Nagy L. (2009): Analysis of production and management risks by stochastic models In: Efficiency in the agriculture (theory and practice) Ed. Szűcs I. – Farkasné F. M.), Agroinform Publisher, Budapest,294-316. p. ISBN: 978-963-502-899-3

Defra (2007): Department for Environmental, Food and Rural Affairs (a): Growing Short Rotation Coppice, Best Practice Guidelines for Applicants to DEFRA's Energy Crop Scheme

Erdős L. – Klenczner A. (2000): A fatermelés szerepe és lehetőségei a távlati földhasználatban. Gazdálkodás XLIV. évfolyam 4. szám. Budapest

Erdős L. (2007): Ültetvényerdők szerepe a távlati földhasználatban. Előadás és tanulmány a Debreceni Agrártudományi Egyetem Nemzetközi Agrár- és Vidékfejlesztési Konferencián; Gazdálkodás 51. évfolyam 4. szám

Gergely S. (2000a): Az Észak-magyarországi régió energiaerdő programjának lehetőségei és korlátai I. Gazdálkodás 2000. 6.sz. Budapest

Gergely S. (2000b): Az Észak-magyarországi régió energiaerdő programjának lehetőségei és korlátai II. Gazdálkodás 2000. 7.sz. Budapest

Hoogeveen Y. – Petersen J.E. – Balazs K. – Higuero I. (2004): High nature value farmland. Characteristics, trends and policy changes. EEA report No 39. European Enviroment Agency. Luxemburg: Office for Official Publications of the European Communities. p. 31. ISBN 92-9167-664-0

Kohlheb N. – Porteleki A. – Szabó B. (2008): An Assessment of the Utilisation of Hungarian Bioenergy Potencial. Central European Biomass Conference. Submittel abstract. Graz

Kondor A. (2007): Adatok az „energia fűz" (Salix viminalis L.) gyomszabályozási lehetőségeiről. Agrártudományi Közlemények (26) különszám

Lukács G. S. (1989): Energiaerdő. Mezőgazdasági Kiadó. Budapest. 55. p.

Marosvölgyi B. – Ivelics R. (2004): Új gépek a rövid vágásfordulójú faültetvények betakarításában Magyarországon. (New machines for harvesting of SRC in Hungary; Ergebnisses in die Entwicklung der Erntetechnik von Holz-Energieplantagen). Presentation. In. 37 th Internationales Symposium "Mechanisierung der Waldarbeit" (FORMEC 2004) Gmunden, Österreich

Marosvölgyi B. (1998): Faültetvények és azok energetikai hasznosítása. XL. Georgikon Napok, Keszthely 1998. szeptember 24–25

Marosvölgyi B. (2004): Energiaerdők, energiaültetvények (fa, nád, fű) kutatási és termelési tapasztalatai. II. Energiaexpo. Debrecen

Nagy L. (2009): Some possibilities for risk analysis in the decision support of crop production. Apsctract (Applied Studies In Agribusiness And Commerce) Vol.3. No 1–2., Debrecen p.79-86. HU-ISSN 1789-221X

Nagy L. (2007): Mikor és mennyit vásároljunk? Optimális gabonavásárlási stratégiák. Agrártudományi közlemények, 2007/27, Debrecen p.175-181. HU-ISSN 158731282

Pfau E. – Széles Gy. (2001): Mezőgazdasági Üzemtan II. Mezőgazdasági Szaktudás Kiadó ISBN: 9633563259. Budapest

Rénes J. (2008): Fás szárú energiaültetvények a gyakorlatban I. Bioenergia Bioenergatikai szaklap III. évfolyam 3. szám. Szekszárd

Robertson A.W – Khail M.A.K (1984): Conifers for Biomass production. Vol. I. and II. Forest Energy Program, Canadian Forestry Service and I.E.A. In. W. Palz – J. Coombs – D.O. Hall: Energy from biomass 3rd E.C. Conference Elsevier applied science publishers. ISBN 0-85334-3969. Brussels and Luxemburg. 1985

Sulyok D. – Megyes A. (2005): Energetikai faültetvényekből származó megújuló energiából VI. Agrárágazat 7. – 8. szám

Szente I. (2007): Energiafű termesztése, avagy új lehetőségek a szántóföldön. http://www.mtesz.hu/093nvt/SzenteImre/energiafu.doc Letöltés: 2007.01.14.

Tar F. – Kárpáti Z. – Marticsek J. (2005): Megújuló energiaforrások termelésének és felhasználásának lehetőségei a mezőgazdaságban. Földművelésügyi és Vidékfejlesztési Minisztérium