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Biofuels in Romania – Regional Strategic Opportunity

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Abstract

This paper aims to define the place of a bio-refinery into the Romanian economic system, presenting both the industrial crops considered by the authors to be the most recommended to obtain biofuels, and, synthetically the technology used in this area.

By estimating the potential market in this field it is also pointed out the possibility to develop a new competitive advantage for certain regions of Romania, if the integration of the new products is undertaken according to marketing and quality concepts.

Key words: *industrial crops, technology, regions, marketing, bio-refinery*

JEL Classification: *F01, L10, M31*

Introduction

One of the most important challenges for the Romanian industry is represented, according to the Directive 30/2003/EC by the necessity to assimilate biofuels, until 2010, in proportion of almost 5.75% of the fossil fuels' volume.

It is necessary to pay attention to the fact that, without having a compulsory character, by the European Commission Green Paper "*Towards a European strategy for the security of energy supply*", it is fixed a substitution objective of fossil fuels with the bio ones in proportion of 20% until 2020, Directive 30/2003/EC being issued in the spirit of the document.

For the oil traditional market, the appearance and development of the alternative energies presents special risks, owing to their indirect substitute goods character. We can appreciate that, in this period, the oil industry starts to face a special form of competition, mainly represented by the energetic raw materials' diversification, phenomena generated by the technical progress and innovations, both being characteristics of knowledge-based economy, while we are the witnesses of the evolution towards ecological forms of this economic sector.

This is the reason for which we consider useful both to estimate the evolution of *fuels* and the necessary *industrial crops* (sorghum and rape - mainly used for obtaining biofuels) market until 2010 and, at the same time, to adapt and develop modern management concepts in order to use profitably the technologies from this area of activity.

As a consequence, it is necessary to make an analysis of the Romanian technological and agricultural potential and to conceive managerial models that can contribute to the efficient use of the mentioned resources in order to assure proportional regional development and at the same time to achieve the major objective formulated by European documents.

Thus, according to the fact that the main biofuels are represented by *bioethanol* (which will be used blended with petrol) and *biodiesel* (used for diesel) it is necessary to shortly present the *industrial crops* cultivated in Romania, used as raw materials in order to obtain the mentioned biochemical products.

To produce bioethanol, the pedological and climatic conditions from Romania favor crops of: sweet sorghum (*Sorghum bicolor (L.) Moench ssp. saccharathum*), corn (*Zea mays*), including sweet corn and sugar beet (*Beta vulgaris*).

The bioethanol resulted from sweet sorghum (both from the plant's stalk and from its seeds) has very high quality, its octane number - 113, being superior to the value of 93, recorded by the Premium petrol, it contains 35% oxygen, it is not toxic, easily biodegradable and it replaces the benzene, representing the best substitute for petrol.

Sorghum is a plant that can be entirely used, besides its quality of profitable renewable source of environmental friendly fuels ("*the production of 6 tone of alcohol/ha – 80% concentration – offers the necessary conditions to obtain petrol at a price close to that resulted from oil*" [1]), it has high productivity (70-120 t/ha), large content of sugar (6-7 t/ha) and starch and it also records multiple auxiliary utilizations: fodders, cellulose, sweetener, manure, etc.

At the same time, from the biological point of view, it presents, compared to the corn, a sum of special advantages by the fact that it has a C4 photosynthesis cycle type (assimilating a larger CO_2 quantity), self-pollination, it is resistant at drought and high humidity, it can be cultivated on variant soils, with different acidity (PH higher than 6) or alkalinity, preferring, because of its subtropical origin, the sandy ones (*thus, it does not affect the areas dedicated to the cereal crops used for obtaining aliments for population*).

As regards the sugar beet, sweet sorghum records higher profitability and pedo-climatic advantages such as: it does not deteriorate the soil (its roots, very branched out, rich in nutritive elements, remain in the ground and contribute to fertilization) and, moreover, it can be cultivated on impoverished and/or arid areas. The recommended ones for this plant's crops are the fields from South Muntenia and Oltenia, Banat Plain and Central Plain of Moldavia.

To obtain biodiesel from plants in Romania it is recommended to use the *rape* (*Brassica napus*), soya (*Glycine max*) and sunflower (*Helianthus annus*), the oils extracted from these being used as raw material for this type of fuel.

From the quality conditions' point of view, in this case it is worth noticing that while the cetane level for diesel in Europe is 51 (EN ISO 5165), the biodiesel records values that reach almost 100. Besides this, there are further problems related to viscosity, sulphur content, point for inflammation, additives, etc.

In the following lines, we are going to present the rape's properties, taking into account arguments as those already mentioned (its usage for producing biodiesel will not affect the balance of population's food market). It is noticed the fact that this plant has a content of 33-49% fats, 19-20% brute protein and 17-18% non nitrated components. The seeds' oil production is almost 3.2 t/ha from which results 1.21 t biofuel and 0.112 t glycerine. The rape's seeds (after their oil content is extracted) can be used as fodders, for heating, as manure or into the process of obtaining volatile bio insecticides.

As regards the cultivation area it must be noticed the fact that the rape prefers both yellow soft soils and sandy ones, involving fertilizers, being raised in the West Plain, Banat, Transylvania, Romanian Plain, Moldavia.

[1] Antohe, I., Tripşa, I., *Sweet sorghum crops and its complete industrialisation. A perspective for sustainable development of Romanian agriculture*, Second edition, Chiminform Data SA Publishing, Bucharest, 2006, p. 9

In the technology of bioethanol and biodiesel production, all types of biomass *conversion processes* are met, such as: physical (grinding, separation, briquette etc.), thermical (hydrogenation, gasification, combustion, pyrolysis), chemical or biochemical (fermentation).

In concrete terms, in order to obtain bioethanol from seeds of sorghum there are successively going through the stages of: grinding, leavening, dextrinise, starch liquefying and saccharify, alcoholically fermentation, distillation. Also, the pulp, which is the raw material in the paper industry, can be obtained from sweet sorghum through a specific technological procedure undertaken after the process of sweet juice's extraction by pressing plant's stalks is finished.

To produce biodiesel, the technological process includes among its main stages: sorting, pressing, neutralizing extracted oils by sodium or potassium hydroxide, esterification with methylated spirit and phases separation. The biofuel obtained has the main weight (over 80%) from the resulted substances.

Experimental Stage

By using a linear regression model having time as exogenous variable we have determined the evolution of Romania's car park until 2010, considering that the petrol and diesel production will be tightly linked to it, because the vehicles represent, by their consumption, the fuels' demand, while the producers will have to adapt to it, including the assurance of 5.75% bio component content.

Working on the data gathered from Romanian Statistical Yearbook between 1990 and 2006 (Annex 1) and using the software E-views 4.1 it has been obtained the following regression equation:

$$Y_t = 316.7041 + 13.92314X_t, \quad t = 25.7 \qquad (1)$$

$$(2.653686) \quad (0.541681) \quad F = 660.67$$

where:

Y_t - the car park from year *t*;

X_t – the time factor.

Using Student Test we have checked the significance of the model parameters, working with a threshold $\alpha = 0.05$ and $v = n-2$ degrees of freedom, resulting that the time factor has a significant influence on the dependent variable (t computed > t tabular, more precisely 25.70>1.75).

In order to validate the model we have used F Test, resulting that for a significant threshold of 5%, $v_1 = 1$ and $v_2 = n-2$ degrees of freedom, the value of correlation report is significantly different from zero, fact equivalent to that the model is correctly specified, identified and estimated (F computed>F tabular, namely 660.67>4.543). The high value of R^2 (0.977) indicates a strong dependence between the explanatory variable (X) and Y.

Applying the model, it resulted that the *total number* of cars in Romania could reach by 2010 the number of 4,837,831 pieces (see Figure 1).

In order to estimate the probable quantity of fuels necessary for this car park we have ignored the *technical progress* (which can influence the average consumption of vehicles), because both usage of biofuels and living standard increase will have as a consequence higher consumption, fact that annuls its effects. Simultaneously, we have considered that the car park's structure will be a comparable one.

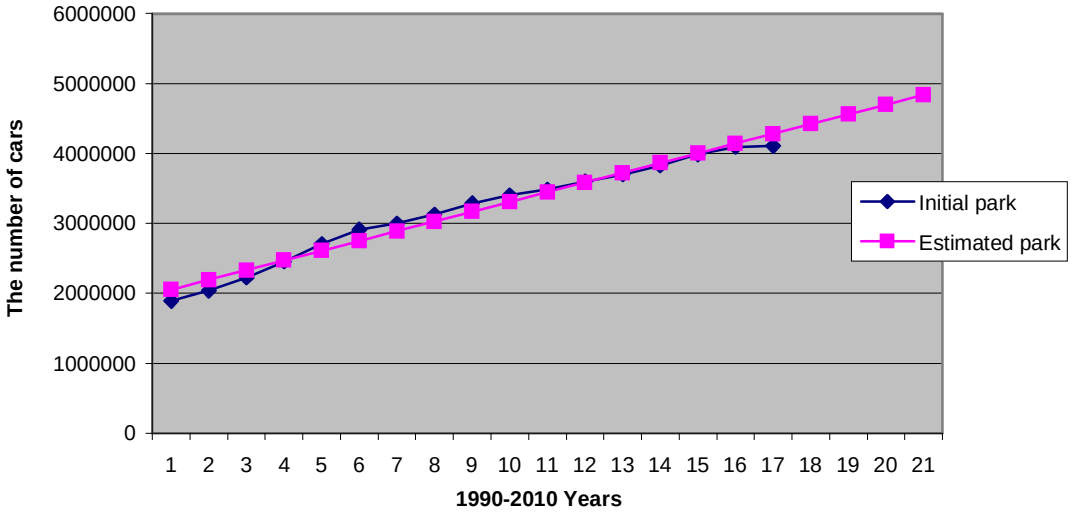

Fig.1. The estimated evolution of car's number by 2010

Thus, computing related to 2005 values, when the total production of petrol and diesel was 9,498 thou tones, from which 4,956 thou tones petrol and 4,542 thou tones diesel, for 2010 year we appreciate that the total fuels volume consumed in Romania will be almost 11,222.92 thou tones, structured as petrol 5,856.0542 thou tones and diesel 5,366.868 thou tones.

Taking account of the fact that, for the moment, the whole domestic refining capacity of 24.4 millions tones yearly is used in average only at a half, for the next three years it is sufficient to produce the estimated fuel quantities.

Moreover, because these ones will have to contain minimum 5.75% biofuels, which can be assured on the domestic market, the refining effort will be lower, from this process resulting only 5,519.33108 thou tones of petrol, respectively 5,058.273 thou tones diesel.

The difference for petrol, in fact almost 336.72316 thou tones will be represented by the bioethanol, while for diesel, almost 308.5949 thou tones, will be formed by biodiesel, reasons for the Romanian agriculture to be prepared to assure the necessary raw materials and for the industry to process it.

As a short scenario, this equates the fact that, in 2010, in Romania, the areas cultivated with sorghum would be of almost 56.125 thou hectares (while those with rape would be of 255.037 thou hectares) if they took the decision to make prevalent use of these plants for biofuels production.

Results and Discussions

The data prove the fact that in the following 3 years Romania has the huge *opportunity* in the agro-industrial sector to develop an important market for bioethanol and biodiesel, both products being dedicated to the energetic field, critical area for European Union's economy.

Practically, the quantities of bioethanol and biodiesel that must be produced in order to satisfy the demand from the tertiary sector – automobile and transport services - make obvious the necessity to build up some *bio-refineries*, as green field investment or as competitive reengineering of former sugar, respectively oil plants. From the point of view of agricultural potential and the proximity to the strategic partners, petroleum refineries or petrochemical plants, we consider it useful to locate the new types of industrial installations in the following Regions: South Muntenia, West, and South-West for bioethanol and in South-East, North-East and Centre for biodiesel.

The aspects mentioned emphasize the fact that the investments in this field can become profitable, offering favorable conditions to develop *new technologies* to process industrial crops and to improve their variety, simultaneously with the development of disfavored regions of Romania.

During the entire investment process, which is also one of knowledge improvement, attention has to be paid to quality, understood from the perspective of the dynamic concept of Total Quality Management – TQM. Thus, from the managerial point of view, there appear new difficulties represented by the situations that can be met in the *interference areas* existing between the agriculture and the industrial sectors, with impact on consumers, including from the sustainable development perspective.

The bio-refineries will represent hybrid economical units between the primary and secondary sectors of the economy and will have to work into an integrated system, developing tight connections with Agricultural Research Institutes, industrial crops producers and the main petroleum refineries.

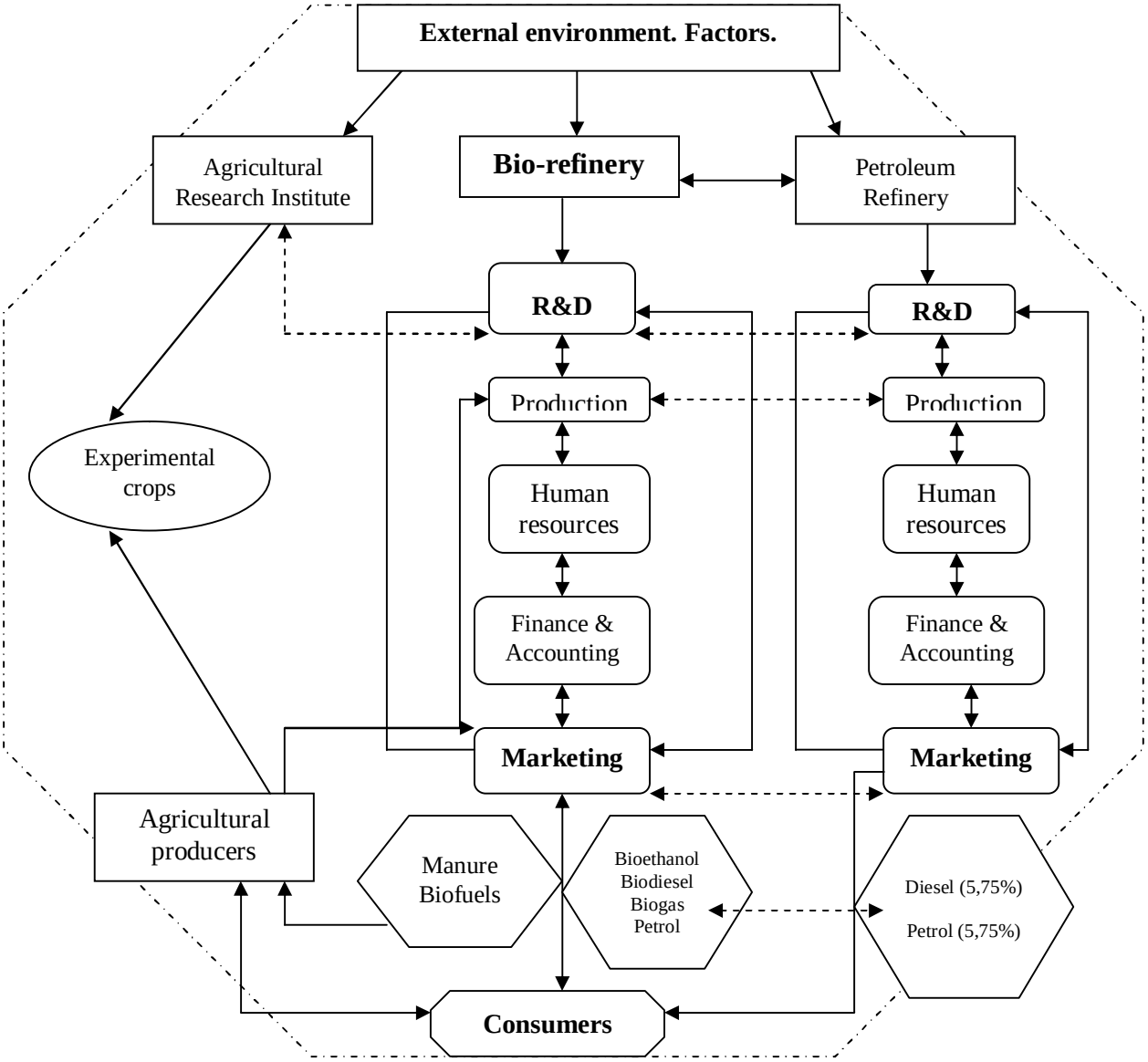

Fig. 2. *Model of the place of a bio-refinery into the agro-industrial system*

Thus, as it can be observed from Figure 2, the main interactions will be recorded between Research&Development (R&D) and Marketing functions. These will have a strong cooperative character between the agricultural sector and the bio-refinery, which will act as in the "*symbiosis*" process. On the other hand, besides the supplier-client relationship, harmonized also at R&D and Marketing functions level, a competitive side is going to develop between bio-refineries and traditional plants of petroleum refining, because of the finite products' characteristics of the two economical unit types.

The bio-refinery is going to win in the long run, both because of the exhaustion of fossil resources and the change of consumers' behavior, who will prefer environmental friendly products, the aspects being mentioned, without exemplification, also in Lindsay Meredith's paper "Scanning for market threats", where it is stated that "*the market threats can arise from shifts in consumers attitudinal trends, like environmentalism*" [2], this thing being characterized as belonging to the *derived demand*, usually associated with a low level of risk.

The system has an open character, the feed-back mechanism being built up on consumer's reactions and according to the shifts in the external environment, and from this perspective, we consider that the main competition between the new and the old type of industry will be undertaken by the Customer Relationship Management (CRM) dimension, the Marketing function quantifying the consumers' importance for a certain business, the market segmentation itself being made from LifeTime Value point of view, estimated on customers current value, potential and loyalty.

The same principle lies at the basis of the new concept of developing the marketing strategy, better focused and balanced, that has as a main objective the maximization of the Net Marketing Contribution (NMC).

In fact, CRM itself, part of the intangible goods, became a key-element of the company's global strategy.

However, in order to grant the success, modern concepts of activity organization, coordination and control need to be applied at the bio-refineries level in order to obtain high quality finite products (both bioethanol and biodiesel presenting some disadvantages from their chemical composition and/or impurities perspective). The quality system has to adapt to sustainable development concept, according to which the success is achieved only when the environmental and social problems (including regional development) are properly approached.

Moreover, the concept of total quality system is substantiated at the level of internal processes of a company, a naturally valid aspect for a bio-refinery, on Just in Time (JIT) type of organization, managed by specialized software on its three dimensions: Production-Marketing-Development.

Critical Views on the Bio Solution

The alternative represented by the biofuels to the problems generated by the energetic crisis is not one without drawbacks.

The main negative effect of this kind of industry development is represented by the *unbalances that it creates on the food markets at global level*, because the raw material used is the same with the one allocated for food production.

[2] Meredith, L., Scanning for market threats, *Journal of Business&Industrial Marketing*, no. 4/2007, volume 22, pp. 213, Emerald Group Publishing Limited

Secondly, *the negative effects for the soil fertilization* have been brought to the specialists' and public opinion's attention, as it loses its natural properties and the productive potential because of the monocultures and excessive use of chemical products.

At the same time, producing biofuels at the industrial scale is going *to encourage the genetic modified cultures*, in such a way that species with high content of sugar or oil will be preferred even if their impact on the environment is not yet enough known.

Another problem generated by this energetic alternative is represented by *the excess of derivative products, hard to commercialize on a saturated market* (for example the glycerine) or to recycle into an environmental friendly manner (without producing greenhouse gases).

With a view to solving these situations there have been some suggestions that have as objectives their transformation into soil improvers, designed so as to decrease its acidity and to stimulate the development of desired micro organisms. Considering all these aspects, when the biofuels are evaluated it is recommended to be taken into account the fact that even the technical crops used to make them emit greenhouse gases.

On the other hand, it is necessary to analyze from the economical point of view *the relation between the energy obtained and the energy invested*, being proved the fact that the former is decreased for biofuels, especially if the engines' efficiency is taken into account (tank to wheel – TTW – Annex no. 2).

Conclusions

The present paper describes the opportunity created for the Romanian agriculture and industry by the shifts in the European energetic policy and their impact on our country's regional development.

Industrial crops, not so well known and cultivated, with major advantages from the point of view of profitability and pedo-climatic conditions that they need to grow up, can become a *source of competitive advantage* for the Romanian regions ready to develop the new agro-industrial type.

Throughout this paper, we have emphasized the role of sweet sorghum for the sandy soils, and the rape's suitability for fields that are not adequate for cereals crops, the land being protected and, consequently, preventing the unbalances that could come up on the food market.

The estimation of the car park's evolution substantiates the necessity to intensify the researches undertaken in order to conceive a new catalyst for gas emissions' purification, similar to those for Diesel engines, in Romanian specialty literature being already proved the fact that if a catalyst plated with platinum materials is used, "*the efficiency of pollutant reduction is practically equivalent to the catalysts with platinum materials*" [3] under more advantageous cost conditions.

Moreover, it is recommended to evaluate the feasibility of developing new equipments necessary to adapt the current technologies from the automobile industry to the new types of fuels.

The article also includes a management model in which we have pointed out the interactions that are going to develop, horizontally and vertically, when the new type of commercial enterprise, the *bio-refinery* will be integrated in the economic system, emphasizing the importance of approaching this aspect from the marketing and total quality concepts perspective, both of them having implications on the regional development dimension.

[3] Sandu, V. et all., Developing some catalysts in order to purify emissions gases from Diesel engines, *The Chemistry Magazine*, Bucharest, 58, no. 8, 2007, p. 763

At the same time, we have emphasized a few negative implications that could be directly related to the biofuels industry development and it is recommended to take them into account when the national strategy in this field is elaborated.

Annex 1. *Data used in order to estimate the total auto park for 2010*

Years	Buses	Microbuses	Cars	Motor bicycles	Motorcycles	Merchandise motor vehicles	Total Auto Park
1990	24,297	3,975	1,292,283	206,202	105,444	258,701	1,890,902
1991	25,199	5,956	1,431,566	207,473	108,006	259,566	2,037,766
1992	26,847	8,232	1,593,029	214,019	108,737	275,487	2,226,351
1993	28,085	9,646	1,793,054	212,854	113,651	298,318	2,455,608
1994	28,862	11,155	2,020,017	204,496	121,205	322,417	2,708,152
1995	30,365	11,682	2,197,477	205,032	122,692	343,064	2,910,312
1996	27,372	12,143	2,326,177	160,073	94,923	376,817	2,997,505
1997	27,426	12,532	2,447,087	153,768	96,742	390,181	3,127,736
1998	27,399	12,986	2,594,571	146,725	98,994	405,743	3,286,418
1999	27,317	13,305	2,702,071	141,490	101,093	417,780	3,403,056
2000	27,181	13,535	2,777,594	137,103	102,105	427,152	3,484,670
2001	26,965	13,826	2,881,191	134,152	103,749	437,968	3,597,851
2002	26,672	14,108	2,973,390	132,955	105,525	447,299	3,699,949
2003	25,829	16,118	3,087,628	132,880	102,970	463,099	3,828,524
2004	25,421	17,771	3,225,367	130,193	104,509	482,425	3,985,686
2005	21,976	17,297	3,363,779	103,556	93,845	493,821	4,094,274
2006							4,104,835*

Source: *Processing on Romanian Statistical Yearbook, NIS 2006*
** Official press release of MIAR, www.mai.gov.ro*

Annex 2. *The energy obtained compared to the invested one for biofuels*

No.	Product	The production and distribution efficiency	The internal burning engine efficiency	The production, distribution and usage efficiency
1	Petroleum	10	0.3	3.0
2	Rape biodiesel	3.2	0.45	1.44
3	Biodiesel from used alimentary oils	5	0.45	2.25
4	Biodiesel from alga	>5	0.45	>2.25
5	Bioethanol from corn	1.34	0.3	0.402
6	Bioethanol from cellulose	2.2	0.3	0.66
7	Hydrogen from natural gas	0.528	0.405	0.214

Source: Oancea Florin, *The bioconversion of the products resulted from biofuels fabrication*, article in *Sweet sorghum crops and its completely industrialization. A perspective for sustainable development of Romanian agriculture*, coord. Ioan Antohe, second edition, Chiminform Data SA Publishing, 2006, pg. 207.

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Biocarburanții în România – oportunitate strategică națională

Rezumat

Articolul îşi propune a defini locul biorafinăriei în sistemul economic românesc, prezentând atât plantele tehnice evaluate de autori a fi cele mai pretabile obținerii de biocombustibili, cât şi, sintetic, tehnologia în domeniu.

De asemenea, prin estimarea pieței potențiale în acest domeniu se evidențiază posibilitatea dezvoltării unui avantaj competitiv pentru anumite regiuni ale României, în cazul în care integrarea noilor produse va fi făcută conform conceptelor de marketing şi calitate.