CONSIDERATIONS ON ENERGETIC CROPS POTENTIAL

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ABSTRACT

In order to breathe fresh and clean air, nature and terrestrial atmosphere should be preserved and protected. Carbon emissions represent one of the main enemies of air quality. Recently, carbon emissions have surpassed all the predictions because the excessive industrialization, becoming the determining factor for global warming. A viable alternative to carbon emissions reduction is the utilization of energy sources that can diminish the noxious substances emissions up to zero. This can be done by using the power of wind, sun, water, energy plants, etc. Among the energetic potential plants, the biomass is obtained- a form of renewable energy which final product is biofuel.

INTRODUCTION

In Romania, the energetic crops may be cultivated in fields without any special works of improvement. After a minimum processing, the energy resulted after the valorization of biomass, namely thermal power, biofuel, biogas-can be gradually include in the distribution system of existing energy.

In its attempt of diminishing the carbon emissions, The European Commission proposes as compulsory goal, that by 2020, one fifth out of the energy produced be generated by renewable sources, the energy plants enabling this. European level policies envisage a clear coordination of energy cultures and those crops designed to food so that each country could establish an appropriate land use, in order to obtain both sustainable food and energy production. [5]

Through the European Funds, the measures from the National Program of Rural Development 2014-2020 that supports the projects designed to obtain energy from renewable sources, are:

Measure 4 ”Investments in physical assets” support among other things, the investment in installations of producing electric and/or thermal power through biomass use. Total financial allotment for the period 2014-2020 is of 2.4 billion euro.

At the same time, the local interest measures that could be funded by measure 19 ”LEADER Local Devlopment” encourage among others the investments related to utilization of heating sources based on biomass, creation and development of biogas at community level. Total funds allotment for the period 2014-2020 is of 563.5 billion euro. Therefore, following these supporting measures, the number of farmers cultivating energetic plants is increasing year by year. [6]

MATERIAL AND METHOD

Renewable energy represents an extremely attractive field for business people as the production costs are not too high, the European Commission

imposing a reduction of carbon emissions.

Thus, in future years, the green energy will continue to develop at a rapid pace, due to costs diminishing.

Studies have shown that, in 2040 the renewable energy will cover 70% out of Europe electricity production succeeding to surpass the natural gas sector in United States of America.

In 2015, renewable energy covered 32% out of Europe electricity production.

In this context, the energy willow represents a viable alternative source of generating renewable energy. It resembles the fossil fuels like coal, fuel oil and crude oil, but the emissions released by energetic willow are almost null.

Energetic willow

Energetic willow is a rapid growing plant of approximately 3 – 3.5 centimeters per day, generating during the first year 1-3 offshoots and reaching about 2-3 m height. At the same time, the crop maintenance is simple, because the majority of works are performed before and at the beginning of growing, according to Company KWG – Energetic Willow.

Willow grows very fast, in the second year of planting generating 10 – 25 offshoots, out of which approximately half reach 6 – 7 meters of height and 5 – 6 centimetes diameter.

Fig. 1 – Energy willow

Fig.2 - Acacia [9]

Fig.3 – Paulownia plantation[10]

The plant advantages are its resistance to different climate conditions, the possibility to grow in swampy lands, sandy soils and reduced productivity fields.

Furthermore, besides these characteristics, the energetic willow has also a series of assets justifying its wide range spreading in Member States of European Union. Due to these features, the energetic willow is subsidized in certain member states of European Union.

From willow stems, biofuel is produced (briquettes, pellets) with high caloric power (almost equal to coal's).

Energy willow has a high caloric power, namely 18,000 – 19,000 kJ/kg

Period of life of an energy willow plantation is of 25 – 30 years and, starting from the second year, and except the harvesting, it does not need any other additional investment, but only chemical fertilizers applying for increasing the productivity.

Another benefit is given by the fact that due to high content of salicylic acid, the chopped willow does not need closed storage. After several months, the water content reduces up to 14 – 16 %, allowing the processing of plant without artificial drying. [8]

Acacia

Acacia is another very profitable energy plant, which culture is established

in autumn. Acacia plantations are established in agro-forestry regime, because this regime does not respect the strict requirements of Forestry Code. A great benefit of this culture is that of growing in the poorest soils, even in uneven areas. After it is planted, the acacia offshoot springs rapidly and its growing speed is impressive, namely of 2-2.5 meters per year. Therefore, the first harvesting is possible in the first year. Starting from the second year, because the acacia gives many offshoots, the biomass quantity obtained double from 8-9 tons/ha to 20 tons/ha. Biomass production obtained will reach 20 tons/ha starting with the third year, with a steady yield during a 20 years period. [7][9]

Paulownia

This species has existed and is existing in Romania since 1973, but only with ornamental uses and not at all in purposes of biomass or timber production; big exploitations are established in Germany, Hungary or Spain – the countries with the largest surfaces in EU. In Romania, farmers were a little reluctant, at first. There are 28 varieties of Paulownia, and those existing in our country were not appropriate for agricultural exploitations on large surfaces. In Romania, the following species are able to appropriately adapt in terms of climate and soil conditions: Paulownia tomentosa, Paulownia Shang tong and Paulownia elongata, Artic Paulownia Fortune Paulownia", (that is the specialist's recommendation). Another important recommendation is relating to pH of soil where planting is made and that should be between 4.5 and 7. Plantation irrigation is essential.

Even from the first year, the little plant of 20-30 centimenters reaches an average height of 3 meters. An important care should be given to plantation maintenance. The maintenance works performed are reasonable in terms of cost. Thus, Paulownia needs fertilization, two hoeing operatios a year and almost a monthly trees canopy cutting. At the same time, irrigation is very important for maintaining Paulownia crop.

Harvesting is made after the fourth year from the crop establishment, but as for capitalization of Paulownia culture everything depends on the type of exploitation chosen. Thus, the tree may be also cultivated in ornamental purpose, for beekeeping, for biomass or timber. Wood harvesting is made in the fourth year of exploitation, when tree diameter reaches 18 centimenters, obtaining an average of 0.5 cubic meter from one tree, at a price of 100 euro/cubic meter cubic of wood. Farmers are interested in investing in Paulownia not only for timber, but also because it can be considered as a forestry belt which establishing expenses are covered by European funds. Besides farmers, different institutions and city halls from Romania and Moldova Republic were interested. [10]

Camelina

Camelina is an energy plant used for obtaining bio - kerosen (fuel used by airplanes) and represents a solution for farmers who are not able to plant rape, because of draught. For Romanian farmers, the variety of Camelia camelina has been created by INCDA Fundulea, Romania.

The morphological features of this plant are: seed contains erucic acid. Plant has significant average and total height (including the branches). Leaf is medium green and porose. Blossoming is rather early. Flower petals are yellow, being short and narrow. Length of silicve is average and its top is short. Camelia variety presents a good resistance to winter, draught and shaking conditions.

Fig 4 – Culture of Camelina[11]

Fig. 5 – Miscanthus crop

Mass of 1000 grains is of 1.2 g., and hectolitre mass is of 66 kg. Quality characteristics: oil content from seeds is about 33.8%.

Production capacity variety of Camelia camelina was obtained during three years of trials, in ISTIS network with an average production of 2210 kg/ha. It can be cultivated in Romania's areas appropriate to this crop.

Due to its tolerance to frost, draught and shaking, camelina is an alternative to rape for Romanian farmers. Expenses necessary to establish one camelina hectare are smaller than for wheat or rape. [11]

Miscanthus

Miscanthus crop is an ecological and economical culture. Usually, after the first year, no field treatment is necessary. For 20-25 years there are not any annual costs related to seeds / rhizomes and field works, as Miscanthus is a prennial plant with high energetic potential.

Plant roots can reach 6m depth in search of water. The fields planted with Miscanthus can easily allow to other types of crops to grow on. It can be planted in certain soils less advisable for other cultures. Miscanthus is excellent for carbon capture, regenerates and stabilizes the soil. Production estimates – approximately 20 tons per hectare. Reduction of carbon emissions potentially generates incomes by green certificates. Miscanthus grows without fertilizers (during winter, all the leaves fall down and act as natural fertilizer). Miscanthus can be also cultivated in polluted soil without extracting the toxical elements from them. It can be used as protection belt around the stored garbage and toxical wastes, for roads against the snow storms, for seed crops. Harvest is simple, made with a combine or balling presses. The collected materials can be easily stored, drying being not necessary. Energy plant Miscanthus belongs to category of plants C4, is very strong and perennial, originating from Asia. Being a sterile grassy plant, it multiplies only in vegetative way, by rhizomes and Arge Miscanthus offers high quality rhizomes imported from Austria. Miscanthus should be planted in spring and remains in the soil for at least twenty-twenty-five years. In the first year from planting it must not be harvested, it is without efficiency, economically speaking and is left in the field. The subsequent year, in spring, Miscanthus is getting higher, leaves fall down again in autumn/winter, offering the necessary nutrients to soil but also natural herbicides. Miscanthus is harvested at the beginning of spring. This cycle repeats year by year.

Hemp

The height of certain plant varieties in fiber culture is of 3-3.5 m, and in seed culture can reach 5 m. Stems are strongly developed, being dark green with 9-12 blades), reaching 40 mm thickness diameter. Fruit is one light grey ovoid nut with mosaic. Mass of one thousand of seeds is ranged between 16 and 18 g. As for the physiological characteristics, it has

noticed a period of growing of 130-140 days in fiber culkture and of 170-180 in seed culture. [12]

Fig. 6 – Hemp crop

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Fig. 7 – Energy poplar

Among the textile plants suitable to temperate climate, hemp ensures the biggest quantity of fibers per hectare (2.2-3.5 t/ha). High yield of fibers and stems per hectare, as well as their valuable features constitute the great assets of this plant in the future. Wood represents up to 55% out of stem weight and has high caloric value (3300-3700 calories), the materials obtained by processing being a very good biofuel. At the same time, they may be used to obtain cellulose, chipboards, insulating boards [1], [12]

Cereals

Corn and wheat are the main cereals from which bioethanol is obtained. Corn is the most efficient method of obtaining bioethanol. One ton of bioethanol is obtained from about 3 tons of corn (costing 90 euros/ton) and is sold with over 700 EUR, being a profitable bussiness. Though, intensive corn crop for bioethanol requires larger quantities of pesticides, which damage the soil. Furhermore, if corn was preserved as the main biofuel source, the harvest designed to food would diminish and a food crisis would be imminent. [5]

Energy poplar

Energy poplar has multiple utilizations: pellets, briquettes, furniture industry, cellulose, etc. As energy plant, it is mostly cultivated on North American continent, hybrid varieties being used. I Romania, this culture is a perspective crop. [5].

Artichoke

Artichoke is a plant from which tubers are mostly used. Romanian market is not yet developed to face this plant benefits. The plant stems are used for producing pellets and briquettes for heating, in thermal stations, and tubers can be successfully used for obtaining biomass for biofuel or in alcohol industry. [6]

Artichoke is not a pretentious crop, it is tolerant to extreme temperatures, to summer draught and spring or winter low temperatures due to its deep root system. Young or mature plants resist even at temperatures below 0ºC up to -5-6ºC. Tubers can easily resist to winter temperature, even at extreme temperatures of -30-40ºC. It is not a pretentious plant in terms of soil. But, positive results can not be obtained in heavy, excessively wet soils; the plant is appropriate to meadow sandy-loamy loosen soils, rich in humus and calcium, with pH-ul of 6-7.5. Though, it is a light demanding plant and prefers soils exposed to sun light.

Fig. 8 – Artichoke crop

Fig. 9 – Culture of saccharate sorghum

Studies performed up to now at S.C.D.L. Buzău have shown that the most appropriate variant of a crop establishment is that of 70 cm distance between rows and 30-35 cm density between plants/row, thus ensuring a density of 30-35, 000 plants/ha. When it is used a gravity system of irrigation in harrow, the field should be ridged, and planting made directly in ridge at 12-16 cm. When drip irrigation is used, the field does not need to be modeled. In non-irrigation crop system and during draught years, production significantly diminishes both quantitatively and qualitatively, most of tubers remaining undeveloped. Quantity of tubers necessary to establish one ha of crop is of 1000-1200 kg. This is the orientative quantity, but the size of tubers is very important, as bigger tubers can be broken, although this species has a great capacity of regeneration and tubers shells arrived in soil, multiply.

Sorghum

This is a herbaceous plant resembling to corn, also named „camel plant", because its capacity of developing there where any other plant could not resist to grow. It is a productive plant, less demanding to soil fertility and resistant to draught; also, its cultivation and processing are done with minimum expenses. Sorghum is successfully used for obtaining bioethanol. [5]

Being environment-friendly, the saccharate sorghum cultivated on large surfaces could solve the problem of air pollution, as, 1 ha of saccharate sorghum annually absorbs up to 50-55 t carbon dioxid from atmosphere, while the deciduous trees absorb 16 t/ha/year dioxid and cereals-3-10 t/ha/an. According to Kyoto Protocole, Romania and Bulgaria have all the possibilities of earning a lot, only by cultivating the saccharate sorghum in large surfaces, as one ha of saccharate sorghum yearly absorbs 50-55 t of carbon dioxid, eliminating important quantities of oxygen[2].

RESULTS AND DISCUSSIONS

In compliance with current regulations, biomass is „the biodegradable fraction of products, waste and residues of biological origin coming from farming (including vegetal and animal substances), forestry and related industries, including fishing and aquaculture, as well as biodegradable fraction of industrial and municipal waste."Agricultural biomass comprises the plants by-products, such as straw, stems (sunflower, soy), leaves (beet), pods (soy, beans), shells (nuts, peanuts), plant seeds (plum, peach, apricot) and

farm garbage. On the other hand, large scale biomass production involves the cultivation of numerous species of plants, the most important being Miscanthus giganteus, switchgrass (Panicum virgatum), hemp (Canabis sativa), corn (Zea mays), poplar (Populus sp.), willow (Salix sp.), sorghum (Sorghum sp.) and sugar cane (Saccharum officinarum), [15] artichoke, camelina (inisorul), poulownia, acacia, rape, wheat, potato, etc.

Thus, on one hectare of saccharate sorghum can be obtained over 3 t de ethanol of 78 mln potential, Mgj and dried vegetal mass of 20 t with energy of 314 thousand Mgj. One rape hectare produces one ton of oil, that is equivalent with one ton of Diesel oil (indicatively) and dry matter of 3 t with a caloric power of 47 mln. Mgj.

Ethanol obtained after fermentation of sachharated jus may be add to petrol (20% ethanol) as fuel for spark ignition engines and the rape oil, after being turned to methyl ester-as fuel for compression ignition engines [3], [4].

The most known types of biofuel, their content and several economic and technical characteristics [13]

Biofuel	What does it represent?	Arguments Pro	Arguments Against
Agricultural biomass ethanol	Alcohol obtained through fermentation of cereals, technical plants and other vegetal sources	Fuel with big octanic figure and reduced greenhouse gas emissions	Difficulties of transport through pipes; it consumes high quantities of agricultural food or foddering biomass.
Lignocelulosic ethanol	Alcohol obtained by converting lignocelulosic biomass to fermentation carbohydrates followed by their fermentation leading to ethanol.	Fuel with big octanic figure and reduced greenhouse gas emissions. It does not use food or fodder raw materials.	Difficulties of transport through pipes. It is more expensive than ethanol obtained from cereals.
Biogas	Gas mixture where prevails methane obtained by anaerobic fermentation of garbage or other agricultural, household or industrial wastes or by-products	The raw material is without value; it has an important role in waste management. It represents an energy source for rural communities or world poor areas.	It hardly liquefies; therefore, it is of no use for transport. It has a heterogenous composition depending on raw matter and technology.
Biodiesel	It is a fuel similar to diesel oil, being obtained from vegetal oils.	Reduces emissions and acts as lubricating element for engines.	Difficulties of transport through pipes. Not all the manufacturers of engines and vehicles prefer biodiesel.
Renewable diesel oil	It is similar to common diesel oil,	It is in accordance with norms related to diesel oil	Emissions are higher than in case of

	obtained out of vegetal fats and hydrocarbons.	with low sulphur content, animal fats added improving its ignition features; can be transported by pipes.	biodiesel
Biobutanol	Alcoholic fuel similar to ethanol	More easy to transport, less corrosive than ethanol	It has not obtained yet at high capacity

CONCLUSIONS

Energy potential plants have been rapidly developed due to new energy plants discovered cultivated in the whole world and also to performances of new varieties of hybrid plants obtained from the existing ones. These new varieties can be easily bound, resist to draught and frost, resist to deseases and pests and can be planted in soils where other plants fail to develop, thus, enabling big yields.

At those said above, we may add their multiple uses, namely in food industry, building material industry, textile industry, pharmaceutical industry and also animal foddering. Being plants at which roots, stems, leaves, flowers, tubers, seeds, pods, fruits are all capitalized, we are convinced that energy plants will be the plants of the future.

BIBLIOGRAPHY

1. **Trotuş E., Lupu C., Druţu A.C., Pochişcanu S., Găucă C., Naie M., Popa L.D., Leonte A.,** 2015 – Cultivation technologies of field plants in Moldova centrall area. Publishing ”Ion Ionescu de la Brad”Publishing House, Iaşi. ISBN 978-973-147-178-5.

2. http://biofuels.dbioro.eu/index.php?pag=ep2

3. http://ies.gov.md/2014/09/producerea-biomasei-prin-cultivarea-plantelor-energetice/

4. **Hăbăsescu I., Cerempei V., Deleu V**., 2009 - Biomass energy: Technologies and technical methods, Chişinău, 2009, p.365.

5.http://www.jurnaluldeafaceri.ro/avantajele-investitiilor-in-plante-energetice/

6.http://sfatnaturist.ro/afacere-cu-topinambur-cum-il-cultivi-cum-il-ingrijesti-si-unde-il-vinzi/

7.https://adevarul.ro/locale/pitesti/cele-mai-eficiente-plante-energetice-cultivate-romania-rentabile-culturile-salcie-salcam-1_59ed8ae55ab6550cb865d236/index.html

8.http://www.jurnaluldeafaceri.ro/o-afacere-de-succes-salcia-energetica/

9.https://www.google.com/search?q=salcamul+energetic&tbm=isch&tbo=u&source=univ&sa=X&ved=2ahUKEwjr1t3xmd3cAhUGLewKHWurBgMQsAR6BAgCEAE&biw=1280&bi

10.http://agrointel.ro/29486/plantatie-paulownia-in-romania-profit-vanzarea-lemnului/

11.https://www.gazetadeagricultura.info/plante/plante-tehnice/13006-camelia-un-nou-soi-de-camelina.html

12.http://www.incdafundulea.ro/anale/84/84.13.pdf

13.http://www.biocombustibil-tm.ro/p1/prezentare.html