ENERGY PLANTS ALTERNATIVE TO FUTURE BIOFUEL PRODUCTION

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ABSTRACT

Replacing fossil fuels with alternative renewable energy sources is a very current issue worldwide. The development of energy plant (lingo-cellulosic) crops represents the promising solution, for the future production of biofuels in order to produce renewable energy and replace fossil fuels. For the implementation of energy crops were elaborated a series of technologies and technical equipment that respond to the requirements of these crops. The paper addresses these technologies, technical equipment and technologies for valorizing energy crops.

INTRODUCTION

Replacing, at least partially, the use of fossil fuels with other energy sources, will contribute to preventing the global warming phenomenon. Industry is the economic sector with the highest contribution to environmental pollution, by its large quantity of gaseous, solid and liquid pollutants released in the environment – air, water, soil, [5].

Important emissions of pollutants in the atmosphere produced by the energy industry also affect other elements of the natural environment (soil, vegetation, fauna) and large quantities of waste are generated.

Currently, energy is obtained mostly from mineral energy resources: coal, petrol, natural gas. The reserves of these fossil fuels are exhaustible.

In the process of burning coal, in the atmosphere are eliminated dust, soot, sulfur, chlorine, fluorine, zinc, lead, nickel, etc. In big cities, as well as in industrial centers, these emissions form smog, [6].

Basically, using fossil fuels raises two main problems: their reserves are exhaustible, but especially, their use leads to environment pollution through harmful emissions of carbon dioxide and sulfur and nitrogen oxides. The answer to the two big problems is represented by – renewable energy – energy crops, their use leading to a significant reduction of the quantities of carbon dioxide gas emissions in the atmosphere, which cause the so called "greenhouse effect".

Energy crops that produce biomass used in energy purposes are:

- Starch-producing crops: cereals, potatoes;
- Sugar-producing crops: sugar cane, sugar beet;
- Oil-producing crops: rape, sun flower, camelina, etc;
- Ligneous-cellulosic crops: willow, poplar, Miscanthus, artichoke, Cynara, Panicum, etc.

Compared to the natural varieties, energy crops ensure:

- Bigger yields on the surface unit, leading to the improvement of their quality / price ratio compared to conventional crops;
- The reduction of the necessary land;
- The reduction of chemical substances associated with the field as well as transport expenses.
  - Energy plants can be grown on agricultural lands that are not currently being used for agriculture, usually on fields that are removed from the agricultural circuit due to various reasons, on fields considered to be unsuitable for growing plants that provide food for humans and animals.

- Compared to traditional agricultural plants, energy plants require less care and less mineral fertilizers and pesticides.
- Future biofuel production is based on these energy crops (ligneous-cellulosic crops) because they represent a promising solution for the energy security at a world level, due to the cyclic nature of the biomass resulted from these crops.
- Based on these considerations, in recent years, crops of energy willow, energy poplar and Miscanthus have developed, being used as energy source as well as in other fields.
- Crops of energy willow (Salix Viminalis) and energy poplar for biomass are practiced in agricultural areas and not on land exploited in forestry.
- Crops can be established:
- on slopes, fixing the soil and improving its quality;
- on heavily degraded lands: on tailing dumps, on saline, eroded, sandy soils, achieving bioremediation of the polluted soils by assimilating excess ions;
- on wetlands (are recommended);

Willow’s high calorific power of 4900 kcal/ha, makes it comparable with other fuel sources such as: natural gas, coal, oil, [7].

Willow biomass is a fuel with neutral carbon that participates to the reduction of global warming.

Willow can be transformed in resources that do not pollute, including:
- heat and electricity through direct combustion, burning together coal and gasification;
- biodegradable plastics and other polymers;
- biofuels.

Energy willow can be successfully used:
- in the pharmaceutical industry (obtaining aspirin);
- riparian buffer – natural barrier that prevents chemicals from penetrating rivers and lakes;
- has the capacity to retain contaminants from used waters;
- barrier against snow – planted strategically within shelter belts for agricultural crops, willow can prevent snow blizzards from reaching crops.

Energy poplar varieties are used for:
- producing energetic biomass;
- decreasing ground water pollution, using residual water from communities for the irrigation and fertilization of plant crops that have short production cycles (2…3 years);
- timber and lightweight packaging;
- fibro-wood boards and plywood;
- agro-forestry shelter belts for the protection of agricultural crops.

Miscanthus crop has become increasingly spread worldwide due to its economic advantages, but especially due to its positive effect on the environment.

According to studies conducted worldwide, mature Miscanthus crops can produce 48.5 tons of dry mass per hectare, with an energetic conversion of 1.2-2% of the incident solar radiation.

Miscanthus plants can be used for producing electric and/or thermal energy both in:
- large power plants (30 MW +) that use thousands of tons of biomass annually;
- small house systems that use a few tons, during winter months.

In the case of Miscanthus, CO_2 emissions resulting from burning are equal with the CO_2 quantity used by the plant during vegetation and thus the process is neutral in terms of “greenhouse gas” emissions.

MATERIAL AND METHOD

For the implementation of energy plant crops were elaborated a series of technologies and technical equipment specific for each crop for establishing, maintaining and harvesting the crops. Figure 1 shows the technology for establishing and harvesting an energy willow crop and the equipment corresponding for this crop.

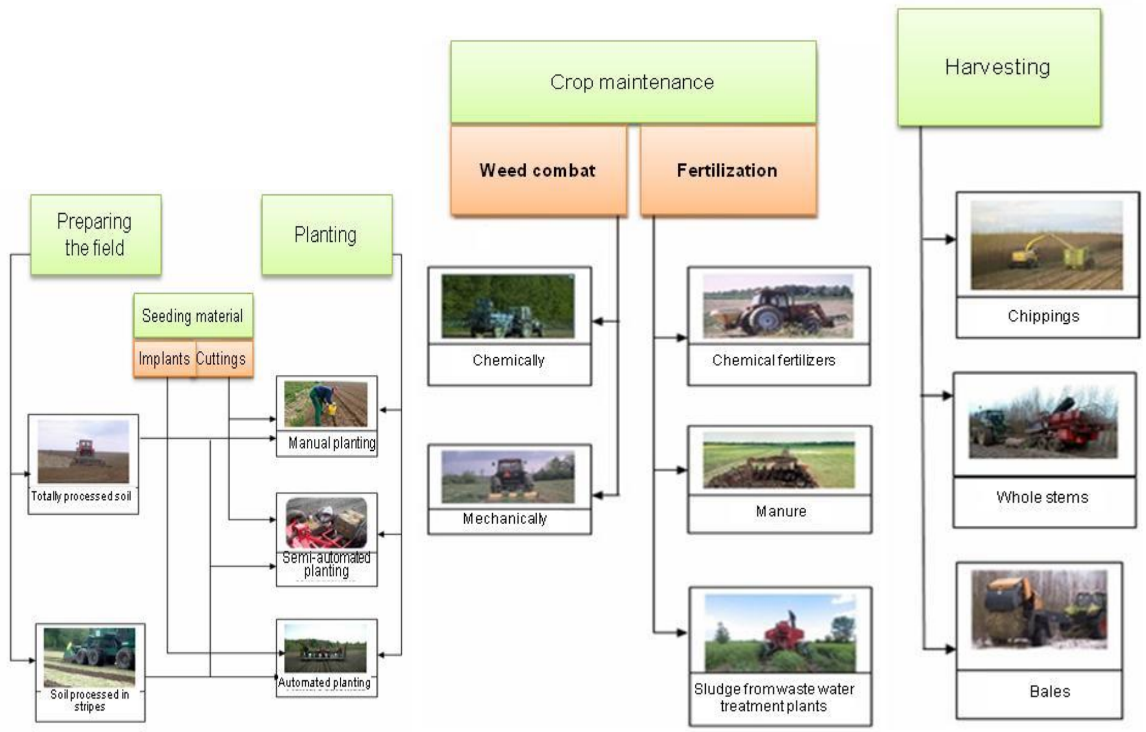

Fig.1 – Technology for establishing, maintaining and harvesting an energy willow crop, [1,2,3,4]

In order to meet all the requirements of the market for equipment destined solely for energy crops, energy willow and poplar, INMA designed a functional model for planting energy willow, figure 2, which meets the requirements of these crops.

Fig. 2 – EIS technical equipments for planting energy willow (Salix Viminalix) [1,2,3,4]

-The technical equipment, of the type carried during transportation and operation, operates in aggregate with 80-150 HP agricultural or forestry tractors on wheels and is destined for the mechanized planting of normal cuttings (18-20 cm), in different schemes and guided work depths, of energy willow as a source for the production of biomass or as shelterbelts.

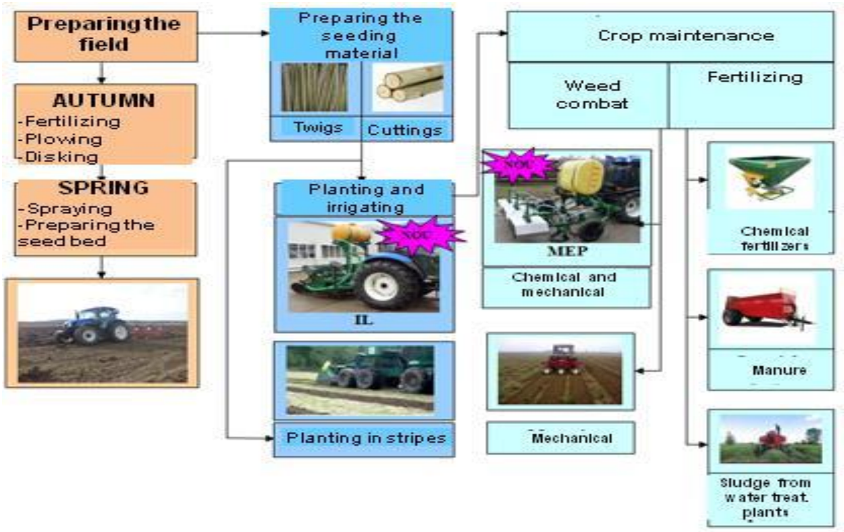

Fig. 3 - Technology for establishing and harvesting an energy poplar crop (POPULUS HIBRIDUS) [1,2,3,4]

The installation for localized irrigation IL-o with the technical equipment for planting energy willow (Salix Viminalix), figure 4, and the Equipment for precision hoeing and spraying in strips MEP, figure 5, are destined for the mechanization of irrigation works when establishing and maintaining the energy crops or shelter belts of energy willow or poplar and represent functional models designed by INMA for the energy poplar technology.

Fig. 4 - Installation for localized irrigation - IL-0, [1,2,3,4]

Fig. 5 – Equipment for precision hoeing and spraying in strips – MEP, [1,2,3,4]

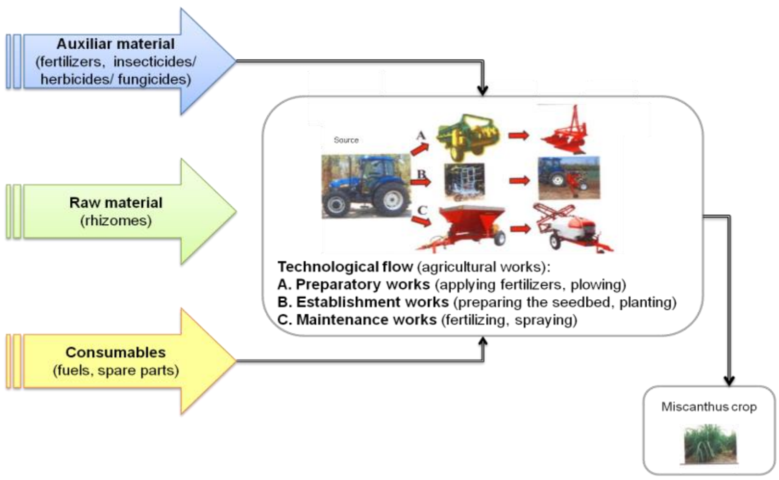

Fig. 6 – Technology for establishing and harvesting a Miscanthus crop, [1,2,3,4]

In order to establish a Miscanthus crop, INMA Bucharest built a machine for planting Miscanthus rhizomes. The MPM 4 machine for planting Miscanthus, figure 7, which works in aggregate with 65 HP wheeled tractors provided with a mechanism for three-point linkage.

Fig. 7 - MPM4 machine for planting Miscanthus, [1,2,3,4]

For the operation of harvesting rhizomes, INMA Bucharest designed a specialized machine called technical equipment for harvesting Miscanthus rhizomes – ERR, figure 8, an equipment carried on the three-point linkage mechanism of 70…80 HP tractors.

Fig. 8 – Technical equipment for harvesting Miscanthus rhizomes – ERR, [1,2,3,4]

INMA Bucharest designed and built a specialized equipment for harvesting Miscanthus stems directly in the field, called EPI, figure 9, an equipment that was assimilated into production by SC MECANICA CEAHLĂU Piatra Neamţ.

Fig. 9 - Towed combine for harvesting fodder CTF with the equipment for harvesting Miscanthus, [1,2,3,4]

RESULTS AND DISCUSSIONS

The working process of the *Technical equipment for planting energy willow (Salix Viminalis)* implies carrying out three operations:

- opening the channel by the plowshare;
- planting the energy willow cutting, performed by the planting mechanism;
- compacting the soil by the wheels of the compacting and entraining mechanism.

Opening the channel implies cutting the soil in a vertical plane on a depth “a” and a width “b”, deforming and displacing the cut soil in a horizontal plane, in order to achieve the channel. Planting is performed by the planting mechanism in two rows with 75 cm distance between them. In order to achieve a planting operation with superior quality indices, the field should have an adequate processing state, characterized mainly by the depth and the grinding degree. After testing the functional model was found that the equipment can perform:

- planting willow cuttings with lengths between 180…250 mm;
- planting on two rows at 75 cm distance between the rows;
- Distance between two cuttings (along the line), cm: 50…100;
- Diameter of the cuttings, mm: 5…25.

The installation for localized irrigation IL-0 – is mounted on the EIS technical equipment and is destined for localized irrigation, simultaneously with the mechanized planting, in different schemes and working depths, of energy willow poplar (Populus hibridus). The installation was tested when establishing an energy poplar crop, and the following technical and functional characteristics were obtained:

- power of the tractor used for planting, HP:80;
- number of stations of the planting machine, pcs.:2;
- water tank capacity, l:300;
- quantity of water that can be distributed to a cutting, l/cutting: 0.1...0.3;
- minimum distance between the cuttings of the row, cm 70;
- number of target plates on a station, pcs: 4.

MEP Equipment for precision hoeing and spraying in strips is destined for the maintenance of energy crops, performing simultaneously or individually the operations of hoeing and protected spraying between the rows of plants.

During the tests performed with the functional mode were obtained the following technical characteristics:

- power of the tractor, HP 45;
- capacity of the liquid tank, l 500;
- pump flow, l/min 104;
- pump speed, rot/min 540;
- max. working pressure, bar 20;
- type of hydraulic motor OMP 100;
- max. torque., Mm 230;
- max. flow., l/min 75;
- no. of hoeing and spraying stations, pcs.3;
- no. of spraying nozzles per station, pcs.2;
- distance between spraying nozzles per station, mm 300.

MPM4 machine for planting Miscanthus performs the following operations:

- opening the channel where the planting material will be introduced by the plowshare of the station;
- introducing the rhizomes (one by one) by an operator in the guiding tube of the plowshare, at the right time and in the right position;

- covering the rhizomes with soil by a pair of spherical discs and pressing the soil with a metallic compaction wheel, situated behind the discs.
- After testing the functional model was found that the equipment can ensure the following technical characteristics:
- No. of planted rows, 4;
- Actual working capacity, ha/h 0.6...0.76;
- Distance between the rows 500…1000;
- Working width, m 2.5...4;
- Planting depth, cm 8...12.

  The ERR technical equipment for harvesting Miscanthus rhizomes performs the harvesting of Miscanthus rhizomes by displacing the soil on the depth of their layout (with the help of a plowshare for displacing), separates them from the ground particles by shaking them (through a separator with eccentric, actuated by a hydraulic motor).

Technical characteristics achieved at testing:

- Power of the tractor in the aggregate, HP 70...80;
- Working width, m 1.2;
- Working depth, cm max. 25.

The EPI equipment for harvesting Miscanthus is mounted on a towed CTF combine for harvesting fodder and works in aggregate with 65-100 HP tractors. The actuation of the working bodies is done from the tractor's PTO through a cardan transmission. The tests for the towed combine for harvesting Miscanthus stems – CRM1.6 were conducted on the experimental field cultivated with Miscanthus at INMA Bucharest where the combine worked in aggregate with the NEW HOLLAND tractor type TD 80 D.

Work quality indexes obtained after testing

Table 1

No.	Specification	M U	Values
1	Speed of the toothed rotor	rot/min	46
2	Speed of the blades	rot/min	288.5
3	Working width	m	1.6
4	Plant cutting height	mm	120 – 150
	Grinding degree	mm	10 – 100
5	Material loss	%	Under 5

CONCLUSIONS

The evaluation and profound analysis of the technologies for renewable energy and their current role in attenuating emissions of greenhouse gases, imposes itself as a necessity and in this context the present work aimed to bring forward valuable information regarding the implementation of energy crops in Romania;

Biomass offers not only food but also energy, construction materials, paper, medicines and chemicals

By using technologies and the equipment corresponding to these technologies it will be possible to implement energy plant crops on fields that are not used for agricultural crops: in slopes, fixing the soil and improving its quality, on highly degraded terrains -

tailing dumps, saline, eroded, sandy soils, achieving bioremediation of the polluted soils by assimilating excess ions; on wetlands (are recommended).

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