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WOOD BIOMASS FROM PLANTATIONS OF FAST- -GROWING TREES AS AN ALTERNATIVE SOURCE OF WOOD RAW MATERIAL IN POLAND

The article presents the results of research on the sources and potential of plantations of fast-growing trees in Poland, as well as the advantages and difficulties connected with them. Additionally, the paper describes the suitability of wood biomass from plantations of fast-growing trees for production and energy purposes. Moreover, the article outlines difficulties in the interpretation of such terms as “fast-growing trees”, “plantation crops”, and “plantation” in the context of place and activities connected with the procurement of biomass from outside forest ecosystems.

Keywords: fast-growing trees, plantation crops, wood biomass, survey

Introduction

Wood is a natural raw material, which is ecological at every stage of its use for material purposes. At the same time, it is one of the oldest carriers of renewable energy. This dualism characteristic of wood biomass, including biomass originating from fast-growing trees, defines the areas and lines of its possible use. Simultaneously, it poses dilemmas connected with the rationality of alternative applications of wood, i.e. its use for production purposes (for material processing) or energy purposes. This issue has currently become more important not only in Poland, but also on a global scale, as the management of wood biomass as an energy carrier is connected with the need to prevent adverse climate change

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resulting from the greenhouse effect, the indispensability of both the reduction of green house gas emissions, including mainly CO₂, and an increase in energy safety and the diversification of the available energy sources. Presently, there are in Poland few possibilities of consuming energy from renewable sources other than wood biomass (wind power, solar radiation, geothermal sources, aerothermal and hydrothermal energy, non-wood biomass, hydropower or the power of waves, currents and sea tides)¹.

The generation of energy from biomass, including biomass from fast-growing trees, is considered to be the fastest way for Poland to fulfil its international commitments concerning the production of electric energy and heat from renewable sources (the share of energy from renewable sources in terms of the gross consumption of final energy at a level of 15% by 2020 and 20% by 2030). In 2010, biomass carriers accounted for 85% of the production of renewable energy at a level of 6.9 Mtoe (tonne of oil equivalent). According to specialists, those carriers were dominated by wood biomass² within which the share of biomass from fast-growing trees was small and hard to unambiguously define.

Since recent years have witnessed deficits in raw wood material intended for material purposes, and a growing competition for wood demonstrated by the power sector (where, at the same time, relatively large forest areas are protected due to the environmental functions they fulfil), the optimum use of available and potential resources of various wood biomass types, and thus the alternative resource of biomass from fast-growing trees, is an important issue in the wood biomass market.

It should be stressed that despite the fact that the problem of the procurement of biomass from fast-growing trees is not a new phenomenon in the wood market, it was not until recently that this problem became a point of broad discussion and interest observed in business practice [Mroziński 2009; Rykowski 2009; Pudelko, Faber 2010; Sidor 2011; Faber 2012; Sawicki 2012].

Research methodology

The management of plantation crops of fast-growing trees and their development is of great importance, not only for economizing on forest raw wood material and

¹ The National Action Plan on Energy from Renewable Sources (adopted by the Council of Ministers in 2010 and amended in 2011) envisages that the set goals regarding use of energy from renewable sources will be achieved mainly by an increase in the production of electric energy from wind power and an increase in the energy use of biomass [Ustawa o odnawialnych źródłach energii 2012].

² In the consumption of solid biomass, the share of wood biomass is estimated to be 60% in public and industrial power plants, and 80% of individual consumption [Flakowicz 2011].

increasing the diversification of energy sources, but, due to its specificity (most often plantation crops are managed in the form of small and medium-size companies located close to the customer and using local resources), it has the possibility to dynamise economic and social development at a local level. These crops may and should be treated as a new area of agricultural production, an additional source of revenue and effective use of fallow land. Despite these aspects, the market in wood biomass from fast-growing trees is still barely recognized. In light of the above, it is important to begin research aimed at broadening knowledge of this market operation and of the opportunities and possible barriers to its development, especially when the rational management of available raw wood material resources is required and the fast growth of the potential of renewable energy sources is necessary [Szostak et al. 2012].

The aim of the research was to carry out a multifaceted analysis of the market in biomass from fast-growing trees in Poland, including mainly biomass intended for energy purposes.

The survey encompassed the main players in the market of biomass from plantation crops of fast-growing trees in Poland, i.e. agriculture, forestry, and the power sector. The survey basically covered the period 2010–2011.

Desk research was supplemented with a direct survey, encompassing suppliers and consumers of wood biomass from fast-growing trees, as well as public administration units as an additional possible source of information on the analysed issue.

The survey was sent to 194 respondents, of whom: 145 were planters of fast-growing trees, 32 public power plants, and 17 public administration units. 47 respondents answered the survey. Those answers were further analysed. The respondents were dominated by planters of fast-growing trees (64%). Public administration units accounted for 19% of the total number of surveyed respondents, whereas power plants accounted for 17% [Szostak et al. 2012].

Biomass from fast-growing trees – a systematization of basic terms

In subject literature, there is a considerable degree of ambiguity as regards the terms used, and often unclear criteria for the classification of biomass from outside forest ecosystems. This concerns the very concept of “fast-growing trees”, but such interpretation issues are also encountered as regards the terms “plantation crops” and “plantation”, which relate to the place and entirety of the activities, understood *sensu lato*, connected with the procurement of wood biomass from fast-growing trees.

By fast-growing trees one means species which facilitate the procurement of raw wood material for the production of wood materials and/or wood intended for energy generation in shortened production cycles, i.e. cycles shorter than traditionally employed in forest management. These tree species are cha-

racterized by a faster, than in the case of other species, increment in wood mass at a young age³.

Wood biomass from outside forest ecosystems, thus from fast-growing trees, may originate from plantations⁴ or plantation crops⁵. More and more often these terms are used interchangeably.

For centuries, plantations meant so-called forest crops (man-made plantations), most often monocultures [Zawiłkowski 2011]. These plantations are „man-made” and they are subjected to very intensive tending and agrotechnical procedures [Rykowski 2009]. In the case of fast-growing trees, plantations are often also called “forest plantations” as opposed to traditional forestry based on natural forests and the harvesting of wood from old-growth forests.

In subject literature, one universal definition of plantation or forest plantation has been developed. This concept often means various types of plantations, and in the case of forest species of fast-growing trees, they can even be mistaken for forest. In Poland, in accordance with the Act on Forests [Ustawa o lasach 1991], forests (due to their production, ecological and social functions, choice of grown plants and the intensity of tending procedures) are distinguished from plantations by the commitment of their owners to managing these forests sustainably, maintaining them and assuring their continuous and rational use, guaranteeing the optimum fulfilment of all forest functions at a local, national and global level without damage to other ecosystems.

According to the Food and Agriculture Organisation of the United Nations (FAO), a forest plantation is “an area afforested, mainly for profit, with fast growing tree species, which, thanks to intensive growing, is characterized by high and sustainable wood production and also the high quality of the harvested product tailored to market requirements” [Terms and Definitions 2004; Zwoliński 2009]. The FAO considers forest plantations to be one of the forms of forest, classified (together with semi-natural forests, i.e. forests composed of indigenous tree species established by planting or seeding with a share of naturally restored trees) as so-called planted forests created through planting, dedicated seeding or the sowing of shoots of planted trees both indigenous and introduced [Zajączkowski 2009]. In Polish economic practice, the FAO’s definition of (forest) productive plantations, which are established mainly with the view of wood production for

³ In Polish forestry, these are trees, which in comparable habitats in lower age classes (25–40 years are characterized by better production effects than pine, which dominates in Poland [Zajączkowski 2009].

⁴ A large area used for a many-year cultivation of a single type of plant [Encyklopedia 1998].

⁵ Irrespective of whether it concerns forests or arable land, it means the entirety of procedures with the view of creating the optimum conditions for plants to grow and increasing the culture of their growth [Encyklopedia 1998].

industrial purposes, is the closest to the concept of plantations of fast-growing trees⁶.

In Poland, it is recognized that the production of wood in shortened production cycles is possible in the case of “the intensive cultivation of clones⁷ or narrow populations of trees, which, depending on the origin of the planting material used, are called plantations or plantation crops of fast-growing trees” [Mroziński 2009], whereas:

- in the case of plantations of fast-growing trees, narrow genetically homogeneous populations, families or clones of fast-growing trees are used, which are selected in terms of their increment and/or quality characteristics (sometimes this term is limited to vegetatively reproduced cultivated tree varieties, mainly poplars) [Zajączkowski, Załęski 2007],
- plantation crops of fast-growing trees are established mainly using generative progeny (from seeds) of chosen populations [Zajączkowski, Załęski 2007].

The method of establishing and managing plantation crops of fast-growing trees, the length of a production cycle or the planting material used, depend mainly on the goal of the plantation and the purpose for which the biomass obtained from the trees is intended [Bodył 2010].

In public statistics, the area of plantations of fast-growing trees and shrubs on farms is defined based on current agricultural research⁸ and data from General Agricultural Registrations⁹, including plantations for energy purposes, managed on both forest lands and arable lands. The term “fast-growing trees and shrubs” means “specialist crops of ligneous plants characterized by an early culmination of increment (e.g. larch, spruce, birch, willow, aspen, and selected varieties of poplar) with the view of gaining in the short term (15 years or less) predetermined economic results, such as a high efficiency of raw wood material, seeds, fruits or Christmas trees”.

The above deliberations concerning biomass from fast-growing trees demonstrate the large degree of arbitrariness and ambiguity as regards the interpretation

⁶ In the case of forest plantations, the FAO differentiates between two kinds depending on their function: productive plantations, i.e. dedicated to the production of wood for industrial purposes („[...] stands of introduced species and stands of native species, established through planting or seeding mainly for the production of wood [...]”), and protective plantations, i.e. established in order to bring environmental benefits [Zajączkowski 2009].

⁷ Vegetative progeny of well-studied trees of even-growth features [Zasady hodowli lasu 2012].

⁸ This is research on farms and other entities which use arable lands. The research is carried out annually based on report R-05, i.e. Report on land use, crop area and harvest (it encompasses entities which use arable land of more than 1 ha), and representative survey R-CzSR of land use, crop area, livestock (carried out on a sample of 3% of individual farms which had been drawn).

⁹ Last General Agricultural Registration was in 2010.

of terms used in connection with this issue, and at the same time they show the urgent need for the standardization of the terminology used in legal regulations and in business practice. Additionally, the above analysis has led to the identification of common elements in the definitions “plantation” and “plantation crops of fast-growing trees”, i.e.:

- they are both cultivations of trees established with the view of obtaining a larger supply of wood biomass of a required quality in a relatively short period,
- their permanent feature is their “artificial origin” from adequately-selected or genetically-modified tree species,
- they are managed in the form of regular spacing and require tending and agro-technical procedures.

Taking the above into consideration, this article basically uses the term “plantation crops of fast-growing trees”, and sometimes the term “plantations of fast-growing trees” (in Poland, mainly in the case of poplar plantations).

The potential of crops of fast-growing trees

Within the Polish economy, wood biomass from fast-growing trees is produced in two sectors, i.e. agriculture and forestry. It is characteristic that these sectors differ significantly in terms of the establishment and management of plantation crops of fast-growing trees. This especially concerns the running time of such an operation, its goals, and also its form.

In Poland, activities connected with the establishment and management of plantation crops of fast-growing trees in agriculture were engaged in relatively recently, when in the 1990s an increased interest in the use of natural energy sources was observed. These activities gathered pace after Poland’s accession to the European Union, when the EU rules concerning energy generation from renewable sources were adopted. Agriculture became the sector in which wood biomass from fast-growing trees is produced intentionally, in an organized way, and based on specialist agrotechnology, mainly with the view of increasing its potential for energy generation. The players in the market involved with this kind of wood biomass are farmers and farm producers, as well as companies registered with the Agricultural Market Agency purchasing and processing biomass.

The production and harvesting of biomass from fast growing trees for energy purposes has become a new line of agricultural production, which is often defined as the agro power industry. In connection with this activity, the term “power agriculture” appears alongside the traditional term “food agriculture” [Budny 2005; Tworkowski, Szczukowski 2005].

The potential of plantation crops of fast-growing trees in agriculture mainly depends on the availability of lands (which are primarily used for food production), climate conditions, and water supply. An important factor affecting the popularization of the production of biomass from fast-growing trees is the in-

flow of financial capital. This was confirmed by the fact that interest in biomass production observed in Polish agriculture, especially in the period 2005–2008, was brought about by economic factors, i.e. the craving to increase one's income through gaining subsidies – initially from the national budget and later on mainly from external financial sources in the form of EU funds. It is worth noting that, in the opinion of specialists, the development of high-energy crops, including crops of fast-growing trees, is an example of the implementation of innovative practices, which take into account environmental protection, and it is conducive to the economic activation of rural areas, which is especially important [Chodkowska-Miszczuk, Szymańska 2011].

In Polish forestry, plantation crops of fast-growing trees are managed on arable lands and in forests. Furthermore, it may be assessed that the plantation crops are both general and dedicated. According to information from the Central Statistical Office of Poland, the area of plantations of fast-growing trees on farms exceeds 143 thou. hectares, of which plantations on arable lands cover an area of approximately 8 thou. hectares, and in forests more than 135 thou. hectares (2010). In these areas, dedicated plantation crops of fast-growing trees are also managed with the view of harvesting the wood biomass for energy purposes.

In the period 2010–2011, the total area of dedicated plantation crops of fast-growing trees covered 11.2 thou. hectares, of which crops on arable lands covered approximately 6.2 thou. hectares (i.e. 55%), and in forests approximately 5.0 thou. hectares (45%) – table 1.

Table 1. The area of plantation crops of fast-growing trees intended for energy purposes in agriculture¹ in Poland in the period 2009–2011

Tabela 1. Powierzchnia upraw plantacyjnych drzew szybkorosnących w rolnictwie^a do celów energetycznych w Polsce w latach 2009–2011

Province Województwo	2009	2010 ^b			2011 ^c		
	Area of plantation crops <i>Powierzchnia upraw plantacyjnych</i>						
	on arable lands <i>na użytkach rolnych</i>	on arable lands <i>na użytkach rolnych</i>	in forests <i>w lasach</i>	in total <i>razem</i>	on arable lands <i>na użytkach rolnych</i>	in forests <i>w lasach</i>	in total <i>razem</i>
1	2	3	4	5	6	7	8
Dolnośląskie	600.7	435.1	317.2	752.3	406.2	124.3	530.5
Kujawsko- -Pomorskie	198.5	161.3	242.6	403.9	181.0	0.4	181.4
Lubelskie	310.7	263.6	260.5	524.1	282.4	118.0	400.4
Lubuskie	410.5	278.7	574.2	852.9	875.7	643.1	1518.8
Łódzkie	214.2	183.3	301.2	484.5	61.7	2.5	64.2

ha

Table 1. Continued
 Tabela 1. Ciąg dalszy

1	2	3	4	5	6	7	8
Małopolskie	63.1	35.7	292.6	328.3	34.0	65.8	99.8
Mazowieckie	763.0	163.0	578.9	741.9	229.0	125.0	354.0
Opolskie	230.1	136.9	130.8	267.7	17.8	36.5	54.3
Podkarpackie	696.9	2197.3	330.7	2528.0	1538.3	2165.7	3704.0
Podlaskie	162.2	245.2	127.1	372.3	229.2	0.0	229.2
Pomorskie	885.8	239.0	213.6	452.6	554.1	1160.3	1714.4
Śląskie	259.6	101.2	249.7	350.9	253.8	11.4	265.2
Świętokrzyskie	99.1	95.1	329.5	424.6	93.0	17.5	110.5
Warmińsko- -Mazurskie	576.6	871.0	282.5	1153.5	881.6	120.5	1002.1
Wielkopolskie	786.1	329.9	398.5	728.4	209.6	40.3	249.9
Zachodniopo- -morskie	574.0	427.0	408.5	835.5	279.8	395.3	675.1
IN TOTAL OGÓLEM	6831.1	6163.3	5038.1	11201.4	6127.2	5026.6	11153.8

¹ On arable lands and in forests/*Na użytkach rolnych i w lasach*

² State as of June 30, 2010/*Stan na 30 czerwca 2010 roku*

³ State as of June 30, 2011/*Stan na 30 czerwca 2011 roku*

Source/*Źródło*: Sprawozdanie o użytkowaniu gruntów, powierzchni zasiewów i zbiorach w 2011 r. (R-05) GUS; Powszechny Spis Rolny w 2010 roku [Grzybek 2011].

In Polish agriculture, the spatial diffusion of innovation in the form of the introduction of plantation crops of fast-growing trees is uneven and observed mainly in the northern and western parts of Poland (fig. 1). The Podkarpackie province deserves special attention, for this region had the largest area of plantations of fast-growing trees. In 2010 in the Podkarpackie province, the area of plantations of fast-growing trees was 2.5 thou. ha, and in 2011 3.7 thou. ha, an increase of approximately 1.2 thou. ha, i.e. 47%. Simultaneously, the locations of plantation crops of fast-growing trees changed significantly in the analysed period: crops on arable lands decreased from 2.2 thou. ha to 1.5 thou. ha, i.e. by 30%, whereas crops in forests increased dramatically, from 0.3 thou. ha to 2.2 thou. ha, i.e. more than 6.5 times.

Analysing the size of the area of plantation crops of fast-growing trees intended for energy purposes in particular provinces, one should notice that in the period 2010–2011, the size of the area of these crops and the degree of their concentration changed greatly: in 2011, in comparison to 2010, the area of plantations of fast-growing trees decreased in as many as thirteen provinces.



Source/Źródło: Sprawozdanie o użytkowaniu gruntów, powierzchni zasiewów i zbiorach w 2011 r. (R-05), GUS.

Fig. 1. The area of plantation crops of fast-growing trees in agriculture (on arable lands and in forests) in 2011

Rys. 1. Powierzchnia upraw plantacyjnych drzew szybkorosnących w rolnictwie (na użytkach rolnych i w lasach) w 2011 roku

This phenomenon, to a large degree, was observed in the following provinces: Łódzkie (a decrease of 7.5-times), Opolskie (5-times), Świętokrzyskie (almost 4-times), Małopolskie (over 3-times), and Wielkopolskie (over 3-times). On the other hand, an increase in plantations of fast-growing trees was observed in just three provinces, i.e. in Pomorskie (4-times), Podkarpackie (by 47%), and Lubuskie (by 78%). In these latter three provinces, the area of plantation crops of fast-growing trees increased by 3.1 thou. ha in total, which was 28% in relation to the total area of crops in Poland in 2011. It should also be noted that changes in the size of the area of plantation crops of fast-growing trees in agriculture were significantly greater on arable lands than in forest areas. In 2011, such crops in forest areas increased only in two provinces, i.e. in Podkarpackie (6.5-times) and Pomorskie (over 5-times). As regards arable lands, such changes were observed in seven provinces: the greatest changes were witnessed in Lubuskie (3-times), Śląskie (2.5-times), and Pomorskie (over 2-times).

Considering the concentration of plantation crops of fast-growing trees in particular provinces, one should observe that in 2010 the areas of such crops exceeding 1 thou. ha were found only in two provinces, i.e. in Podkarpackie (2.5 thou. ha) and Warmińsko-Mazurskie (1.2 thou. ha), while in 2011, this had risen to four provinces, i.e. Podkarpackie (3.7 thou. ha), Pomorskie (1.7 thou. ha), Lubuskie (1.5 thou. ha), and Warmińsko-Mazurskie (1.0 thou. ha). Generally, in 2010, 72% of the total area of plantation crops of fast-growing trees was concentrated in eight provinces (crops exceeding 0.5 thou. ha), while in 2011, 82% of the total area resided in six provinces.

The fast-growing trees cultivated in Polish agriculture on arable lands are dominated by willow, accounting for approximately 90% [Budzyński, Bielski 2004; Grzybek 2008; Grzybek 2011]. An analysis of the area of willow crops in the period 2005–2011 indicates that most of the crops of this tree species were cultivated in 2006 and they covered approximately 7.2 thou. ha (table 2), meaning a 21% increase in relation to 2005.

Table 2. The area of plantation crops of willow in agriculture (on arable lands) in Poland in the period 2005–2011

Tabela 2. Powierzchnia upraw plantacyjnych wierzby w rolnictwie (na użytkach rolnych) w Polsce w latach 2005–2011

Years <i>Lata</i>	Area of crops <i>Powierzchnia upraw</i> ha/ha
2005	5960
2006	7192
2007	6480
2008	6700
2009	6160
2010 ¹	5550
2011 ¹	5515

¹ For the period 2010–2011, the authors' own calculations assume that the area of plantation crops of willow accounts for 90% of the total area of plantation crops of fast-growing trees on arable lands

¹ *Lata 2010–2011 obliczenia własne, przy założeniu, że powierzchnia upraw plantacyjnych wierzby stanowi 90% ogólnej powierzchni upraw plantacyjnych drzew szybkorosnących na użytkach rolnych*

Source/Źródło: [Grzybek 2008; Grzybek, Muzalewski 2010; Grzybek 2011; Szostak et al. 2012]

It can be estimated that the increased interest in willow crops resulted from the introduction of subsidies for the establishment of such plantations. At the same time, it should be noted that this interest proved to be short-lived, despite further subsidies in the period 2007–2008 (national as well as EU subsidies). Since 2007, willow crops virtually ceased to develop, and since 2009 there has been a clear downward trend, probably resulting from the fact that, in 2009, subsidies for this kind of activity were withdrawn. In 2011, willow crops reached a level of 5.5 thou. ha, a 23% decrease in such crops in relation to 2006. It is estimated that in

Poland, willow is grown by 600 planters, most of them in Warmińsko-Mazurskie and Wielkopolskie provinces [Forowicz 2011].

Generally, it should be said that hitherto in Polish agriculture, dedicated plantation crops of fast-growing trees have been managed to a limited extent, although, thanks to these plantations, wood biomass, which is a raw material for the production of both wood materials and energy (thermal and electric), can be produced in an organized way. Moreover, the establishment of these crops seems to be one of the most positive lines of sustainable local development.

Dedicated plantation crops of fast-growing trees which are currently managed in Polish agriculture on an area of approximately 11 thou. ha and the biomass harvested from them can hardly be considered an energy carrier source of some significance. Assuming that 20 tonnes of dry wood mass¹⁰ can be obtained from 1 ha of plantation, the total area of plantation crops of fast-growing trees in Poland delivers 220 thou. tonnes of wood biomass per annum. For comparison, according to calculations, the consumption of wood biomass by all its customers (public power plants, industrial power plants, and individual customers) amounted to 10.1–11.5 M tonnes in 2010 [Ratajczak et al. 2012].

Experts estimate¹¹ that Polish agriculture has a very large potential for biomass production, including biomass from plantation crops of fast-growing trees. According to various opinions and estimates, the potential in Poland of lands on which plantation crops of energy plants may be established amounts to 1.1–2.0 M ha [Szcukowski, Tworkowski 2005; Pudelko, Faber 2010; Faber 2012]. The potential of lands that may be used for dedicated energy crops for the power industry (where solid biomass is produced, mainly from fast-growing trees) is estimated to be 0.3–0.6 M ha [Bodył 2012]. Experts have calculated that approximately 3.7–6.5 M tonnes of dry biomass could be obtained from such an area. Such an amount of biomass from agriculture could satisfy 33% of the demand for biomass from the 20 largest system power plants [Pudelko, Faber 2010]. It has also been suggested that plantation crops of energy plants could be located in approx. 1600 communes, i.e. 65% of the total number which is 2479 [Pudelko, Faber 2010; GUS 2012].

Generalising, it may be said that if Polish agriculture does not become a producer of biomass to a significantly larger degree (especially of wood biomass from plantation crops of fast-growing trees), Poland may not achieve the set goals for

¹⁰ According to different information sources, 4 tonnes, 8 tonnes, 12.5–21.5 tonnes, 15–30 tonnes, 20 tonnes, or 30–40 tonnes of dry wood mass can be obtained from 1 ha of plantation [Leitfaden bioenergie 2000; Mickiewicz 2004; Fechner 2006; Fabisiak et al. 2008; Zawilkowski 2011].

¹¹ In Poland, there is 0.42 ha of arable land per capita. In Germany, that index is 50% less, and in the EU it is 0.19 ha. Much of this land area is made up of soil of bad quality, which could be used for crops of energy plants [Nowe szanse dla rolnictwa... 2012; Prezes Polskiej Izby Biomasy...wnp.pl].

energy generation from renewable sources. Biomass will be a much sought-after energy carrier, if Poland fulfils the resolutions of the Climate Package 3×20 ¹². Bearing this in mind, the power sector has recently taken steps to establish, in cooperation with farmers, new areas of dedicated plantation crops of fast-growing trees, especially willow. The goal of the activity is to assure a future supply of biomass for energy sector entities, i.e. adequate amounts of biomass with the appropriate parameters and at a predictable price.

In the case of forestry, it is known that plantation crops of fast-growing trees were established at the beginning of 1950s¹³. In the period 1956–1975, the establishment of 27 thou. ha of forest plantations of fast-growing trees was envisaged, of which only 11 thou. ha was intended for plantations of trees for manufacturing purposes (the rest was intended to have been Christmas tree plantations). On the other hand, the prognosis of 1972 anticipated that within the 20-year period of 1970–1990, forest plantations of fast-growing trees should have been established on an area of at least 100 thou. ha, and by the year 2000, 300 thou. ha [Zajączkowski 2009]. These plans were not executed. By the end of 1989, only 4.2 thou. ha of such plantations had been established, with 1/3 of the area being used for spruce plantations.

In Poland in the forest sector, there is a long tradition of activities connected with plantation crops of fast-growing trees, especially poplar; however, for many decades these activities were not widely popularized. A dominant goal of establishing such plantations was the use of wood biomass for material purposes [Zajączkowski 2009].

Currently in forestry, activities related to the establishment and management of plantation crops of fast-growing trees are declining. This is due to the fact that in Polish forests a semi-natural cultivation of the forest, based on a knowledge of the habitats and their potential, has been practised in accordance with the adopted principle of sustainable growth [Kozioł, Matras 2011]. Since the mid-1970s in the forest sector, no plantations intended for the production of wood for both industrial and energy purposes should be established [Zajączkowski 2009]. After 1989, the area of small plantations established in 1970s began to gradually decrease in size and, according to studies¹⁴, in 2011 was 2.5 thou. ha¹⁵.

¹² The name 3×20 stems from three postulates: a reduction in energy consumption by 20%, reduction in greenhouse gas emissions by 20%, and achievement of a 20% share of energy from renewable sources in terms of total energy consumption in the UE by 2020 [Notatka informacyjna... 2008].

¹³ On the initiative of the Ministry of Forestry, in December 1952, a conference on poplar plantations was organized, which was attended by a broad group of interested departments and scientists from forestry faculties of universities and from the Forest Research Institute. This conference is considered to have been the starting point for planned plantation crops of poplar coordinated by the state [Zajączkowski 2009].

¹⁴ A survey carried out by the Wood Technology Institute in Poznan [Szostak et al. 2012].

¹⁵ It can be found in secondary literature sources that 4–10 thou. ha of plantation crops

However, it has been supposed that the forest sector is now prepared to engage in this activity to a wider extent than previously and intend to develop it. An unquestionable asset is the profound knowledge and experience of specialists in forest management and scientists¹⁶.

Currently, plantation crops of fast-growing trees are located within the area of 13 out of 17 State Forests Regional Directorates (RDLP) – table 3.

Analysis of the extent of such plantation crops in particular RDLPs, shows that the greatest areas are within RDLPs in Lublin – over 0.6 thou. ha, Olsztyn – approximately 0.5 thou. ha, and Radom – approximately 0.4 thou. ha, whereas the smallest areas are within RDLPs in Szczecin and Cracow – 0.06 thou. ha in each location.

There are 363 plantations in Polish forestry altogether. Most of them are found within the RDLPs in Olsztyn (62), Torun (58), and Gdansk (57), while the fewest are found within the RDLPs in Cracow (1), Szczecin (11), and Katowice (12).

An average plantation land area is 6.9 ha. Particular RDLPs differ from one another in terms of the size of the plantation area. As regards the land area, the largest plantations are located within RDLPs in Radom (15.9 ha) and Olsztyn (15.7 ha), and the smallest within RDLPs in Szczecin (0.5 ha) and Zielona Góra (1.1 ha), meaning that the largest plantations exceed more than twice the national average plantation land area, whereas the smallest account for 7–16% of the national average plantation land area.

The main tree species grown on forestry plantations are: poplar, larch, birch, spruce, linden, Douglas fir, maple, willow, and sweet cherry¹⁷.

Presently, forestry plantations of fast-growing trees are, to a large extent, experimental areas, on which long-term research is carried out. Many of these plantations are being converted into economic stands (this mainly concerns old poplar plantations).

of fast-growing trees are located on areas of the State Forest National Forest Holding (PGL LP) [Kozioł, Matras 2011; Sawicki 2012].

¹⁶ For 50 years scientists have carried out research on plantation crops of poplar in the natural conditions in Poland. Research has found that an adequate productivity of a plantation, achieved in Southern and Western Europe, can be obtained through the use of appropriate varieties of poplar, the establishment of plantations in appropriate habitats (III–IV class of land) and with appropriate spacing, the appropriate preparation of the soil and the employment of adequate tending and protective procedures. It was recognized that in the natural and economic conditions of Poland the following trees species can possibly be cultivated: cottonwood and balmy poplar, poplar, aspen, willow, European larch, Douglas fir, Norway spruce, common birch, sweet cherry, locust tree [Bodył 2010; Zajączkowski 2009].

¹⁷ Based on a survey carried out by the Wood Technology Institute in Poznan [Szostak et al. 2012] and [Kozioł, Matras, 2011].

Table 3. The area of plantation crops in forestry in Poland in 2011
Tabela 3. Powierzchnia upraw plantacyjnych w leśnictwie w Polsce w 2011 roku

State Forests Regional Directorates <i>Regionalna Dyrekcja Lasów Państwowych</i>	Number of plantations <i>Liczba plantacji</i>	Area of plantation crops <i>Powierzchnia upraw plantacyjnych</i>	Average area of plantation crops <i>Średnia powierzchnia upraw plantacyjnych</i>
		ha	
Białystok	17	110.9	6.5
Gdańsk	57	339.2	6.0
Katowice	12	26.6	2.2
Kraków	1	6.1	6.1
Krosno	10	47.1	4.7
Lublin	62	624.2	10.1
Łódź	44	116.7	2.7
Olsztyn	29	454.3	15.7
Piła	–	–	–
Poznań	–	–	–
Radom	24	381.4	15.9
Szczecin	11	5.8	0.5
Szczecinek			
Toruń	58	248.8	4.3
Warszawa	24	124.6	5.2
Wrocław	–	–	–
Zielona Góra	14	15.7	1.1
IN TOTAL <i>OGÓLEM</i>	363	2501.3	6.9

Source: State Forests Directorate General in Warsaw – survey carried out by the Wood Technology Institute in Poznan

Źródło: Dyrekcja Generalna Lasów Państwowych w Warszawie – badania ankietowe Instytutu Technologii Drewna w Poznaniu

In the opinion of the State Forests Directorate General¹⁸, Poland currently lacks areas suitable for the establishment of plantation crops of fast-growing trees. The Agricultural Market Agency has also taken no steps to transfer land for that purpose to the State Forests. Furthermore, as a result of changes in forestry management adopted in 1991, virtually no monocultures have been established [Ustawa o lasach 1991]. Taking the above into consideration, no expansion of the area of plantation crops of fast-growing trees in Polish forestry is envisaged in the near future. Nevertheless, it should be noted that in connection with interest in the

¹⁸ An opinion expressed in a survey which was part of direct research carried out by the Wood Technology Institute in Poznan [Szostak et al. 2012] and [Sawicki 2012]

cultivation of fast-growing trees expressed by producers from the wood sector, e.g. with a view to harvesting the wood for the production of chemical wood pulp and paper, the State Forests National Forest Holding (PGL LP) has started co-operation as regards plantation crops of fast-growing trees¹⁹. The role of forestry in this co-operation is to indicate which clones of poplar would be most suitable for the pulp and paper industry. The first experimental crop of this tree species was established on the area of Wichrowo Forest Division (RDLP in Olsztyn), where the staff have many years of experience as regards plantations of fast-growing trees.

In 2011, the area of dedicated plantation crops in Poland was 13.7 thou. ha in both the agriculture and forestry sectors together. In the opinion of specialists, in 2020 the area of such plantation crops should amount to approximately 0.5 M ha in order to meet the demands of the power sector, i.e. so-called public power plants, for biomass from fast-growing trees [Stefaniak 2009; Forowicz 2011; Rynek biomasy].

Consumers of wood biomass from fast growing trees

Over the last few years, due to the increasing demand for wood, wood biomass from plantation crops of fast-growing trees has become one of the alternatives to forest wood sources of raw wood material. Wood from this source can be used for material and energy purposes. The suitability of wood biomass from plantation crops for material and energy purposes stems from both the properties of the biomass and the existing technologies used for material and energy processing. However, it should be stressed that in business practice, wood biomass from plantation crops of fast-growing trees is mainly treated as a source of energy. This was confirmed by a survey carried out amongst planters of fast-growing trees, where 89% of the respondents indicated that wood biomass from plantation crops was used for energy purposes [Szostak et al. 2012].

The wood of fast-growing tree species, mainly willow and poplar, from agricultural and forest plantation crops, can be useful as a substitute for wood particles and fibres obtained from forest wood and used in the production of wood-based panels, and for the production of various dedicated composite materials [Ratajczak et al. 2011]. The form of the alternative raw materials makes it possible to obtain from them particles of various types and geometry, and the diverse specific density creates the possibility of producing composite materials of different structures, density and strength. The wood from agricultural and forest plantation crops

¹⁹ In September 2008, the State Forests, International Paper Kwidzyn Sp. z o.o., and the Forest Research Institute signed a trilateral agreement on co-operation in the field of the management of plantation crops of poplar dedicated to the purposes of the pulp and paper industry. This agreement defines the terms and conditions of the 15-year co-operation concerning experiments on Polish and foreign varieties of poplar [Body 2011; Sawicki 2012].

can also be used in the pulp industry. In general, the recently rising deficit in forest raw material used for the production of wood pulp is the reason for action which is currently being taken with a view to establishing plantations of trees with defined features, which are grown from selected material characterized by the greatest suitability for the needs of a specific consumer/industry [Bodył 2011; Sawicki 2012].

One material use of the wood from fast-growing trees is the production of wood pellets and briquettes. The technology for the manufacture of these products from raw material originating from agricultural and forest plantation crops, makes it possible to obtain products of high quality, smooth and glassy surface, and good calorific value (17–18 MJ/kg) [Kwaśniewski 2008].

Generalising from former knowledge, it should be said that in the wood sector it is mainly wood from forests that has been used for material purposes; however, in the light of the growing demand for this raw material, the procurement of wood biomass from outside forest ecosystems is becoming important. One of the remedies for the lack of balance between the supply of and demand for wood biomass is to increase the production of wood from agricultural and forest plantation crops. The suitability of wood biomass of such origin for the production of agglomerated wood-based panels and wood pulp, which has been confirmed by many studies, simultaneously means the necessity of creating an adequately-sized raw material base [Oniśko 2011]. Bearing this in mind, it is necessary to prepare packets of instruments stimulating and encouraging the intensive establishment of new plantation crops of fast-growing trees and the development of existing ones. At the same time, steps taken in this area will support active forest management.

For the time being, wood biomass from plantation crops of fast-growing trees in Poland is used to a rather insignificant degree for material purposes. This was confirmed by the survey carried out amongst planters of fast-growing trees, where only 10% of respondents indicated that producers from the wood sector were consumers of wood biomass from their plantation crops.

The wood from agricultural and forest plantation crops is used for energy generation, thus it supplements in Poland the balance of wood biomass on the energy market (mainly it is wood of frutescent willow and poplar).

In Poland, producers of thermal and electric energy are the consumers of wood biomass from fast-growing trees intended for energy purposes. The consumers may be both collective and individual. Taking into account the great demand from the power sector for energy carriers, it should be stressed that the sector may consume a considerable quantity wood biomass, including biomass from agricultural and forest plantation crops. Unfortunately, there is still a lack of a mature and comprehensive system for streamlining the production, distribution, and use of such biomass, for only the simultaneous development of all these elements can assure the success of a system of renewable energy source utilisation, which is based on wood biomass from plantation crops.

According to specialists [Bartczak 2008; Sidor 2011; Guła 2012; Kutrzuba 2012], in the face of a huge demand for energy, supplies of wood biomass from dedicated plantation crops are important for public power plants. At the same time, wood biomass from these sources should be mainly used to generate heat on a local scale, i.e. within no more than 50–70 km from the place of production, determined by transport profitability.

The above statements are confirmed, to some degree, by the survey carried out amongst planters of fast-growing trees [Szostak et al. 2012], namely the answers of respondents suggested that wood biomass from plantation crops was primarily consumed by business entities operating up to 50 km from the biomass source. Such information was given by 79% of the respondents. In this group, most of the respondents (42%) indicated that they supplied wood biomass within a distance of up to 30 km.

The survey also suggested that wood biomass from plantation crops of fast-growing trees is mainly consumed by collective customers (75% of the answers). Amongst other consumers, there are individual customers (29% of the answers) and middlemen who deliver biomass to power producers (18% of the answers). The indicated group of collective consumers was composed mainly of public power plants (68% of the answers), primarily including combined heat and power plants (32%), municipal/local power plants (11% of the answers), and industrial power plants (11% of the answers). The indicated group of individual consumers was composed mainly of planters, who used such wood biomass to satisfy their own energy demand (29% of the answers)²⁰, and then households, which purchased such biomass to use for heating (7% of the answers).

It should be noted that over recent years the interest of power sector entities in wood biomass from agricultural and forest plantation crops has increased considerably. This fact can be considered a drive towards a stabilization of the situation in the currently shallow market in wood biomass used for energy purposes. Some co-operation with farmers as regards the supply of wood biomass from plantation crops has started. Multiannual contracts for the supply of such wood biomass to defined CHP plants and heat-generating plants have been signed. The establishment of a plantation, its tending and harvesting and the transport of the biomass to a given plant has also been agreed. Power sector entities themselves have also established model plantations of fast-growing trees²¹. In light of the above, it can

²⁰ The establishment and management of plantations of fast-growing trees on small areas can, to a considerable extent, be a solution to the problem of supplying farms with thermal energy. As little as 0.5 ha of willow can provide fuel for a farm for the whole year [Gutowska 2005].

²¹ For instance, in industrial areas and on slag heaps owned by Katowice Coal Holding, willow plantations have been established to satisfy the demand from the combined heat and power plant in Tychy [Katowicki Holding Węglowy... 2003]. Large-area plantations of willow are being developed by PGNiG Termika Company, which contracted an area of 350 ha for 17 years for the cultivation of willow [Kozłowska, Kałużna 2012]. The Experimental Station for Grasslands Melioration in Biebrza, as well as local farm-

therefore be supposed that an individual owner of a small plantation can become a less attractive supplier of wood biomass for a big power company, whose demand for that energy carrier is great.

The activity of the power sector consisting in establishment of its own plantation crops of fast-growing trees was confirmed by the survey [Szostak et al. 2012]. The respondents representing power plants (29% of all the respondents) indicated that they used wood biomass from their own plantation crops as well as biomass from plantation crops managed by farmers who had contracts with that particular power plant. The CHP plants surveyed (29% of all the respondents) used wood biomass from their own plantation crops, while heat-generating plants (42%) used wood biomass from their own plantation crops and from plantations located on the lands leased from farmers. All the respondents intended to develop plantation crops of fast-growing trees or at least maintain their previous size, but not one of the respondents planned to liquidate such plantation crops.

Secondary sources [Samborski 2011; Chojnacki 2012; Mazurkiewicz 2012; *Własne plantacje...*] and the survey carried out by the Wood Technology Institute in Poznan [Szostak et al. 2012] suggest that companies from the wood sector are also taking steps to establish their own plantation crops of fast-growing trees for energy purposes. An example is International Paper Kwidzyn Sp. z o.o. – a company which already owns 164 ha of plantations of 3–5 year-old poplar to meet the demand of the company's own CHP plant. International Paper Kwidzyn has also started the execution of a project (in co-operation with the company Green Word Resources Poland) consisting of the establishment of the biggest plantation of fast-growing poplar in Europe, which is to cover an area of approximately 10 thou. ha over three years and has a target of 25 thou. ha. It is envisaged that the plantation will be established on lands leased from local farmers.

To conclude, it should be observed that in comparison to previously small areas of agricultural and forest plantation crops, big plantations established by companies are a prospective source of wood biomass. It should be emphasized that the local availability of biomass as an energy carrier from plantation crops of fast-growing trees is of special importance to its harvesting and the logistics of its supplies, as regular deliveries to customers should be assured. At the same time, it should be noted that the location of power plants in Poland increases the strong competition for biomass resources [Pudełko, Faber 2010], which is especially visible in southern Poland, as 12 (i.e. 63%) out of 19 power plants operate in this area. Therefore, the spatial layout of land for plantation crops of fast-growing trees, is quite uneven and limited in relation to existing consumers of such a type of biomass.

ers, manages a plantation of energy willow (approx. 10 ha) to meet demand from the Heat-Power Engineering Company in Grajewo, whereas the demand from the combined heat and power plant in Białystok is to be partially met by two established plantations with an area of 130 ha, which can be expanded to 200 ha. It should be added that the demand for biomass from that CHP plant is estimated to be 4000 ha [Mystkowski 2010].

Benefits and difficulties connected with management of crops of fast growing trees

The development of alternative sources of raw wood material and an increase in the procurement of wood biomass from outside forest ecosystems has become a necessity. This concerns wood for industrial purposes and, to a greater and greater extent, wood biomass for energy purposes. The reasons for this are:

- the growing demand from the wood sector for raw wood material for material purposes, especially in periods of economic prosperity and wood deficits which then occur,
- the growing demand for final energy forcing the development of energy carriers alternative to fossil fuels, since the resources of traditional energy raw material are limited,
- the growing drive towards the relative reduction in wood harvesting in forests and expanding their ecological and social functions at the expense of their production function, which is connected with the protection of large forest areas within the Nature 2000 Programme [Bodył 2011].

It is estimated that at present relatively large unused reserves of wood biomass, especially as an energy carrier, are primarily found in plantation crops of fast-growing trees. However, putting them to use still requires the surmounting of many economic, technological, and organizational barriers.

The as yet unexploited chances to gradually increase the potential of wood biomass are primarily found in Polish agriculture. Plantation crops of fast-growing trees in this sector can and should be treated not only as a source of biomass, but also as a stimulus for regional development, especially rural development, as the establishment of these crops on lower-quality soils (soils of low production), soils which are contaminated and not suitable for edible crops, fallow lands or degraded areas, is an additional source of income for farmers (very good and good soils, which account for 54% of total arable land in Poland, should be used only for the production of food and forage). Therefore, this can be a way to improve the economic performance of many farms. It also creates new jobs, which is especially important in underdeveloped areas, usually characterized by a high unemployment rate.

The development of plantation crops of fast-growing trees in agriculture can also be a way to protect forest ecosystems from their excessive exploitation. Moreover, “energy” crops have the ability to accumulate contamination and over a few years they can clean the soil of heavy metals. The use of biomass from fast-growing trees as an energy carrier should also increase the degree of energy safety, especially locally in places where the biomass is produced, assuring a supply of energy, especially in areas where the power infrastructure is underdeveloped. The notion that there is potential demand for this energy carrier can be derived from the fact that approximately 1 M single houses in Poland are already heated by wood biomass [Sawicki 2012].

Unfortunately, the market in biomass from fast growing trees is emerging relatively slowly (due to the time necessary for cultivated stands to reach their full yield capacity), the costs of the establishment, management and liquidation of such plantations are relatively high, and a return on the investment period is fairly long. The establishment of plantations is also most often discouraged by their (hitherto) low profitability in relation to traditional agricultural crops. In the opinion of specialists, in current conditions only very well-organized crops may be effective, i.e. crops which assure a high yield at relatively low production costs [Kwaśniewski 2011].

Assuming the anticipated further development of plantation crops of fast-growing trees in agriculture, one should remember that the allocation of too much land for these crops can pose some danger. Since the basic role of agriculture is to assure the food safety of the country (a food supply), the development of plantation crops should not limit the land area available for food and forage crops, for it consequently would lead to an increase in food and forage prices.

As mentioned earlier, the market in biomass from fast-growing trees has a high development potential, which has not been exploited fully. The lines of its future development will be set mainly by the growing demand from the wood sector for wood for material purposes and the necessity to develop renewable energy source alternatives to fossil fuels, amongst which biomass plays an important role. Depending on their final form, legal regulations and economic tools (effective and pending), and especially their comprehensiveness, unambiguity, cohesion, and stability, will be the primary stimuli for or curbs to the development of this market (table 4).

Table 4. Major conditions for the development of the market in biomass from fast-growing trees in Poland – opportunities and barriers

Tabela 4. Ważniejsze uwarunkowania rozwoju rynku biomasy z drzew szybko rosnących w Polsce – możliwości i bariery

Opportunities <i>Możliwości</i>	Barriers <i>Bariery</i>
I	2
<p>Legislation supporting the development of sources of wood biomass from outside forest ecosystems <i>Legislacja wspierająca rozwój źródeł biomasy drzewnej spoza ekosystemów leśnych</i></p> <p>Considerable areas of fallow land in Poland, which facilitate their possible use for the production of biomass from fast-growing trees <i>Znaczne obszary nieużytków w Polsce umożliwiające ich ewentualne wykorzystanie do produkcji biomasy z drzew szybko rosnących</i></p>	<p>Lack of financial support for investments in plantation crops of fast-growing trees (subsidies, preferential loans) <i>Brak wsparcia finansowego inwestycji w uprawy plantacyjnych drzew szybko rosnących (dopłaty, kredyty preferencyjne)</i></p> <p>Lack of organizational and legal support for investors, instability of the law made in relation to plantation crops of fast-growing trees <i>Brak wsparcia organizacyjnego i prawnego inwestorów, niestabilność stanowionego prawa w odniesieniu do upraw plantacyjnych drzew szybko rosnących</i></p>
<p>A relatively high tolerance of plantation crops of fast-growing trees as regards habitats and environment (soils which are not used for the cultivation of food and forage, fallow and degraded lands) <i>Relatywnie duża tolerancja siedliskowa i środowiskowa upraw plantacyjnych drzew szybko rosnących (gleby niewykorzystane dla uprawy żywności i pasz, grunty odlogowane, zdegradowane)</i></p>	<p>The relatively high costs of the establishment, management and liquidation of plantation crops of fast-growing trees <i>Stosunkowo wysokie koszty założenia, prowadzenia i likwidacji upraw plantacyjnych drzew szybko rosnących</i></p> <p>Most often a long period of return on invested capital, which may result in the loss of the financial liquidity of the planters <i>Najczęściej długi okres zwrotu zainwestowanych środków grożący utratą płynności finansowej plantatorów</i></p>
<p>The possibility to cultivate fast-growing trees on fallow places, irregularly stocked open stands and areas where previously stands were classified for complete conversion <i>Możliwość uprawy szybko rosnących drzew leśnych na haliznach, płazowinach oraz powierzchniach po drzewostanach zakwalifikowanych do przebudowy całkowitej</i></p>	<p>The lowest profitability from the production of biomass from fast-growing trees, especially in relation to traditional agricultural crops <i>Niska opłacalność produkcji biomasy z drzew szybko rosnących, szczególnie w odniesieniu do tradycyjnych upraw rolniczych</i></p>

Table 4. Continued
Tabela 4. Ciąg dalszy

1	2
<p>A relatively short production cycle of biomass from fast-growing trees (in relation to traditional forest plantations) <i>Stosunkowo krótki cykl produkcyjny biomasy z drzew szybkorosnących (w relacji do tradycyjnych upraw leśnych)</i></p> <p>The relatively high productivity of plantation crops of fast-growing trees in relation to forest plantations <i>Relatywnie wysoka produktywność upraw plantacyjnych drzew szybkorosnących w odniesieniu do upraw leśnych</i></p> <p>Production of biomass from fast-growing trees in line with the set goal, a biomass of defined and desired properties and tailor-made <i>Produkcja biomasy z drzew szybkorosnących zgodna z założonym celem, o określonych i pożądanych cechach, zgodna z wymaganiami odbiorcy</i></p>	<p>Hitherto low competitiveness of plantation crops of fast-growing trees in relation to other types of agricultural production <i>Mała, jak dotychczas, konkurencyjność upraw plantacyjnych drzew szybkorosnących w stosunku do innych rodzajów produkcji rolniczej</i></p> <p>In the case of dedicated energy crops of a short rotation, there is a necessity for the quick use of harvested raw material; after harvesting, biomass is characterized by high moisture content, is bulky, difficult to store and transport <i>Konieczność – w wypadku celowych upraw energetycznych o krótkiej rotacji – szybkiego wykorzystania zebranego surowca, duża wilgotność biomasy po zbiorze, jej duża objętość, trudne przechowywanie, magazynowanie i transport</i></p>
<p>Considerable technical possibilities of converting biomass from fast-growing trees into materials and using it as an energy carrier <i>Duże możliwości techniczne przetwarzania biomasy z drzew szybkorosnących na cele materiałowe i jako nośnika energii</i></p>	<p>The lack of a comprehensive, developed ready market and an organized system of contracting the supply of biomass from fast-growing trees <i>Brak kompleksowego, rozbudowanego rynku zbytu, zorganizowanego systemu kontraktacji dostaw biomasy z drzew szybkorosnących</i></p>
<p>A relatively low investment risk in the case of energy crops (investments in renewable energy sources are believed to be low risk investments in the long-term) <i>Stosunkowo niski stopień ryzyka inwestycyjnego w wypadku upraw energetycznych (inwestycje w odnawialne źródła energii uważa się za inwestycje o niskim stopniu ryzyka w długim okresie)</i></p>	<p>Threats stemming from managing monocultures on large areas in forests, the reduction of the biological diversity of stands <i>Zagrożenia wynikające z prowadzenia upraw monokulturowych na dużych obszarach w lasach, zmniejszenie różnorodności biologicznej drzewostanów</i></p>

Table 4. Continued
 Tabela 4. Ciąg dalszy

1	2
<p>The possibilities of cultivating plantation crops of fast-growing trees in co-operation with domestic and foreign companies, which manage them</p> <p><i>Możliwość prowadzenia upraw plantacyjnych drzew szybko rosnących na zasadzie współpracy z krajowymi i zagranicznymi firmami zajmującymi się ich zarządzaniem</i></p>	<p>A Lack of knowledge of the environmental and landscape consequences of plantation crops of fast-growing trees in agriculture</p> <p><i>Zbyt mało rozpoznane następstwa środowiskowe i krajobrazowe upraw plantacyjnych drzew szybko rosnących w rolnictwie</i></p> <p>The lack of areas suitable for plantation crops of forest trees, as the Agricultural Market Agency does not transfer suitable areas to the State Forests</p> <p><i>Brak odpowiednich powierzchni pod uprawy plantacyjne drzew leśnych, nieprzekazywanie Lasom Państwowym odpowiednich powierzchni przez Agencję Rynku Rolnego</i></p> <p>In agriculture, there is the priority of the food safety of the country and the sustainable use of agricultural areas</p> <p><i>W rolnictwie – priorytet bezpieczeństwa żywnościowego kraju i zrównoważonego wykorzystania obszarów rolniczych</i></p> <p>The lack of adequately developed processing, storage, and market infrastructure for biomass from plantation crops of fast-growing trees (professional harvesting machines, specialist equipment for plantation management)</p> <p><i>Brak odpowiednio rozwiniętej infrastruktury przetwórczej, magazynowej i rynkowej dla biomasy z upraw plantacyjnych drzew szybko rosnących (profesjonalnych maszyn do zbioru, specjalistycznego sprzętu do prowadzenia upraw)</i></p> <p>Relatively high requirements as regards tending to plantation crops of fast-growing trees</p> <p><i>Stosunkowo duże wymogi pielęgnacyjne upraw plantacyjnych drzew szybko rosnących</i></p> <p>The lack of a developed system of information on the supply of and demand for biomass from fast-growing trees, which hampers investment decisions</p> <p><i>Brak rozwiniętego systemu informacji o podaży i popycie na biomasę z drzew szybko rosnących utrudniający podejmowanie decyzji inwestycyjnych</i></p> <p>Little disseminated specialist knowledge of the management of plantation crops of fast-growing trees</p> <p><i>Słabo rozpowszechniona wiedza specjalistyczna o prowadzeniu upraw plantacyjnych drzew szybko rosnących</i></p>

Conclusions

Over the last few years, the procurement of biomass from fast-growing trees has become a point of broad discussion and interest as observed in business practice. In subject literature, there is still a degree of ambiguity as regards the terms used and often unclear criteria for the classification of categories used within the field. This concerns the concept of “fast-growing trees” as well as the terms “plantation crops” and “plantation” (which most often relate to the place and entirety of activities, understood *sensu lato*, connected with the procurement of biomass from fast-growing trees, thus biomass originating from outside forest ecosystems). This ambiguity underlines the urgent need to standardize the terminology used at the level of both legal regulations and business practice. However, it is possible to capture common elements of the definitions „plantation” and „plantation crops of fast-growing trees”, namely that they are tree crops established with a view to obtaining a larger supply of wood biomass of a required quality in a relatively short period, that their permanent feature is their „artificial origin” from adequately-selected or genetically-modified tree species, and they are managed in the form of regular spacing and require tending and agrotechnical procedures.

In the Polish economy, biomass from fast-growing trees is produced in two sectors, i.e. agriculture and forestry. These sectors have a large developmental potential as regards plantation crops of fast-growing trees. The potential of lands for dedicated crops for the power industry is determined to be 0.3–0.6 M ha. On the other hand, in agriculture, after a short period of interest in the management of crops of fast-growing trees in the period 2005–2008 (which was the result of economic factors, i.e. initially subsidies from the national budget, and later also from EU funds), in the following years a downward trend in the size of the area of such crops was observed. Recently, i.e. in the period 2010–2011, the area of plantation crops of fast-growing trees was approximately 11 thou. ha. In forestry, plantations of fast-growing trees play an insignificant role. They cover small areas, which are usually the remnants of plantations established in the mid-1970s. In 2011, the area of dedicated plantation crops of fast-growing trees in Poland was 13.7 thou. ha in agriculture and forestry together.

Over the last few years, in the face of a growing demand for wood, wood biomass from plantation crops of fast-growing trees has become an alternative source of raw wood material from outside forest ecosystems. The wood from this source may be used for material and energy purposes; however, in business practice, wood biomass from plantation crops of fast-growing trees is treated mainly as a source of energy. The suitability of wood biomass from plantation crops for material and energy purposes stems from both its properties and the existing technologies used for its processing for material and energy purposes.

Despite the challenges which the Polish power industry currently face, the official assumption of the Polish economic policy is that the consumption of wood

for energy purposes should not cause a deficit for industrial processing. The combustion of wood should be the last form of its use after it has been used as material and multiply recycled, for the effectiveness of raw wood material conversion into wood products, especially those of high value added, is many times greater than in the case of its conversion into energy, even if it is „green energy”. Therefore, the need to increase the wood supply, so as to avoid the dilemma of its use for material or energy purposes, is the rationale behind the optimum use of all the available resources of various biomass types in business practice, as well as an increase in the biomass harvesting of plantation crops of fast-growing trees.

The lines of the future development of the market in biomass from fast-growing trees will be set mainly by the growing demand from the wood sector for wood for material purposes and the need to develop renewable energy sources as an alternative to fossil fuels, amongst which biomass plays an important role. Depending on their final form, legal regulations and economic tools (effective and pending), and especially their comprehensiveness, unambiguity, cohesion, and stability, will be the primary stimuli for or curbs to the development of the market, for it is conditioned, to a great extent, by active financial and legal support, assuring the profitability of the process of harvesting and processing biomass from fast-growing trees. Therefore, the main and most important task is to develop, at a national level as well as business entity level, a systems approach to solving existing and future issues connected with the operation of this market.

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BIOMASA DRZEWNA Z UPRAW DRZEW SZYBKOROSNĄCYCH JAKO ALTERNATYWNE ŹRÓDŁO SUROWCA DRZEWNEGO W POLSCE

Streszczenie

Prowadzenie upraw plantacyjnych drzew szybkorosnących i ich rozwój ma duże znaczenie nie tylko dla oszczędności surowca drzewnego z lasu i zwiększenia dywersyfikacji źródeł energii, ale przez swoją specyfikę (najczęściej są to małe i średnie firmy zlokalizowane blisko odbiorcy i korzystające z lokalnych zasobów) może i powinien dynamizować rozwój ekonomiczno-społeczny na poziomie lokalnym. Uprawy te mogą i powinny być traktowane zwłaszcza jako nowa dziedzina produkcji rolniczej, dodatkowe źródło dochodów i efektywne wykorzystanie odłogowanej ziemi. Pomimo tych aspektów rynek biomasy z drzew szybkorosnących jest jednak nadal stosunkowo mało rozpoznany.

Celem podjętych badań było przeprowadzenie wieloaspektowej analizy rynku biomasy z drzew szybkorosnących w Polsce, w tym głównie przeznaczonej na cele energetyczne.

Zakresem podmiotowym badania objęły głównych uczestników rynku biomasy z upraw plantacyjnych drzew szybkorosnących w Polsce: to jest: rolnictwo leśnictwo oraz sektor energetyczny. Zakres czasowy badań obejmował zasadniczo lata 2010–2011.

Proces badawczy o charakterze desk research uzupełniony został badaniami bezpośrednimi obejmującymi dostawców i odbiorców biomasy drzewnej z drzew szybkorosnących, a także jako dodatkowe możliwe źródło informacji z zakresu analizowanej problematyki – jednostki administracji publicznej.

Z przeprowadzonych badań wynika, że w polskiej gospodarce miejscem powstawania biomasy z drzew szybkorosnących są dwa sektory: rolnictwo i leśnictwo. Sektory te posiadają duży potencjał rozwojowy w zakresie upraw plantacyjnych drzew szybkorosnących. Potencjał gruntów dla upraw celowych dla energetyki określany jest na 0,3–0,6 mln ha. Tymczasem w rolnictwie, po krótkim okresie zainteresowania prowadzeniem upraw drzew szybkorosnących w latach 2005–2008, spowodowanego przesłankami ekonomicznymi, tj. początkowo wsparciem z budżetu krajowego, a później również z funduszy unijnych, w kolejnych latach pojawiły się tendencje spadkowe wielkości powierzchni tego rodzaju upraw. W ostatnim okresie, tj. w latach 2010–2011, powierzchnia upraw plantacyjnych drzew szybkorosnących wynosiła około 11 tys. ha. W leśnictwie plantacje drzew szybkorosnących pełnią znikomą rolę. Są to niewielkie powierzchnie, będące na ogół pozostałością po plantacjach zakładanych w połowie lat siedemdziesiątych ubiegłego wieku. Łącznie w Polsce, w rolnictwie i leśnictwie, powierzchnia celowych upraw plantacyjnych drzew szybkorosnących w 2011 roku wynosiła 13,7 tys. ha.

Możliwości systematycznego zwiększania potencjału biomasy drzewnej istnieją przede wszystkim w polskim rolnictwie. Uprawy plantacyjne drzew szybkorosnących w tym sektorze mogą i powinny być traktowane jako stymulator rozwoju regionalnego, szczególnie obszarów wiejskich. Wykorzystanie pod te uprawy gleb gorszej jakości (nisko produkcyjnych), zanieczyszczonych i nienadających się do uprawy roślin jadalnych, ziemi odłogowanej lub terenów zdegradowanych jest bowiem dla rolników dodatkowym źródłem dochodów. Może być sposobem na poprawę efektywności ekonomicznej wielu gospo-

darstw. Stwarza również nowe miejsca pracy, co jest szczególnie ważne na terenach słabo rozwiniętych, charakteryzujących się z reguły wysoką stopą bezrobocia. Kierunki przyszłego rozwoju rynku biomasy z drzew szyborosnących wyznaczać będą głównie rosnące potrzeby sektora drzewnego na drewno do przerobu materiałowego i konieczność rozwoju alternatywnych wobec paliw kopalnych odnawialnych źródeł energii, wśród których biomasa drzewna odgrywa istotną rolę. Stymulująco lub destymulująco, w zależności od ich ostatecznego ukierunkowania, na rozwój tego rynku będą wpływać przede wszystkim regulacje prawne i instrumenty ekonomiczne (już obowiązujące i przygotowywane), ich kompleksowość, jednoznaczność, spójność i stabilność. Rozwój rynku biomasy z drzew szybkorosnących jest bowiem w dużym stopniu uwarunkowana aktywnym wsparciem finansowym i prawnym, zapewniającym opłacalność procesu jej pozyskiwania i przetwarzania. Główną kwestią i najważniejszym zadaniem jest zatem wypracowanie zarówno na poziomie krajowym, jak i na poziomie poszczególnych podmiotów gospodarczych, systemowego podejścia do rozwiązania już istniejących i przyszłych problemów funkcjonowania tego rynku.

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