Sustainable Bioenergy
Solutions for Tomorrow

RESEARCH REPORT
NO D1.4.1
HELSINKI 2016

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BEST task 1.4.1 – Case Poland:

Polish Farmers' Ability and Willingness to Supply Biomass for Energy Production

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ISBN 978-952-5947-93-9

Sustainable Bioenergy Solutions for Tomorrow

CLIC Innovation
Research report no D1.4.1b

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Joensuu, April 2016

Name of the report: Polish Farmers' Ability and Willingness to Supply Biomass for Energy Production

Key words: Poland; Farmers; Willingness; Torun; Upper Silesia (US)

Contents

Key Findings:

- Farmers play a pivotal role in ensuring the affordable and sustainable biomass supply chain. The objective of this survey-based study is to investigate the farmers' willingness to supply surplus biomass for power generations in Torun and Upper Silesia (US) province in Poland. Furthermore, the farmers' perceptions of the bioenergy challenges were also investigated. In this study, 212 farmers participated in filling-in the questionnaire.

- The results show that the majority of farmers who participated in this study were males, over 40 years old, own their property, own farming machinery, and their property is mainly agriculture fields. The farmers mainly plant cereals such as wheat, barley, corn, rye, and triticale rendering by-product straw as the main biomass material available for energy generation.

- Farmers used biomass (straw) for animal bedding and animal fodder with trivial amount being used for heating and cooking in Torun province and/or sold out to the market or acquaintances. The farmers use multiple fuels and interchangeably according to season, fuel availability, and prices. However, coal remain the key fuel for domestic use in US province.

- A key important finding is the farmers' shown unwillingness to collect, store, and transport their surplus biomass to power plants. It might be that the farmers may not paid enough for this extra activities or they may not have such efficient vehicle capacity for meeting the market price of biomass transportation. This is attributed by the current biomass market collapse due to low Green Certificate prices. Thus, the farmers shown less interest in cultivating energy crops or collect and store biomass residuals from the agriculture.

- In Torun and Upper Silesia (US), 50% of farmers consider farming as the only source of income. About 75% of farmers consider farming as a cultural heritage.

- The majority of farmers in Torun would sell their biomass to any destination but pelleting and briquetting industry is preferable. In US, the farmers have no preferences. The farmers appeared willing to have a fixed-contract with the power companies or market agent.

- About 80% of the farmers in Torun expressed their worries about social transformation in rural areas- young people migrating to cities for economic reasons. Logistics, lack of seasonal workers, and lack of policy support are among the key obstacles to bioenergy market.

- In Upper Silesia, the lack of well-established biomass market was the prime obstacle followed by the high availability and use of coal in the region.

- Old farmer, who own his agricultural land, consider farming as a cultural heritage, is less willing to change to bioenergy feedstock (willow or miscanthus plantations).

- Ownership of the land, and size did not influence the farmer's willingness to sell their biomass based on buyback agreement with companies or biomass traders. This is reflected from the present market conditions which is not favorable for biomass producers.

1. Introduction

Ensuring affordable and sustainable fuel supply chain is the main challenge to bioenergy development. This includes collection, sorting, pre-processing and logistics (IRENA, 2015). Farmers play a pivotal role in creating the cost-effective biomass supply chain for energy production purposes and in sustainable ways. In this pretext, farmers are the biomass producers and their cropping systems and agricultural activities largely determine the quantity and quality of biomass available in the market. More importantly, their ability to e.g. collect and transport the raw materials from their fields and their overall willingness to engage in biomass-to-energy supply chain largely and crucially influence the biomass prices and ultimately affect the energy production costs and the economic feasibility of the industry (Zyadin et al, 2015; Altman et al., 2015; Altman and Sanders, 2012; Caldas et al., 2014; Convery et al., 2014; Jensen et al., 2007).

Figure 1. *A Polish farmer standing by his Miscanthus plantation and pointing to the drought effect on his crop (brown stems)*

There are number of socio-economic, environmental, logistical, behavioral, and market factors that influence the farmers' ability and willingness to supply/grow biomass for energy production. In the vein of socio-economic factors, age, educational attainment, family and home size, and prior knowledge of biomass crops have been considered very important factors in biomass availability for selling. Other considerations include whether farmers are on bank-loan, and whether the farmers have other sources of income (off-farming income). For instance, In the USA, younger farmers with higher levels of educational attainment and off-farm incomes were willing to convert a higher share of farmland to switchgrass production (Jensen et al., 2007) whilst older farmers with large leased land are unwilling to supply biomass. (Altman et al., 2015). Profitability from farming remain a core objective of farming however farmers may appear satisfied with certain level of income "profit sufficiency" that covers the production costs and provide a profit marginal. On the other hand, farmers who seek "profit maximization" are the ones who are more interested in selling more biomass in the market and more willing to

switch to energy plantations in their fields. Altman et al., 2015 studied the degree to which biomass producers, from mid Missouri and southern Illinois, USA, will respond to price incentives to supply their products and found that producers will supply an additional 17-24% of their biomass production for 10 dollars per ton increase in price and that supply for three types of biomass (stover, straw and hay) is elastic. Recent studies from UK and Australia however showed that farmers have had other objectives from farming such as farming being a lifestyle with sense of place and lineage, it gives autonomy and being interesting outdoor activity (Caldas et al., 2014; Convery et al., 2014).

Climatic and environmental factors have a pronounced effect on the quantity and quality of biomass produced. Drought frequency, soil conditions, diseases, tillage practices, and cutting height are the number of studied factors. Kaija Hakala and her colleagues from the Natural Resources Institute (Luke) studied the influence of cutting height on “harvestable biomass” availability in Southern Finland, Varsinais-Suomi, which is a main cereal production area. Harvesting is usually done at 10-25 cm height. This means that about 30% of straw biomass is left on the ground. They indicated that as the cutting height increases (say 40 cm), the biomass availability decreases and organic matter in soil therefore increases. When considering emissions, soil fertility and carbon stock, they recommend to harvest straw every second year with lower cut (higher straw amount) than every year with higher cut and less straw (Hakala et al., 2015). During 2015, the Southern Poland suffered unprecedented three-month drought period. The effect felt by a Polish farmer who grows Miscanthus crop for energy production (see Photo 1 above).

Market related factors include market development and supportive policies, biomass import, and prices elasticities. For farmers, the nature of biomass purchase contracts (fixed-price, annual, market-based) and the farmer’s prior experience in selling biomass seems important factors (Caldas et al., 2014; Convery et al., 2014). In India, 97%, 79%, 69% of farmers in Maharashtra, Madhya Pradesh, and Tamil Nadu are willing to have a binding contract with energy producers and without the involvement of middlemen (Zyadin et al., 2015). In general, Farmers with prior experience in selling biomass appeared more willing to engage in biomass-to-energy supply chain (Caldas et al., 2014). The previous experience help farmers make decisions on where, when, and to whom to sell the biomass. On the supply-chain logistical issues, the availability of farm machines (such as harvester, baler, tractor, and truck), farm size, farm ownership, availability of storage place at the farm, transportation

distance and costs are crucial factors that may influence the farmers' ability and willingness to sell their surplus biomass in the market. Farmers with large land holding may able to supply more biomass but may not be willing to transport the large quantities of biomass Caldas et al., 2014; Convery et al., 2014; Zyadin et a.,2015). In Poland, farmers owning their own vehicles and having contracts with energy companies were transporting biomass to the plant's gate- the authors witnessed this system during their field excursion to Poland between June and July 2015.

Other psychological factors studied by Convery et al. 2012 alluded to the importance of the "*follow the leader*" mentality where one farmer must first start the biomass business and then others will follow in a so called snow-ball effect. Confidence is also crucial to the success of biomass supply chain, this confidence can be gained through contracts with secured buyer and stable monthly income.

Poland is the 9th largest country in Europe located in Central Europe with a population of 38.5 million people. Poland uses renewable energy for around 12% (2013) of their gross final energy consumption of which around 90 % is from biofuels (GUS 2015a). The primary source of energy is coal with 61 % of total energy consumption, followed by lignite (18.2 %), natural gas (5.5 %) and crude oil (1.4 %), which totals to 86.1 % (GUS 2015b). Even though the amount of renewable energy is still fairly low, the reserves of different biomass which could be used for bioenergy production are large. It has been estimated that Poland has from 60 to 150 PJ (4 to 11 Mtons) bioenergy potential from agriculture straw, and 20-30 PJ from forest residues (Nilsson et al. 2004).

Following the accession to the European Union (EU) in 2004, Poland was pledged to adopt a number of EU energy and enviromental directives particularly the EU Directive 2009/28/EC that introduced a binding target for Poland to increase the share of renewable energy to 15% of gross final energy consumption (from 7.2% in 2005), the directive also set a separate target for the transport sector: 10% of energy use in transport must come from biofuels or other renewable energy sources by 2020. Poland also has a specific target for renewables-based electricity set by Directive 2001/77/EC: 7.5% in 2010.

The successional governments in Poland developed and adopted a number of key policies and amendments to navigate the country's pathway toward a comprehensive energy sector reform. These policies also aimed at addressing the growing domestic energy needs, maintain dynamic economic growth, harness the local wind and biomass

resources, and exonerate the energy sector from the repercussions of political events [Crimea Island]. Key policies include (1) Polish Energy Policies Until 2030 [adopted in 2005], (2) National Renewable Energy Action Plan [submitted to EC in 2010] and (3) the long awaiting Renewable Energy Resources Act [adopted in 2015].

The key support mechanism in the aforementioned policies is "quota obligation with tradable *certificate of origin* or so called "green certificate". It means energy suppliers must ensure that a certain share of electricity sales comes from co-generation (at least 13.7% in 2005 and 16% in 2010). In this regard, electricity suppliers must either submit the requested amount of certificates of CHP origin (so called "red/brown certificates") to the Energy Regulatory Office, or pay a substitution fee equivalent to 68€/MWh. Suppliers can acquire the certificates of origin by generating their own CHP or buy them on the tradable certificates market. For coal-based power plants this mechanism was strong economic incentive has led to considerable increase in co-firing in large pulverized fuel (PF) boilers in Poland (IEA, 2011; Lars et al., 2006; Ericsson, 2007; Oniszk-Pop et al., 2003; Paska and Surma, 2014).).

The mechanism worked well until biomass import led to a glut of biomass availability in the market at relatively low prices and also substantial use of biomass in co-firing with attractive revenues for cofiring industries. As a result, green certificates flooded the market and their prices dropped drastically to about 25 euros per MWh. The year 2012 marked the collapse of biomass market and further policy adjustment were needed to fix the biomass market situation. Farmers were hit hard by this market dilemma and their ability and willingness to supply biomass have been adversely affected and changed.

The BEST project case Poland task 1.4 is divided into five different subtasks: subtask 1.4.1 the social processes and influences are studied focusing on the social acceptance and farmers' ability and willingness to supply biomass for energy generation under current biomass conditions.

In this report, the results of the farmers' ability and willingness to supply biomass raw materials for power generation is presented through a survey study conducted in two contrasting locations in Poland: Upper Silesia (coal-based region), and Torun (agriculture and high renewable energy potential region). The aim is to understand the factors that influence the farmers' capabilities and wiliness to re-engage in biomass supply chain.

2. Methodology

The main methodological approach implemented in this study is a self-instructed survey tool designed for farmers and also energy plantation growers in two contrasting regions in Poland (see map 1). In the North, Torun (Kujawsko-Pomorskie province) and the surrounding areas, and in the South, Upper Silesia and the surrounding regions were selected for this study. Torun is a key agricultural area and also home from other renewables such as wind energy. Torun province has also a number of well-established pellets producers. Down south, the Upper Silesia region is the home of extensive coal reservoirs and high forest areas. The first part of the questionnaire was devoted to investigate size and type of land holding, agricultural activities and productivity, use of fertilizers, and the existing uses of biomass in farms. The aim was to calculate the biomass potentials and also calculate the share of biomass used in farm activities such as animal feed, bedding, ploughing, cooking etc. The objective is calculate the surplus biomass that can be used for energy production taking into account the livelihoods of rural communities who rely on biomass for household use. An important considerations such as whether farming is the only source of income, considered as a cultural heritage, and whether the farmer is willing to switch to energy plantations under ideal conditions were considered in the questionnaire items. The farmers' understanding of the problems and challenges in bioenergy sector in Poland were investigated through 8 statements with a Likert-scale ranging from *highly relevant, relevant, irrelevant, highly irrelevant, and I don't know*. Farmers' ability and willingness to engage in a new biomass supply chain for energy production was investigated through another 8 statements with optional answers *yes, no, I am not sure, I cannot answer.* Other socio-demographic factors such as age, gender, and land ownership were also included in the survey. Full version of the questionnaire is attached to this report in Annex 1. The questionnaire was written in English, distributed to partners for commenting, and later on was sent to our BEST projects

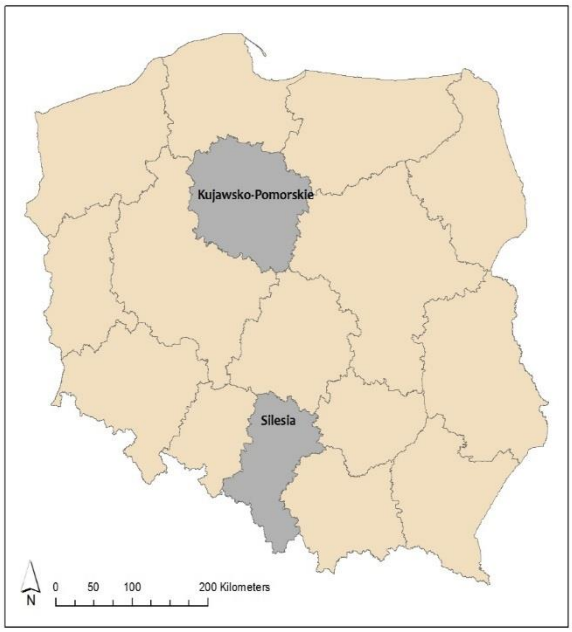

***Figure 2**. Locations of the farmers' survey study*

partners in Poland to be translated to the Polish language. The data collection period extended from July to September 2015 during which the harvesting season was in peak rendering data collection difficult in some locations and with some farmers. In Upper Silesia, in the beginning farmers were approached by mobile phones and email which gave no results. The first success was the search for farmers selling their biomass (straw, corn, and rapeseed or energy willow) on online auctions and/or advertisement sites. This method was proven successful, and gave us a possibility of obtaining phone numbers to contact the farmers.

To exploit every potential possibility, we also tried to use email addresses from the same auction sites as before, and during one week we sent out over 300 emails in which we asked farmers to fill in the attached questionnaire. Unfortunately we have received no response at all for any of our requests to fill in the survey. The last attempt to collect data was through visiting Agricultural Advisory offices in Kluczbork, Częstochowa, Łódź, Opole and Kraków cities. The idea is to leave certain number of questionnaire copies and come back in a week or two to collect the filled-in questionnaires. About 50 questionnaires were filled through this method. Some of the reasons for the refusal to fill in the questionnaire were being busy with harvesting, too long questionnaire, and the unwillingness to provide personal data or data related to land activities.

In Torun and the surrounding province, the survey research was conducted mainly in person by our research Anna Igliński and Bartłomiej Igliński- from Nicolaus Copernicus University. If there wasn't any person who could give information, the questionnaire with envelope and stamp were left in the mailbox. We received five surveys this way. Some surveys were conducted by BioFuture Company worker from biomass producers in Lubień Kujawski and also worker of OpecBio Company in Grudziądz. In total, 112 surveys were collected from Torun province and the surrounding areas.

3. Results

3.1 Socio-Economic, land ownership, and Demographic features

In total, 212 farmers participated in this survey study (100 from Upper Silesia and 112 from Torun). Six questionnaires were rejected due to incomplete or bizarre data filling. In both locations the majority of the participants were male with average age 44 years in Torun and 46 years in Upper Silesia (Figure 3).

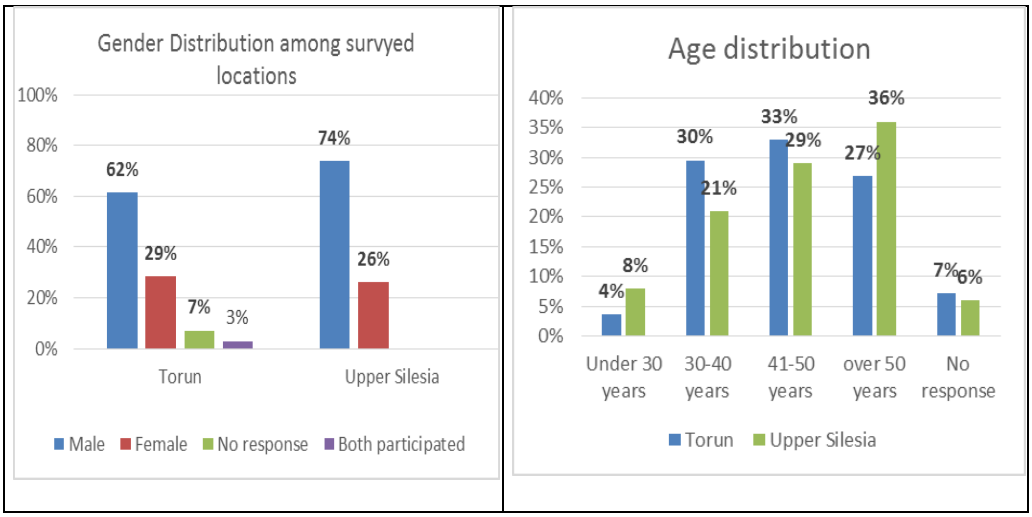

***Figure 3**. Gender and Age distribution among the participated farmers from both locations*

In Torun, 56% of the farmers indicated that the cultivated field is their property, 11% of the farmers have own farmlands and rent, 22% of the respondents rent the land (mainly it is in south-west part of researched area, and 11% did not report ownership. In terms of numbers, 97 farmers have agricultural field – the smallest is 1 ha, the biggest is 181 ha, average area is 25.50 ha. 45 farmers have grassland besides their agricultural field – the smallest is 0.3 ha, the biggest is 50 ha, average area is 6.63 ha (for 45 farmers). 4 farmers have little energy plantation (around 1 ha). Area of energy plantations declined in recent years. There are two reasons for this: lack of subsidies and the reluctance of the power plants to buy small quantities of biomass. 15 farmers have a forest land in kujawsko-pomorskie voivodeship province which is the least forested in Poland with a 22% forest cover. The average area of forest land is 1.65 ha.

In Upper Silesia the majority of farmers (94%) own their land and 81% of the land cultivated is agricultural field and/ or mixed 16% consisting of agriculture, grassland or small energy plantations. The average size of agricultural land in Upper Silesia is 7.2 hectares and in Łódz 7.6 hectares per farm. When it comes to crops and cropping systems, the participated farmers from Torun province cultivate more than one crop in a given

season. Crops such as wheat, barely, triticale, rapeseed, and corn are very common with average planting area of 12 ha, 3 ha, 6 ha, 10 ha, 10 ha respectively. Almost every farmer uses fertilizers. About 70 farmers in this study use animal manure for soil fertilization with average quantity at 27.31 Mg/ha. Moreover, 78 farmers use Nitrogen fertilizer – average 238.97 kg/ha. 72 farmers use Phosphorous fertilizer – average 156.42 kg/ha. Some farmers also use another fertilizers. It has been noted that the nearer the big city is (for example Turzno near Toruń), the more fruit and vegetables are cultivated for the local market. In Upper Silesia, wheat, barley, rye, corn, and potato are the main crops with cultivated land area ranges from 1 ha up to 60 ha (average 4.7 ha). Farmers use nitrogen fertilizer mainly followed by phosphorus and organic manure. The highest amount of nitrogen used is 200 kg/hectare- as reported by the participants.

3.2 Biomass existing uses

As indicated in **figure 4** the majority of famers in both locations use their biomass as animal fodder, animal bedding, and ploughing with the soil. About 7 farmers in Torun indicated the use of biomass for cooking and heating and it is increasing whilst in Upper Silesia not a single farmer indicated the use of biomass for cooking or heating.

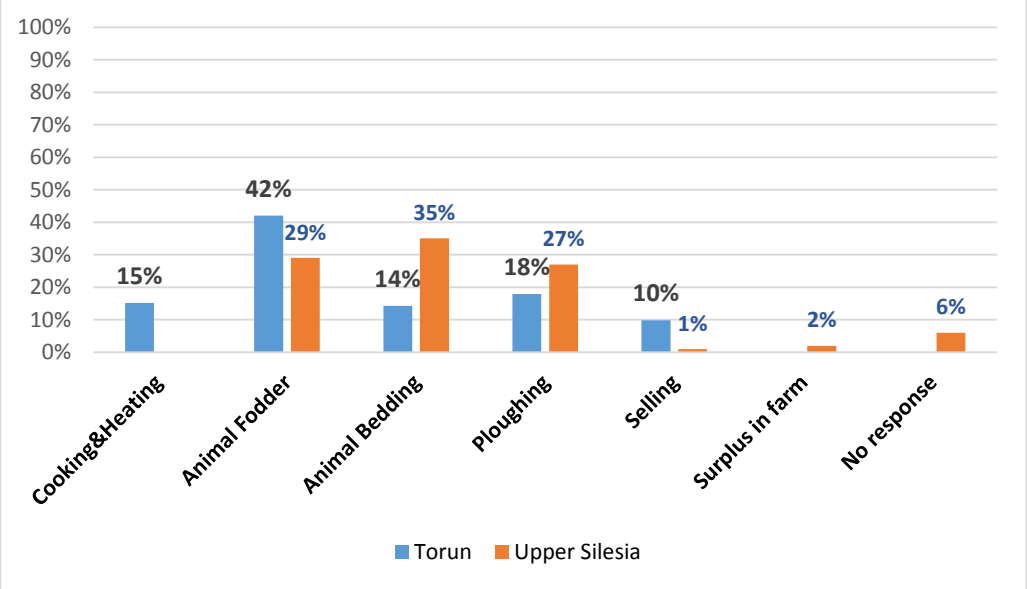

***Figure 4**. Uses of biomass at the household level after harvesting in both locations*

For profit expectations and farming objectives, 50% of farmers in both locations consider farming as only source of income and the other 50% have off-farm income from other public or private sources. A noteworthy finding is that about 75% of the farmers consider farming as “cultural

heritage", therefore, 55 farmers from Torun and 54 farmers from Upper Silesia were unwilling to change the traditional existing farming practices into feedstock for energy production. There were about one-third of the farmers in both locations whom were not sure to do so.

The farmers were asked to indicate what types of agricultural machinery they possess. In Torun and Upper Silesia provinces, almost every farmer has tractor and small farmer equipment. The bigger field area, the more machineries the farmer has in his possession. Space-heating in winter time is crucial factor for the use of biomass therefore the farmers were asked to indicate the fuel choices used in space-heating their homes. The figures show that farmers use multiple fuels and interchangeably. In Upper Silesia coal was the major and almost the only source of heating- this is not surprising given the abundance of coal in this region. They also indicate the use of firewood probably due to the high share of forest cover which also provide a source of firewood from thinning or clear felling operations. The government sells the residues of thinning operations as 15 PLN/m^3 (6 euros) for locals, which is very affordable price.

In Torun, energy sources for spacing heating were much diverse including 9% agro-biomass, and other modern renewables such as solar and heat pumps.

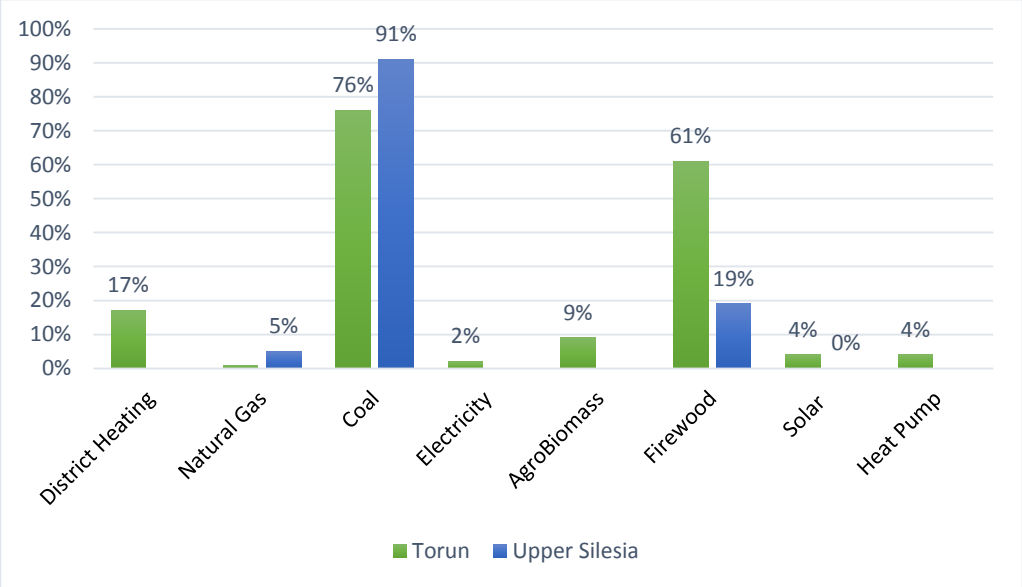

***Figure 5**. Farmers fuel choices for space heating in both locations*

Given the harsh time the biomass market is currently going through in Poland, the farmers were asked to whom they would like to sell their surplus biomass. The farmers from Torun were more eager and willing to sell their biomass to almost all interested parties with "pellet and briquette

plants" were of particular interest. This is probably due to the experience of the famers with the existing pellet factories in Torun such as the BIO-OPEC Company, and BIOFURURE Company. In Upper Silesia, and according to our knowledge, no large scale pellet industries exist. The collapse of the biomass market (low prices and low demand) made many farmers abandon their energy plantations and for normal farmers it became difficult to sell biomass in the market. Therefore, the existing uses of biomass has increased in farms and at both regions.

3.3 Farmers' ability and willingness to supply/sell surplus biomass for energy production in Poland

The farmers' ability and willingness to sell surplus biomass for energy producers was tested through eight statements with answers include yes, no, I am not sure, and I cannot answer. Figure 3.3.1 presents descriptive statistics of the farmers' answers from Torun province. About 50% of the farmers seem unaware whether there is a high demand for biomass in Poland or not however 38% believe that selling biomass would increase their income. 30% of the farmers indicated that they have surplus biomass for selling whereas small farmers may not have surplus biomass for selling since biomass is fully utilized as feed for livestock, bedding, and ploughing with the soil. A key important finding is the farmers' unwillingness to collect, store, and transport their surplus biomass to power plants. This might be explained by the lack of transportation vehicle and/or the transportation costs associated with transporting the raw materials, particularly in the light of low biomass prices at the moment. Since nature of purchasing contracts may have an influence on the farmers' willingness, the farmers in this study were questioned about the type of contract they would like to have. In Torun province, 38% of the farmers seem willing to have a fixed-contract through which a buyer and stable income are both secured with confidence. Market price appeared not a favorable option given the low biomass prices at the moment.

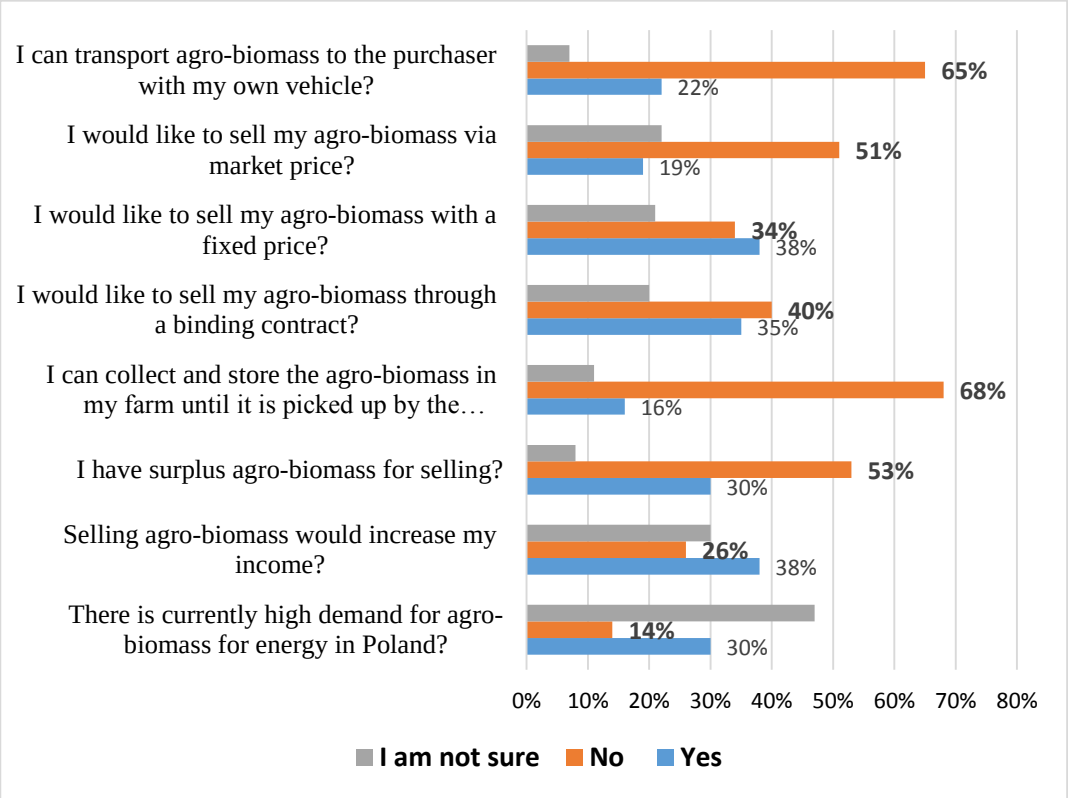

***Figure 6**. Farmers' ability and willingness to supply/sell surplus biomass for energy producers in Torun province*

In Upper Silesia, the majority of the respondents either do not believe/know that there is a demand for biomass or selling biomass would increase their income. This is a natural perception giving the chaotic biomass market at the moment (low price, low demand). Although the average land sizes might be small in Upper Silesia (about 7 ha), still one-third of the farmers stated that they have surplus biomass for selling. This share is elastic and might increase with favorable market conditions. Similar results to Torun province, the farmers showed unwillingness to collect, store, and transport biomass to power plants. This is also associated with the low biomass prices, transportation costs, and the deduction fees the power plants charging when biomass quantities and qualities do not meet the requirements set by the power plants. It is estimated that these deduction fees causes up to 700 PLN/daily (28 euros) loss for the biomass provider or 14000 per month (56 euros). Table 1 below shows the parameters of the minimum biomass requirements set by a power plant in Poland. The table also indicate the scale of price deductions if the supplier fail to meet the biomass requirement.

Table 1. Example of the biomass requirements set by a power plant in Poland and price deduction (Aleksander Lisowski, 2016, personal communication).

Parameter		Unit	Min/max	Value
Calorific value	cv_g	GJ·Mg^{-1}	min	7,0
Moisture content	w_g	%	max	50 (April- September) 60 (October - March)
Sulfur content	z_{sg}	%	max	0.3
Ash content	z_{pg}	%	max	5.0
Granulation: length/width/height	g_z	mm	min max	10/10/10 50/50/50
Basic price (mass)	p_{pm}	PLN·Mg^{-1}	-	193.50
Basic price (calorific value)	p_{pc}	PLN·GJ^{-1}	-	21.50
Price reduction for exceeding the value of the contract				
Calorific value	p_{cj}	PLN·GJ^{-1}	-	1,08-1,12
Moisture content	p_{wj}	PLN·GJ^{-1}	-	1,08-1,12
Sulfur content	p_{sj}	PLN·GJ^{-1}	-	1,08-1,12
Ash content	p_{pj}	PLN·GJ^{-1}	-	1,08-1,12

Yet again, some 37% of the farmers are willing to collect and store biomass until it is picked up by the purchaser. This is partially due to the willingness to sell surplus biomass to generate extra income and the probably the low quantities of biomass the farmers have in their farm, which can be transported by their own vehicles. About 30% of the farmers are willing to sell biomass by either market price or fixed price with less interest in a binding-contract. It is difficult to provide an explanation to these findings as the nature of contracts is not clear to farmers at this stage of the study and the authors have no knowledge of the farmer's previous experience in biomass procurement methods and system of contracting. What appears compelling to argue is that Upper Silesia accommodate large number of coal-fired power plants and also the scale of co-firing is high. That means contracts remain a crucial factor in developing new and a cost-effective biomass supply chain in this region. This also shows that ICT tools and mobile-based applications will surely help identify the biomass locations and enhance the logistics of biomass supply chain at a cost-effective schemes.

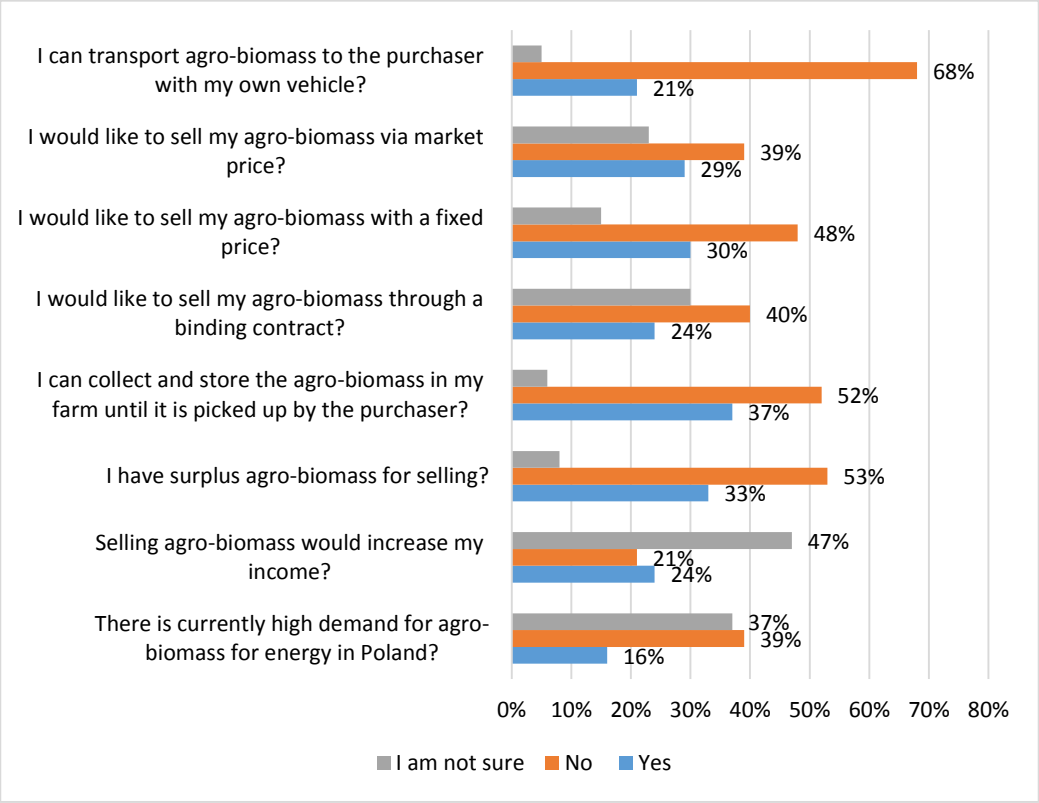

Figure 7. *Farmers' willingness to supply/sell surplus biomass for energy producers in Upper Silesia region*

3.4 Farmers' perceptions toward challenges to bioenergy development in Poland

Giving the status of bioenergy market in Poland and the current difficulties it is confronted with, the farmers were asked about the main challenges and factors which they considered problematic to biomass market in their regions. For doing so, eight statements were presented to the farmers with answers scale from highly relevant, relevant, I do know, irrelevant, and highly irrelevant. Figure 3.4.1 presents the scorings of the respondents' answers in Torun province. The figure clearly shows that all the factors and challenges are highly relevant and/or relevant for the biomass market. Noteworthy is the respondents' scoring of "transformation in agriculture" with young generations flee the rural areas for better life opportunities in cities. Economic migration of young people to cities not only reduces the interest in continuing farming practices but also reduces the "replacement rate" of farmers. Older farmers will retire and new blood is needed, therefore, future outlook of biomass market development will largely depends on policy and efforts put in place to encourage young people to engage and continue farming. The nature of succession is generally such that business decision-making does not devolve to offspring until the parents are well into retirement (Convery et

al., 2012), therefore, policymakers are encouraged to develop new policies aiming at early succession with the involvement of the young offspring. Logistical costs associated with collecting and transporting biomass comes as a second most relevant factors. This is typical reason giving the extra costs associated with transportation and the low prices of biomass making transportation a financial burden on the farmers.

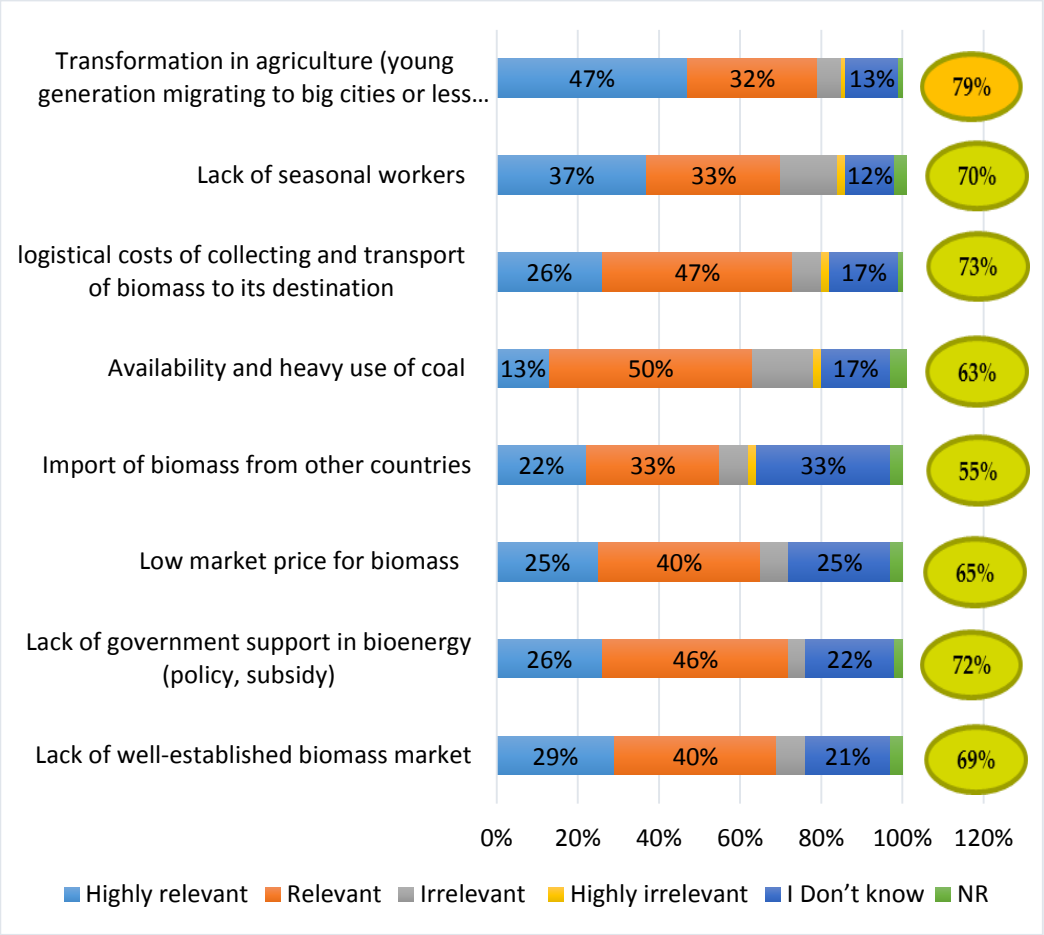

Figure 8. *Farmers' perceptions toward challenges to bioenergy development in Torun province*

In Upper Silesia region, the scorings of the respondents showed slight differences from Torun province (Figure 3.4.2). Two major challenges considered very relevant to bioenergy markets were the "lack of well-established biomass market" and the "availability and heavy use of coal". The region was the home for number of energy plantations which suffered financial difficulties and were forced to shut down rendering the biomass market uncertain and chaotic. Furthermore, the region is the home of large coal reserves and therefore biomass is considered secondary option for energy production. Compared to Torun the lack of season workers and import of biomass were the least challenging factors. Half of the respondents indicated the relevance of transformation in agriculture

sector and the migration of young folks to cities. This issue seem to be also important in Upper Silesia.

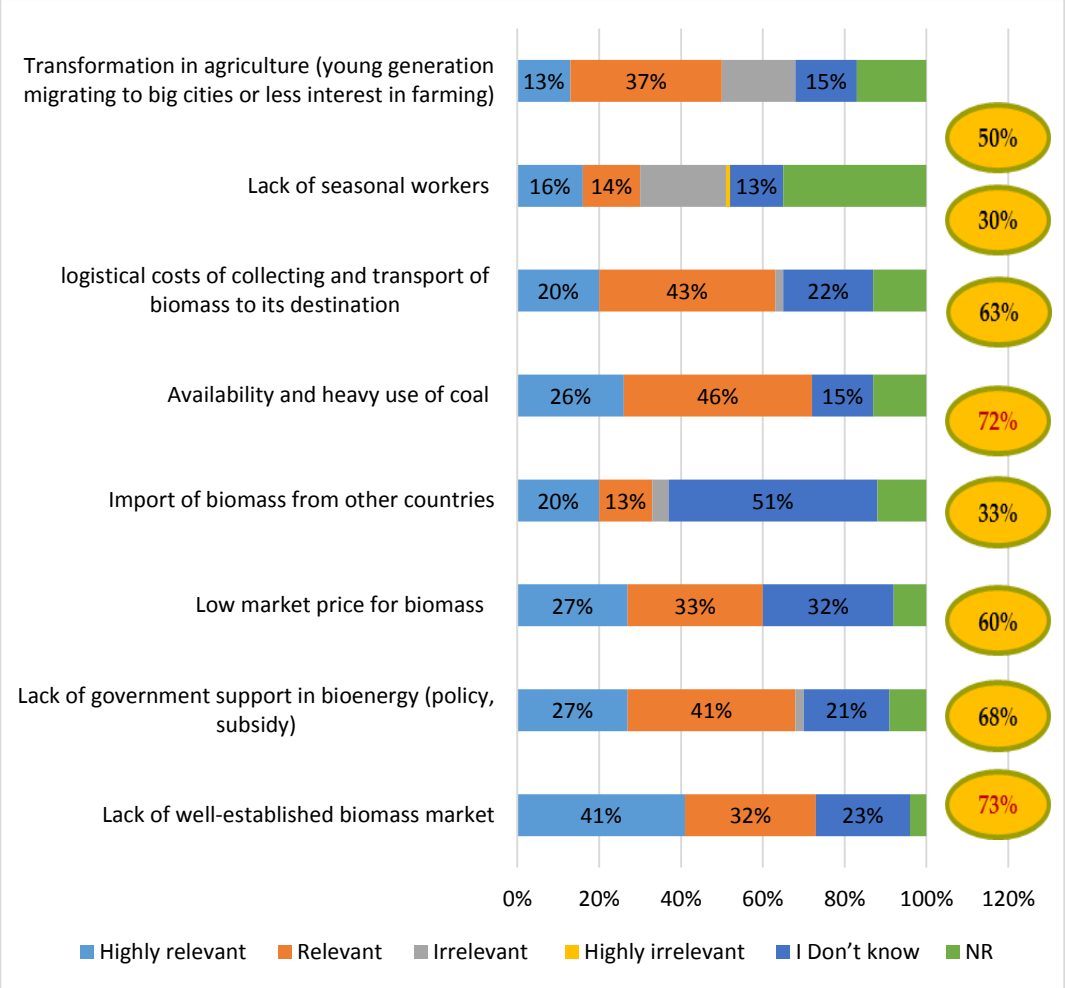

Figure 9. *Farmers' perceptions toward challenges to bioenergy development in Upper Silesia province*

The responses from farmers confirm the difficulties the biomass market is currently going through in Poland and thus it highlights the need for policy reform and continuous support schemes. Prices must reflect the farmers' need to encourage farmers to engage the biomass supply chain. Investing in creating new businesses and employment opportunities will not only maintain stable flow of biomass for energy purposes but also help address the economic migration of young people by smoothening the succession process, guide young people in energy plantation options and opportunities, and maintaining fair and acceptable levels of support schemes.

4. Acknowledgement

The work was carried out in the Sustainable Bioenergy Solutions for Tomorrow (BEST) research program coordinated by CLIC Innovation with funding from the Finnish Funding Agency for Innovation, Tekes. The authors would like to sincerely thank Elena Fedorova and Eva Pongracz from Oulu University, Petri Latva-Käyrä from Arbonaut for commenting and improving earlier version of the questionnaire.

The authors would like to greatly thank the following project partners from Poland for their efforts to conduct the survey data among Polish farmers: Bartlomiej Iglinski from the Nicolaus Copernicus University, Aleksandra Kaczmarek, the International Faculty of Engineering, Lodz University of Technology, and Jakub Kajdanek, the Faculty of Biology and Environmental Protection, University of Lodz.

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Annex 1: Survey tool

Participant number ……Province ……county…….

Contact address……..

Section 1. Background information.

1.1. I am ( ) male, ( ) female farmer and my age is …….years old.

1.2. I own ( ) or rent ( ) the following land holding: Please use the (×) mark.

Field type	Agriculture field	Energy Plantation	Forest land
Size (Hectare)			

1.3. **I plant the following crops:**

Name of the crop planted (corn, wheat, oats etc)	Season (Sown – harvest)	Cultivated area (ha)	Crop production (tons/ha)	Crop residue type (straw, combs)	Crop residues production (tons/ha)	share of crop residues for selling (%)

1.4. **I use the following fertilizers for my crops:**

Animal Manure (tons/ha)	Nitrogen (kg/ha)	phosphorus (kg/ha)	others (kg/ha)	others (kg/ha)

1.5.**Existing use of crop residues. I use crop residues for the following uses:**

type of crop residue	Cooking & heating at home (%)	Animal fodder (%)	Animal bedding (%)	Ploughing (%)	Others (%)	Surplus in farm (%)

1.6. If there are other uses of biomass please specify here (%)……/……

1.7. What is the source of water for irrigation in your field……/…….....

1.8. What type of fuel you use for your agriculture machinery……/……

1.9. Is farming the only source of income for you? ☐Yes ☐No ☐ I don't know

1.10. Do you consider farming as a cultural heritage? ☐Yes ☐No ☐ I don't know

2. Are you willing to change the traditional and the heritage of stock production and dairying into feedstock for bioenergy production?

Yes	No	I am not sure	I cannot answer
☐	☐	☐	☐

3. I own the following machines: Please use the (×) mark.

Tractor	Harvester	Baler	truck	plower	others, please write here:
☐	☐	☐	☐	☐	

***3.1.*How do you heat your house? you can choose more than one if you wish.**

- ○ Central or district heating
- ○ Natural Gas
- ○ Coal
- ○ Electricity
- ○ Diesel boiler
- ○ *Other (specify, please)*_____
- ○ Agro biomass
- ○ Firewood (billets, pellets,)
- ○ Biogas
- ○ Wind
- ○ Solar

***3.2.*Please use the (×) mark in the table below.**

	Yes	No	I am not sure	I cannot answer
There is currently high demand for agro-biomass for energy in Poland?				
Selling agro-biomass would increase my income?				
I have surplus agro-biomass for selling?				
I can collect and store the agro-biomass in my farm until it is picked up by the purchaser?				
I would like to sell my agro-biomass through a binding contract?				
I would like to sell my agro-biomass with a fixed price?				
I would like to sell my agro-biomass via market price?				
I can transport agro-biomass to the purchaser with my own vehicle?				

***3.3.*If you wish to sell you surplus biomass, to whom you would like to sell?**

- ○ Municipal thermal power plant (co-firing)
- ○ Private thermal power plant
- ○ Private biogas producer
- ○ Pellet and/or briquette producer
- ○ *Other (please specify)*----------

3.4.Which of the following you considered problematic to biomass market in your region?

	Highly relevant	Relevant	Irrelevant	Highly irrelevant	I don't know
Lack of well-established biomass market	☐	☐	☐	☐	☐
Lack of government support in bioenergy (policy, subsidy)	☐	☐	☐	☐	☐
Low market price for biomass	☐	☐	☐	☐	☐
Import of biomass from other countries	☐	☐	☐	☐	☐
Availability and heavy use of coal	☐	☐	☐	☐	☐
logistical costs of collecting and transport of biomass to its destination	☐	☐	☐	☐	☐
Lack of seasonal workers	☐	☐	☐	☐	☐
Transformation in agriculture (young generation migrating to big cities or less interest in farming)	☐	☐	☐	☐	☐

Section 2: if you are energy crop producer or planning to start energy crop plantation, please answer to the following questions:

1. The land size of the energy crop plantation in hectares is:
   a. …… (existing) & b. …….. (planned)

2. The land is owned ☐ or rented ☐

3. The type of energy crop is: please selected from the table below, please mark (X).

Willow	Poplar	Alder	Virginia Mallow	Jerusalem Artichoke	Miscanthus
☐	☐	☐	☐	☐	☐

Others, please specify……..

4. What is the source of water for irrigating your energy crops……/……....**...**

5. Is energy crops the only source of income for you? ☐Yes ☐No ☐ I don't know

6. Do you fertilizers for your energy crops farm? ☐Yes ☐No I don't know

If yes, please specify here……..

2.1. Please answer the following questions by placing (X) mark in the small box.

	Yes	No	I do not know
Do you produce energy crops for your own use only?	☐	☐	☐
Do you sell energy crops to energy company?	☐	☐	☐
Do you think energy crop farm is profitable?	☐	☐	☐
Have you received financial support to start your energy crop farming?	☐	☐	☐
Are you planning to start new energy crop plantation?	☐	☐	☐
Are you planning to expand your existing energy crop plantation?	☐	☐	☐

2.2. Which of the following you considered challenging to energy crop plantation in your region?

	Highly relevant	Relevant	Irrelevant	Highly irrelevant	I don't know
Lack of well-established biomass market	☐	☐	☐	☐	☐
Lack of government support in bioenergy (policy, subsidy)	☐	☐	☐	☐	☐
Low market price for biomass	☐	☐	☐	☐	☐
Import of biomass from other countries	☐	☐	☐	☐	☐
Availability and heavy use of coal	☐	☐	☐	☐	☐
Logistical costs of collecting and transport of biomass to its destination	☐	☐	☐	☐	☐
Attack of fungal diseases, and pests	☐	☐	☐	☐	☐
Lack of seasonal workers					
Transformation in agriculture (young generation migrating to big cities or less interest in farming)	☐	☐	☐	☐	☐
My lack of knowledge and training	☐	☐	☐	☐	☐

Dear Farmer, if you have something else to add regarding bioenergy future, challenges, and opportunities in Poland please feel free to write it down in your own wording here. You experience, thought, and opinions are valuable to us. Please use the back of the pages to write your comments if you need more space. THANK YOU

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