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Potential of Utilised Agricultural Area for Bioenergy Production: the Case of Latvia

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Abstract

Utilised agricultural area (UAA) used for food production is the national wealth of any country. Yet, it is important to maintain land for next generations in the face of climate changes and to utilise it efficiently today. Lately, the agricultural land in the European Union (EU) is being more and more used for biomass production to produce energy from renewable energy resources (RER) of agricultural origin. Therefore, competition increases among various types of agricultural land utilisation. A unique situation is observed in Latvia, since 302 thousand hectares (ha) or 13% of its utilised agricultural area was not used for agricultural production in 2011. Here, the main reason being uncultivated or overgrown land areas. In addition, its agricultural productivity – gross value added of the agricultural industry per hectare was the lowest one in the EU. The present research helped ascertain potentials for a more productive use of UAA and cultivation of presently unutilised agricultural area for increasing both the output of food and the output of biomass for energy production in Latvia.

Keywords: utilised agricultural area; renewable energy resources; productivity

1. Introduction

Land is the most valuable resource in most countries. Accesses to land, security of tenure and land management have significant implications for development [1]. In Latvia, totally 98% of land is situated in the countryside. According to the State Land Service (SLS) information, woodland comprised 46.3% and UAA - 37.3% of the total area in Latvia at the beginning of 2012 [2]. Therefore, a more efficient use of every

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hectare of UAA becomes an important issue. Traditionally, UAA is regarded as a territory for the production of agricultural produce [3]. If land cannot be used efficiently in agriculture, it is necessary to free it for the needs of other uses – forestry, civil engineering etc., where it is possible to get higher economic benefit [4].

The EU development becomes topically dependent on renewable energy resources (RER). The output of RER has increased over the recent years. In the future, agriculture as a supplier of biomass for RER producers will play a very important role [5]. In the EU, biogas production from agricultural plants reached 36% in 2007 [6]. There were approximately 4000 biogas facilities in Germany in 2008 [7], about 3% of the agricultural land area is used for bioenergy production (70 000 ha) in Sweden [8], and political interest in biogas has also increased in Denmark, where they forecast a growing potential of biogas energy from agricultural biomass before 2020 [9].

Interest in renewable energy resources, including biogas production from biomass of agricultural origin, has arisen in Latvia since 2009 with the construction of the first biogas facilities [10]. It is a new economic industry, and thus, it is a research object for several scientists in economics, for instance, A.Kalnins [7], V.Strikis, A.Lenerts [5], S. Rivza, I.Pilvere, P.Rivza, B.Rivza [11], J.Leikucs [12], A.Bronka, A.Zvirbule-Berzina [13] etc. Hence, it is important to find out whether sufficient resources will be available for developing the biogas industry exploiting biomass of agricultural origin. The aim of the present research is to assess the use efficiency of UAA in Latvia in order to determine the potential for increasing the output of RER biogas. Economic analysis methods [14] and information on various aspects of UAA available to the governmental institutions of Latvia were employed in the assessment.

2. Land use efficiency in the European Union Member States

There is a renewed interest for land in Europe, and especially prime - agricultural land. This derives from demand for increased food and biomass production from a growing world population. At the same time, there is a need to adapt agriculture to climate changes. Also, claims on the available land from urban development, bioenergy cropping and nature development are directed towards land currently in use for agriculture [15]. Under such circumstances, it is important that agriculture is efficient and exploits the available resources in a rational way, especially UAA. Productivity means the amount produced per unit area of land or per person employed [16]. The productivity level per hectare differs 35 times among the EU Member States. It is 2.1 times higher in the old Member States compared with the new ones (Figure 1).

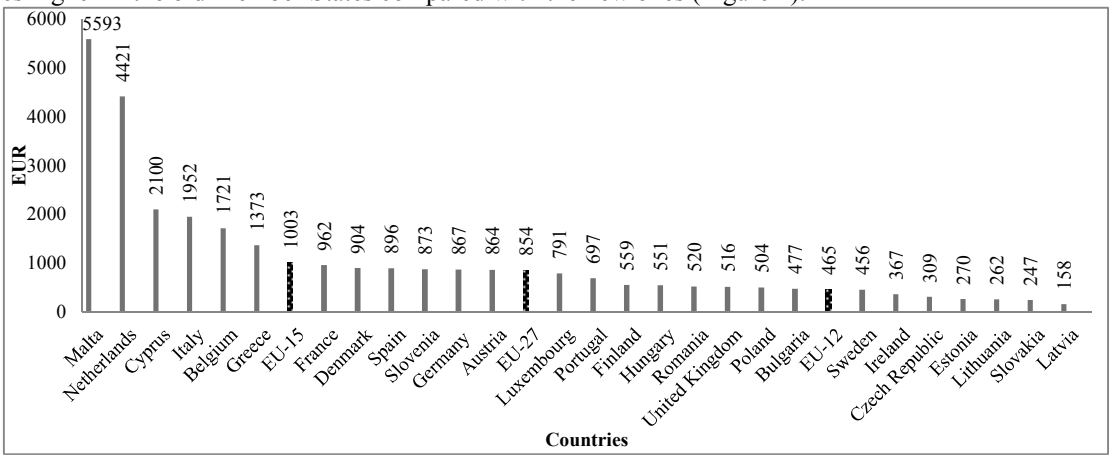

Fig. 1. Gross value added (GVA) of the agricultural industry - average basic and producer prices in 2006-2011 per hectare of UAA (2007) in the European Union countries and country groups, EUR [17, 18]

The lowest GVA of the agricultural industry per ha of UAA is observed in Latvia, and it is 5.4 times lower than in the EU on average and 2.9 times lower than in the new Member States having joined the EU after 2004. It points to a comparatively small output of agricultural products and large land resources. Therefore, it is important to search for the possibilities to increase agricultural productivity and efficiency, and to assess the main resource – UAA – in Latvia.

3. Assessment of the use of utilised agricultural area in Latvia

Starting from the autumn of 2010, the Rural Support Service (RSS) surveys the utilised agricultural area in Latvia and provides information to local governments on the calculation of the additional immovable property tax rate (1.5%). The related Cabinet regulations set the criteria for stating that the land is not maintained in a good agricultural and environmental condition [19].

3.1. Land resources and the assessment of their use

The RSS visually surveys those units of agricultural land, the area of which exceeds one hectare. The UAA is regarded as uncultivated if the grass on it has not been mowed, removed, or chopped and spread at least once until 1 September of the current year. If some trees or shrubs are observed on it, the land is declared as overgrown [19]. The uncultivated and overgrown area in Latvia has decreased by 61.5 thousand ha and accounted for 13% of the total agricultural area in 2011 (Table 1).

Table 1. Survey results of agricultural land in Latvia in the period of 2010-2011 [20, 21]

Indicators/Years	2010		2011		2011/2010	
	ha	structure, %	ha	structure, %	ha	%
Cultivated UAA	1978255	84	2024792	87	46538	102
Uncultivated UAA	314047	13	260374	11	-53673	83
Overgrown UAA	49524	3	41688	2	-7836	84
Total UAA	2341556	100	2326854	100	-14702	99

Totally 9082 cadastral units (units of property) of an overgrown land area of 36724 ha (88% of total) and 50217 cadastral units of an uncultivated agricultural area of 245762 ha (94%) were selected and analysed in detail at the beginning of 2012 to assess the future possibilities for using UAA. These areas were subject to analysis, since their purpose of use corresponded to agricultural activity. All cadastral units (59299 units of land) were grouped by size and the agricultural land qualitative estimate (ALQE) in points was performed using the Excel tool Data Filter. The agricultural land qualitative estimate (in points per ha) is a measurement of soil fertility - the higher number of points, the more fertile is the soil [22]. The ALQE ranged from 5 to 80 points in the present research. The ALQE was below 25 points for 33% of the analysed area, thus, agricultural production on this area might not be profitable in the future.

3.2. Economic efficiency of the uncultivated and overgrown agricultural area

This assessment is derived from an approach that every hectare of land shall produce income, which means that the value of crop (quantity of produce multiplied by its price) per hectare shall exceed the expenditure on crop production. The average weighted ALQE is 38 points [22] in Latvia. This figure is regarded as the minimum soil fertility level for agricultural land on climatic conditions of Latvia to ensure commercially viable agricultural activity. Yet, the SLS states that a point of ALQE, according to a measure of productivity, is worth as follows: one land quality point equals 70 kg of rye [23]. Therefore, this indicator has

been used to determine the profitability of each land unit depending on its ALQE. The calculations were performed using several equations. Equation 1 specifies income per ha of UAA, considering the ALQE and various levels of price and subsidies – single area payments (SAP) and the excise tax for fuel, since farmers pay no excise tax on diesel fuel.

$$TR_{1n-2n}=ALQE_{1n} \text{ x70kg x } P_{2n,} \quad (1)$$

where TR stands for total revenue per ha depending on the cadastral size and the ALQE. The $ALQE_{1n}$ and the rye price (P_{2n}) determination principles and versions are presented in Table 2.

Table 2. The average $ALQE_{1n}$ and price (P_{2n}) determination principles and versions per ha of UAA in Latvia [24, 25, 26]

Average $ALQE_{1n}$		P_{2n}		
Versions	Values	Versions	Value	Comments
1.1	20	2.1	171.01 EUR t^{-1}	Average rye price in Latvia in 2011
1.2	(25-21)/2	2.2.	123.65 EUR t^{-1}	Average rye price in Latvia in 2006-2011
1.3	(30-26)/2	2.3.	171.01 EUR t^{-1} +72.20 EUR ha^{-1}+ 33.30 EUR ha^{-1}	Average rye price in Latvia in 2011 + SAP + diesel fuel excise tax refund
1.4	(35-31)/2	2.4.	123.65 EUR t^{-1} +72.20 EUR ha^{-1}+ 33.30 EUR ha^{-1}	Average rye price in Latvia in 2006-2011 + SAP + diesel fuel excise tax refund
1.5	(40-36)/2			
1.6	(50-40)/2			

The entire farm will gain profit and be able to develop if each ha of UAA provides profit in the result of efficient management [27]. The value of crop output and the cost level will also affect the profit level per ha [27], see Equation 2.

$$PROFIT=TR_{1n-2n} - TC_{3-4n} > 0, \quad (2)$$

where TC_{3-4n} – total costs per ha, their calculation versions are shown in Table 4.

Table 3. Total costs determination principles and versions per ha of utilised agricultural area in Latvia

TC_{3-4n}		
Versions	Value	Estimations
3	586 EUR ha^{-1}	Average land cultivation costs for field crops per ha in Latvia in 2011 [28]
4.1	586 EUR ha^{-1} x 1.4	If the area of a land unit is 1.01-2.0 ha
4.2	586 EUR ha^{-1} x 1.3	If the area of a land unit is 2.01-3.0 ha
4.3	586 EUR ha^{-1} x 1.2	If the area of a land unit is 3.01-4.0 ha
4.4	586 EUR $ha^{-1}ha^{-1}$ x 1.1	If the area of a land unit is 4.01-10.0 ha
4.5	586 EUR ha-1ha-1 x 1.0	If the area of a land unit is >10.0 ha

The area of presently uncultivated and overgrown land profitable for future agricultural production was calculated basing on the two equations and the assumptions presented in Tables 2 and 3 as well as the size and the ALQE of land units (Table 4).

Table 4. Summary of the possibilities for using UAA depending on its economic efficiency in Latvia, ha

Indicators at which the area may be used for agricultural production, since profit per ha >0	UAA, ha		
	Overgrown	Uncultivated	Total

If the rye price is at the level of 2011, the SAP and excise tax refunds are received and adjusting coefficients are applied to the costs depending on the size of land unit	10508	89309	99817
If the rye price is at the average level of 2006-2011, the SAP and excise tax refunds are received and adjusting coefficients are applied to the costs depending on the size of land unit	5613	46731	52344
If the rye price is at the level of 2011, the SAP and excise tax refunds are received and the costs are equal for all area groups	14357	120500	134858
If the rye price is at the average level of 2006-2011, the SAP and excise tax refunds are received and the costs are equal for all area groups	8615	77293	85908
Average	9773	83458	93232

The calculation results show that it would be profitable to utilise only 93232 ha of the presently uncultivated and overgrown land for agricultural production in Latvia, since only such an area is able to provide profit from agricultural activity (larger land units and higher ALQE). It means that the remaining area of 189254 ha may be used for biomass production to produce electricity from biogas. This idea is also supported by other EU scientists, emphasising that the use of land for bioenergy cropping has become debated due to the increased demand for food and feed production. On the global scale, there is limited additional high-quality land available for bioenergy cropping, and there is uncertainty regarding the use of marginal land [15]. Furthermore, surplus land provides potential opportunities for the substitution of food production by energy production through the widespread cultivation of bioenergy crops [29].

4. Potential of UAA for increasing the output of biogas in Latvia

In 2009, the Ministry of Economics of Latvia granted quotas to 58 entrepreneurs for biogas production with a total installed electric capacity of almost 54 MW [10]. Twenty-three biogas facilities with a total capacity of 30 MW were operating at the beginning of 2012; additionally 12 facilities were under construction [30], while the other entrepreneurs were planning to start producing biogas in the near future. It means an increase in the demand for feedstock. Besides, it has to be taken into account that one of the issues on the agenda of the EU and other leading world countries are the challenges that include the need to double world food production by 2050 to cater for population growth and wealthier consumers eating more meat – in the face of climate change impacts [31].

Further calculations were performed for two scenarios: 1) a medium-term forecasting that it is possible to utilise the presently uncultivated and overgrown agricultural area for biomass production to produce biogas and 2) a long-term forecasting that the GVA of the agricultural industry reaches at least the average EU-12 level (465 EUR ha^{-1}- Figure 1) owing to an increase in efficiency and productivity. Hence, the output of food will double first, and the rest output may be used for bioenergy production.

Production of 2.7 million tons of silage is possible by using 189254 ha to produce agricultural biomass assuming that 50% of the area produces green mass of grasses and 50% - maize silage, simultaneously considering the average yield of these crops obtained in the period of 2006-2011 in Latvia - 12.8 t ha^{-1} and 22.8 t ha^{-1} respectively [32]. This could result in production of approximately 500 million m^3 of biogas [33] and generation of 1.1 million MW of electricity. It requires installation of additional power plants with the capacity of 125 MW (4 million m³ of biogas per 1 MW of installed electric capacity), i.e. approximately 250 biogas facilities with an electric capacity of 500 kW each [7].

Production of a GVA equalling EUR 264 million is possible if the agricultural productivity and efficiency per ha of utilised agricultural area is increased in Latvia and part of additional GVA of the agricultural industry – at basic and producer prices of 149 EUR ha^{-1} (465-158x2) – is contributed to the production of biomass of agricultural origin. Since feed crops account for 32.7% in the structure of sown area [34], such an additional part of GVA (EUR 86 million) may be attributed to the potential biomass production. According to the data on gross margins for 2011 [35] and the Eurostat definition that GVA at producer prices is the output at producer prices minus intermediate consumption at purchaser prices [36], one can calculate the expected

output of silage - 26 million tons a year, which would enable the production of 4.8 million m^3 of biogas or 1200 MW of electricity. To achieve it, it is necessary to construct 2400 new facilities with a capacity of 500 kW each. This would promote both the development of respective rural territories, and the creation of new jobs and the increase of tax revenues to governmental and municipal budgets; decrease of the incurred ecological effects in the sphere of environmental protection by reducing the emissions of greenhouse gases; diversification of farmers income sources [6]; reduction of the necessary resources for purchasing fertilisers; improvement of crop rotation by avoiding monoculture [7]; use of thermal energy etc.

5. Conclusions

In 2011, the lowest agricultural productivity in the EU and 302 thousand ha of unutilised agricultural area were observed in Latvia. It determines a potential for a significant increase of both the output of food and energy from RER. After assessing a possibility to recover the unutilised agricultural area for agricultural production, based on the economic profitability and considering the size and the ALQE of each land unit, one can forecast that approximately 93 thousand ha of land could be used for agriculture. Therefore, in a medium-term it is possible to increase the output of electricity generated from biogas 2.3 times compared with the present installed electric capacity by producing biomass on the presently unutilised agricultural area; it would require 250 new biogas facilities of small capacity.

In a long-term, by increasing the agricultural productivity and efficiency in Latvia at least to the EU-12 level, it is possible both to double the output of food and to increase the output of electricity produced from biomass of agricultural origin 22 times compared with the present level. Approximately 2400 new biogas facilities are necessary to achieve this result. Hence, there is a potential and a possibility in Latvia to develop not only food production, but also renewable energy resources.

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References

[1] Food and Agriculture Organization of the United Nations (FAO). Land Tenure Studies. Good Governance in Land Tenure and Administration. Rome, 2007; 32.

[2] Valsts zemes dienests (SLS). Latvijas Republikas administrativo teritoriju un teritorialo vienibu zemes parskats uz 2012. gada 1. janvari. Available: http://www.vzd.gov.lv/sakums/publikacijas-un-statistika/parskats/?id=846.

[3] Dobele A. Zemes resursu izmantosana Latvija. Promocijas darba kopsavilkums, Latvijas lauksaimniecibas universitate, Jelgava, 2005; 33.

[4] Pilvere I. Characteristics of Land Resources in Latvia. *Economics and Rural Development: Research Papers*, Vol.4, No. 1. Lithuania: Akademija, 2008; 29-36.

[5] Strikis V., Lenerts A. Production Development of Renewable Energy Sources. *Management Theory and Studies for Rural Business and Infrastructure Development*. Lithuania University of Agriculture. Research Papers 3 (27), Kaunas, 2011; 176-182.

[6] Boese Ch. Driving Growth in the European Bio-based Economies. 2010; 37.

[7] Kalnins A. Biogazes razosanas saimnieciskie un vides ieguvumi. 2009; 200.

[8] Palm O. Bioenergy from Agriculture and Bioenergy in Sweden. 2010; 27.

[9] Al Seadi T. Biogas in Denmark – Present and Future. 2009; 24.
[10] Latvijas Biogazes asociacija. Biogazes attistiba Latvija. Available: http://www.latvijasbiogaze.lv/?c=1.
[11] Rivza S., Pilvere I., Rivza P., Rivza B. Conceptual Models of Risk Assessment in Renewable Energy Production in Latvia. *Proceedings of the15th World Multi-Conference on Systemics, Cybernetics and Informatics: WMSCI 2011*, Orlando, Florida, USA, 2011; 118.-122.
[12] Leikucs J. The Analysis of Institutional Environment of Latvia's RES-E Generation. *Management Theory and Studies for Rural Business and Infrastructure Development.* Lithuania University of Agriculture. Research Papers 3 (27), Kaunas, 2011; 104-112.
[13] Bronka A., Zvirbule-Berzina A. Contribution Aspect of Renewable Energy Resources Usage in the Context of Latvia's Sustainable Development. *Economic Science for Rural Development: Proceedings of the International Scientific Conference*, No. 25. Jelgava: LLU, 2011; 48-57.
[14] Pindyck R.S., Rubinfeld D.L. Marginal Revenue, Marginal Cost, and Profit Maximazation. Microeconomics 5th ed. New Jersey: Prentice- Hall International, Inc.; 2001; 255:258.
[15] Verzandvoort S., Hack Alterra M. Pressures on Prime Agricultural Land in Europe. Wageningen UR. 2009; 17.
[16] Darlington D. What is Efficient Agriculture? Available: http://veganorganic.net/what-is-efficient-agriculture/.
[17] Eurostat. Other Land: Number of Farms and Areas by Agricultural Size of Farm. Available: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ef_powood&lang=en.
[18] Eurostat. Gross Value Added of the Agricultural Industry - Basic and Producer Prices. Available: http://epp.eurostat.ec.europa.eu/tgm/download.do?tab=table&plugin=1&language=en&pcode=tag00056.
[19] LR Ministru kabinets. MK noteikumi Nr.635 "Kartiba, kada apseko un nosaka neapstradatas lauksaimnieciba izmantojamas zemes platibu un sniedz informaciju par to". LV, 119 (4311), Riga, 13.07.2010.
[20] Lauku atbalsta dienests (RSS). LIZ apsekosanas rezultati novadu un platibu grupu griezuma. 03.11.2010. Available: http://www.lad.gov.lv/lv/citi-pakalpojumi/lauksaimnieciba-izmantojamas-zemes-apsekosana/.
[21] Lauku atbalsta dienests (RSS). LIZ apsekošanas rezultati novadu griezuma. 03.11.2011. Available: http://www.lad.gov.lv/files/statistika_2010_2011.pdf.
[22] LR Ministru kabinets. Zemes politikas pamatnostadnes 2008. – 2014.gadam. MK 2008.gada 13.oktobra rikojums Nr.613. Riga, 2008; 39.
[23] Valsts zemes dienests (SLS). Lauksaimnieciba izmantojamas zemes un meza zemes kvalitate. Available: http://kadastralavertiba.lv/profesionali/vertibu-ietekmejosie-faktori/tehniskie-raditaji/.
[24] LR Centrala statistikas parvalde. LIG0112. Lauksaimniecibas produkcijas iepirkuma cenas (latos par 1 tonnu). 2006.-2011.gads. Available: http://data.csb.gov.lv/Dialog/varval.asp?ma=LI0112&ti=LIG0112%2E+LAUKSAIMNIEC%CEBAS+PRODUKCIJAS+IEPIRKUMA+CENAS+%28latos+par+1+tonnu%29&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/01Lauks_visp/&lang=16.
[25] Lauku atbalsta dienests (RSS). Atbalsta likmes 2011.gadā. Available: http://www.lad.gov.lv/lv/es-atbalsts/tiesie-maksajumi/atbalsta-likmes-2011-gada/.
[26] LR likums "Par akcizes nodokli". LV, 161 (2926), Zinotajs No. 23, Riga, 11.12.2003.
[27] Rounsevella M.D.A., Ewertb F., Reginstera I.R., Leemansc, Carterd T.R. Future Scenarios of European Agricultural Land Use II. Projecting Changes in Cropland and Grassland. Agriculture, Ecosystems and Environment 107. 2005; 117–135.
[28] Zemkopības ministrija. Parskats par lauksaimniecības produktivitati un izmaksam. Riga, maijs, 2012; 28.
[29] Ciaian P., Kancs D., Swinnen J.F.M. EU Land Markets and the Common Agricultural Policy. 2010; 367.
[30] Karklins A. Biogazes razosanas nozares aktualitates Latvija un Eiropa. Riga, 2012; 19.
[31] European Union. Agriculture. 2012. Available: http://europa.eu/pol/agr/index_en.htm. Retrieved 27.04.2012.
[32] LR Centrala statistikas parvalde. LAG417. Lopbaribas kulturu kopraza un raziba. Available: http://data.csb.gov.lv/Dialog/varval.asp?ma=LA4170&ti=LAG417.+LOPBAR%CEBAS+KULT%DBRU+K

OPRA%DEA+UN+RA%DE%CEBA&path=../DATABASE/lauks/Ikgad%E7jie%20statistikas%20dati/03Augk/&lang=16.
[33] Karklins A. Biogazes razosanas tehnologijas izveles prieksnoteikumi, produkcijas raksturojums, izmantosanas iespejas. Riga, 2012,15.
[34] LR Centrala statistikas parvalde. LSK10-II08. Lauksaimniecibas kulturaugu sejumu platibas regionos un novados Available: http://data.csb.gov.lv/Dialog/varval.asp?ma=LSK10-I08&ti=LSK10%2DII08%2E+LAUKSAIMNIEC%CEBAS+KULT%DBRAUGU+S%C7JUMU+PLAT%CEBAS+RE%CCIONOS+UN+NOVADOS+%28ha%29&path=../DATABASE/laukskait_10/II%20ZEMES%20IZMANTO%D0ANA/&lang=1.
[35] Latvijas lauku un konsultaciju izglitibas centrs. Bruto seguma aprekins zemnieku saimniecibai 2011. gada. Skabbariba. Available: http://www.llkc.lv/upload_file/400459/Skabbariba_2011.pdf .
[36] Eurostat. Glossary: Gross Value Added at Market Prices. Available: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Value_added.