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SUSTAINABLE ENERGY DEVELOPMENT: TRENDS OF ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN LITHUANIAN AGRICULTURAL SECTOR

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Abstract

In 2008, about 4.2% of the total value added was generated by the Lithuanian agricultural sector. However, this sector produced some 21% of the total greenhouse gas emissions and consumed 2.3% of the total energy input. The measurement, assessment, and effective mitigation of energy intensity and greenhouse gas emission compose a foremost objective of contemporary energy policy. Moreover, the strategy *Europe 2020* and particularly so called *20/20/20* targets require both 20% reduction in GHG emission and energy efficiency increase which should cause reduction in energy consumption. It is therefore important to identify and estimate the underlying factors affecting trends of these phenomena in the Lithuanian agricultural sector. Our study, therefore, is aimed at analysing the energy intensity trends in the Lithuanian agricultural sector. The investigation covers the period of 1995–2008. The simplified Logarithmic Mean Divisia Index was applied for index decomposition analysis. The carried out research identified generally positive trends of energy consumption and GHG emissions. The GHG emission reporting and mitigation, however, remain an especially important issue for Lithuanian agricultural sector. Further studies can be focused on revealing the impact of energy sources mix and livestock structure on the GHG emission.

Keywords: energy intensity, energy efficiency, GHG emission, sustainable development, index decomposition analysis, LMDI, Lithuania, agriculture.

Introduction

The indicators of both energy and emission intensity are those to be considered when performing integrated assessments of sustainable development at a regional level (Ciegis et al., 2009a, 2009b; Štreimikienė, Mikalauskienė, 2009; Jasaitis, 2010). Assessment of sustainable rural development was performed by Baležentis and Baležentis (2010; 2011) at the national and supranational level. The energy efficiency, alongside with the remaining sorts of efficiency, is an important factor of international competitiveness of the Lithuanian agriculture. The appropriate management of energy intensity compose a foremost objective of contemporary energy policy. For energy is an important factor in socio-economic development in any state (Tolon-Becerra et al., 2010; Omer, 2008). Consequently, the sustainable energy policy enables to handle the issues of energy security, economic competitiveness, and environmental sustainability (Ang et al., 2010). The pattern of energy sources used to generate the required volume of energy, however, impacts the greenhouse gas (GHG) emission. In addition, as a party to the United Nations Framework Convention on Climate Change (UNFCCC) Lithuania is required to develop and periodically update national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by Montreal Protocol (Štreimikienė, Pušinaitė, 2006).

Lithuania, acceded to the European Union (EU) in 2004, still exhibits relatively high energy intensity (Brauers et al., 2011; Baležentis et al., 2010; Streimikiene et al., 2008). Nevertheless, many EU strategic documents (Streimikiene and Šivickas, 2006), including the new strategy *Europe 2020* (European Commission, 2010), stressed the importance of the energy efficiency in the EU. More specifically, the so called *20/20/20* targets, namely reduction of greenhouse gas emissions (by 20%), increase in share of the renewable energy (by 20%), and increase of energy efficiency thus saving up to 20% in the energy consumption, implied the need for elaborating appropriate policy measures aimed at achieving the aforementioned aims by 2020 (Tolon-Becerra et al., 2010). It is, hence, important to analyse the energy intensity and the related phenomena in agriculture as well as in the Lithuanian economy as a whole.

A number of studies on energy intensity in Lithuania have been carried out (Juknys, 2010; Dagiliūtė, Juknys, 2009; Streimikiene et al., 2007, 2008; Streimikiene and Šivickas, 2008; Klevas and Minkstimas, 2004). These studies, however, were not aimed at performing a decomposition analysis of energy consumption changes, especially of those in the agricultural sector. Indeed, the volume of gross value added created in the Lithuanian economy has doubled since

1995, whereas the energy consumption decreased by a half and GHG emissions remained virtually at the same level (Statistics Lithuania, 2011). In 2008, about 4.2% of the total value–added was generated by the Lithuanian agricultural sector. However, this sector produced some 21% of the total greenhouse gas emissions and consumed 2.3% of the total energy input (National …, 2009). These findings suggest that the Lithuanian economy has undergone some transformations, both intensive and extensive. Our study, therefore, is aimed at analysing the energy and GHG intensity trends in the agricultural sector. The investigation covers the period of 1995–2009.

To analyse and understand diachronic changes in economic, environmental, or other socio–economic indicators, it is essential to assess the main factors that underlie these developments (Hoekstra, van der Bergh, 2003). The two methods are widely applied for decomposition of indicator changes, namely structural decomposition analysis (SDA) and index decomposition analysis (IDA). The SDA is based on input–output model (Hoekstra, van der Bergh, 2003), whereas IDA uses aggregate data at the sectoral level. Meanwhile, IDA is widely applied in energy related studies (Cornillie, Fankhauser, 2004; Ang, 2005; Hatzigeorgiou et al., 2008; Zha et al., 2009; Duro, Padilla, 2011). As for the Lithuanian practice, Valkauskas (2006) has applied the latter method in the analysis of productivity, Mackevičius and Molienė (2009) – in analysis of GDP per capita, Čiulevičienė and Šiuliauskienė (2006) – in the crop yield analysis. The IDA will be applied in this study. The IDA methods can be generally divided into those based on Laspeyres index and those based on Divisia index (Ang, 2004). The logarithmic mean Divisia index I (henceforth referred to as LMDI) is simplified and applied in this study. Moreover, both additive and multiplicative forms of the simplified LMDI are employed.

This article is therefore organized in the following way. Section 2 presents the basics of the simplified LMDI method. The following Section 3 describes the trends of energy consumption and GHG emissions from the agricultural sector during 1995–2009. Finally, Section 4 focuses on the index decomposition analysis of changes in energy consumption and GHG emissions.

1. The simplified LMDI method

Hoekstra and van der Bergh (2003), with reference to Ang and Zhang (2000), describe the three properties particularly relevant to decomposition analysis, namely 1) completeness, 2) time reversal, and 3) zero value robustness. The principle of *completeness* means that the IDA decomposition should yield no residual terms, i. e. the change in certain indicator is completely identified and decomposed. As for additive IDA models, the residual term should be equal to 0, whereas the multiplicative IDA models should result in the residual term equal to 1. The *time reversal* test shows that if the time period of the determinants were reversed the decomposition would yield the reciprocal result. *Zero value robustness* means the ability of the IDA method to handle zero values in the dataset. For instance, LMDI would provide robust results if zero values were replaced with infinitely small numbers. Offered by Ang et al. (1998), the LMDI therefore is peculiar with all the three characteristics of robust IDA method. Noteworthy, the LMDI is based on Divisia index (Divisia, 1925). The following procedure of LMDI application is reported with reference to Ang (2005).

Changes in energy consumption may be assessed by considering three factors, namely overall industrial activity (activity effect), activity mix (structure effect), and sectoral energy intensity (intensity effect). The sub-category of the aggregate is industrial sector. Given that our analysis is mainly focussed on one sector, namely the agricultural sector, we will omit the structure effect. The following IDA identity, thus, describes the total energy consumption:

$$E = Q\frac{E}{Q} = QI\ , \qquad (1)$$

where E denotes the total energy consumption (or GHG emissions) in the agricultural sector, Q is the total economic activity level, and I is the energy intensity. As for GHG emissions, I denotes GHG emission intensity. For additive decomposition, we decompose the difference:

$$\Delta E = E^T - E^0 = \Delta E_Q + \Delta E_I\,. \qquad (2)$$

For multiplicative decomposition, we decompose the ratio:

$$D = E^T / E^0 = D_Q \cdot D_I\,. \qquad (3)$$

In Eqs. (2) and (3) E^T and E^0 are energy consumption (or GHG emission) volumes during period T and 0, respectively; the subscripts Q and I denote the impacts of activity effect and intensity effect, respectively. Consequently, these effects are estimated by employing the following equations for additive decomposition:

$$\Delta E_Q = \frac{E^T - E^0}{\ln E^T - \ln E^0}\ln\left(\frac{Q^T}{Q^0}\right), \qquad (4)$$

$$\Delta E_I = \frac{E^T - E^0}{\ln E^T - \ln E^0}\ln\left(\frac{I^T}{I^0}\right). \qquad (5)$$

Similarly, the relative estimations of these effects can be obtained for multiplicative decomposition. In our case, however, the indexes can be simplified to:

$$D_Q = Q^T / Q^0 , \tag{6}$$

$$D_I = I^T / I^0 . \tag{7}$$

2. The main trends of energy consumption and GHG emissions in agriculture

In order to analyze the main trends of energy consumption and GHG emissions, the three indicators were obtained (Statistics Lithuania, 2011), namely gross value–added generated in the agricultural sector (measured in millions of Litas), volume of energy consumption in the agricultural sector (terajoules), and volume of GHG emission from the agricultural sector (millions tonnes of CO_2 equivalent). The energy intensity (thousands of joules per Litas) with emission intensity (tonnes of CO_2 equivalent per Litas) were thus computed by dividing volumes of energy consumption and GHG emission, respectively, by the gross value–added created in the agricultural sector (Table 1).

Ir must be noted that the share of the gross value–added generated in the agricultural sector has been constantly declining compared to that of other sectors: it dropped from 7.4% of the total gross value–added in 1995 down to 4.2% in 2008. However, the recent data of 2010 indicate that the agricultural value–added constitute some 4.8% of the total value–added, hence it might be concluded that the economic downturn affected the agricultural sector to a lesser extent than other sectors. In absolute terms, the gross value–added generated in the agricultural sector reached its minimum in 1999 (2424.1 million Lt), whereas maximum was achieved in 2009 (3093.2 million Lt). The energy consumption generally declined during the investigated period from 8540 TJ in 1996 to 4116 TJ in 2000. However, the value of the latter indicator has increased afterwards. As for GHG emissions, they reached their peak in 2009 (5490 TJ), whereas their lowest point was achieved in 2000 (4417 TJ). As Table 3 suggests, both energy consumption and energy intensity in agriculture varied to a higher extent than respective indicators of GHG emissions. This difference might be caused by significant reduction of energy consumption during the transformation years 1996–2000.

Table 1

The dynamics of energy consumption and GHG emission related indicators, 1995–2009

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gross value–added, millions Lt	2434.1	2720.7	2974.2	2824.2	2421.1	2578.0	2464.9	2668.3	2865.7	2851.8	2908.8	2617.3	2961.3	3049.6	3093.2
Energy consumption, TJ	8525	8540	7394	6758	4739	4116	4205	4273	4308	4385	4311	4602	4912	4779	4273
GHG emission, millions t CO2 eq.	4700	5068	5090	4872	4650	4417	4627	4847	5009	4999	4988	5490	5225	5012	n.a.
Energy intensity, thousands J per Lt	3.50	3.14	2.49	2.39	1.96	1.60	1.71	1.60	1.50	1.54	1.48	1.76	1.66	1.57	1.38
Emission intensity, t CO2 eq. per Lt	1.93	1.86	1.71	1.73	1.92	1.71	1.88	1.82	1.75	1.75	1.71	2.10	1.76	1.64	n.a.

Source: Statistics Lithuania, 2011; EUROSTAT database.

Table 2

The results of index decomposition analysis

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Energy consumption (additive decomposition)														
ΔE	15	-1146	-636	-2019	-623	89	68	35	77	-74	291	310	-133	-506
ΔE_Q	949.7	708.7	-365.9	-876.1	277.5	-186.6	335.9	306.3	-21.1	86.0	-470.4	587.1	142.5	64.1
ΔE_I	-934.7	-1854.7	-270.1	-1142.9	-900.5	275.6	-267.9	-271.3	98.1	-160.0	761.4	-277.1	-275.5	-570.1
Energy consumption (multiplicative decomposition)														
D	1.00	0.87	0.91	0.70	0.87	1.02	1.02	1.01	1.02	0.98	1.07	1.07	0.97	0.89
D_Q	1.12	1.09	0.95	0.86	1.06	0.96	1.08	1.07	1.00	1.02	0.90	1.13	1.03	1.01
D_I	0.90	0.79	0.96	0.82	0.82	1.07	0.94	0.94	1.02	0.96	1.19	0.94	0.94	0.88
GHG emissions (additive decomposition)														
ΔE	368	22	-218	-222	-233	210	220	162	-10	-11	502	-265	-213	n.a.
ΔE_Q	543.3	452.6	-257.7	-733.1	284.5	-202.7	375.4	351.8	-24.3	98.8	-552.7	661.3	150.5	n.a.
ΔE_I	-175.3	-430.6	39.7	511.1	-517.5	412.7	-155.4	-189.8	14.3	-109.8	1054.7	-926.3	-363.5	n.a.
GHG emissions (multiplicative decomposition)														
D	1.08	1.00	0.96	0.95	0.95	1.05	1.05	1.03	1.00	1.00	1.10	0.95	0.96	n.a.
D_Q	1.12	1.09	0.95	0.86	1.06	0.96	1.08	1.07	1.00	1.02	0.90	1.13	1.03	n.a.
D_I	0.96	0.92	1.01	1.11	0.89	1.10	0.97	0.96	1.00	0.98	1.22	0.84	0.93	n.a.

Table 3

Variation of energy consumption and GHG emission intensity indicators, 1995–2008

Indicator, dimension	Standard deviation	Mean	Coefficient of variation
Gross value–added, millions Lt	211.5	2738.6	0.08
Energy consumption, TJ	1638.3	5417.6	0.30
GHG emission, millions t CO2 eq.	272.1	4928.1	0.06
Energy intensity, thousands J per Lt	0.6	2.0	0.32
Emission intensity, t CO2 eq. per Lt	0.1	1.8	0.07

The dynamics of energy and GHG emission intensity for the agricultural sector are presented in Fig. 1. The rapid decrease in energy intensity was followed by increases in 2001 and 2006. The energy intensity, nonetheless, has been declining since 2006. The similar shocks can be identified for GHG emission intensity. However, the GHG emission intensity remained more or less stable during the investigated period.

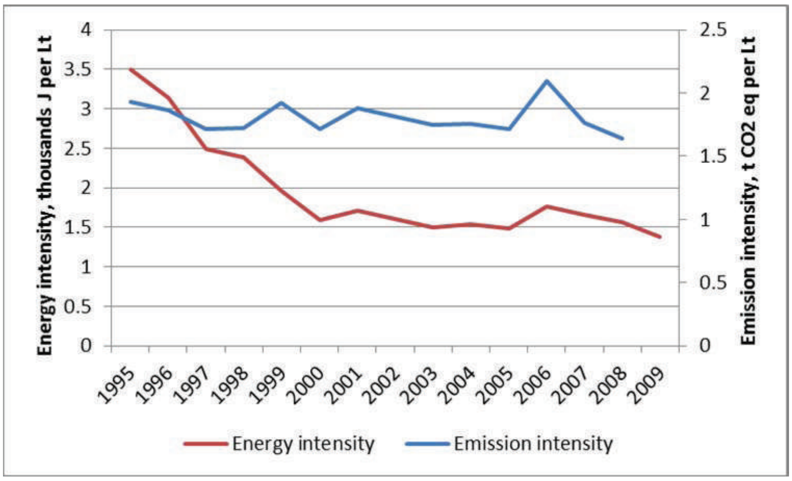

Figure 1. Energy and GHG emission intensity in the Lithuanian agricultural sector, 1995–2009

The described changes partially can be explained by analysing changes in the structure of energy sources in agriculture (Fig. 2). As one can notice, the share of energy from transport diesel had been decreasing till year 2001. This decrease might be interlinked with the renewal of the technological basis of agriculture. On the other hand, the increased usage of natural gas might have positively impacted GHG emission intensity, for its emission factor is one of the lowest (Štreimikienė, Pušinaitė, 2006).

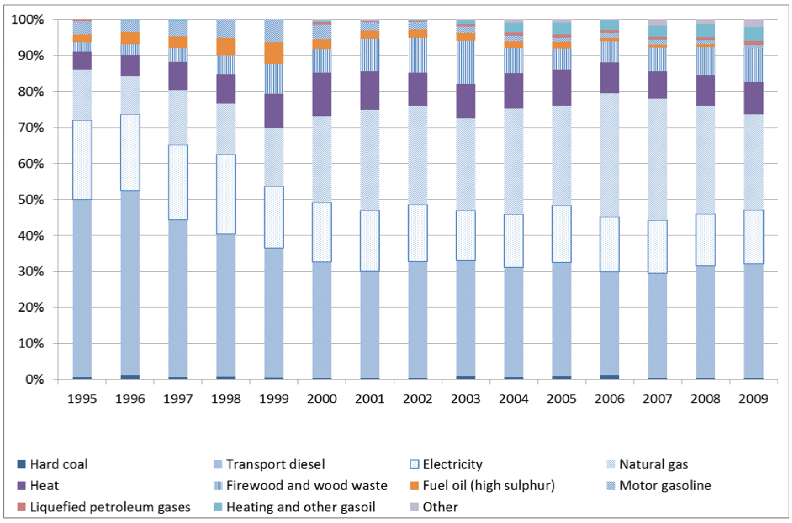

Figure 2. The structure of energy sources in agriculture, 1995–2009

The following Fig. 3 demonstrates the differences in rates of change between gross value–added, energy consumption, and GHG emission in the Lithuanian agricultural sector. Although the directions of change generally coincide, there is some discordance. For instance, the amount of gross value–added from agricultural sector increased in 1997, whereas energy consumption declined and did so repeatedly till 2000. Furthermore, both the gross value–added and GHG emission reached negative growth rates in 1998. In 2000, however, the gross value–added increased by some 6% and the other two indicators remained with negative growth rates. In 2001 the situation reversed. Again, we can see some disturbances in 2006–2008. These phenomena might be attributed to lags in economic and energetic processes as well as their causal relationships.

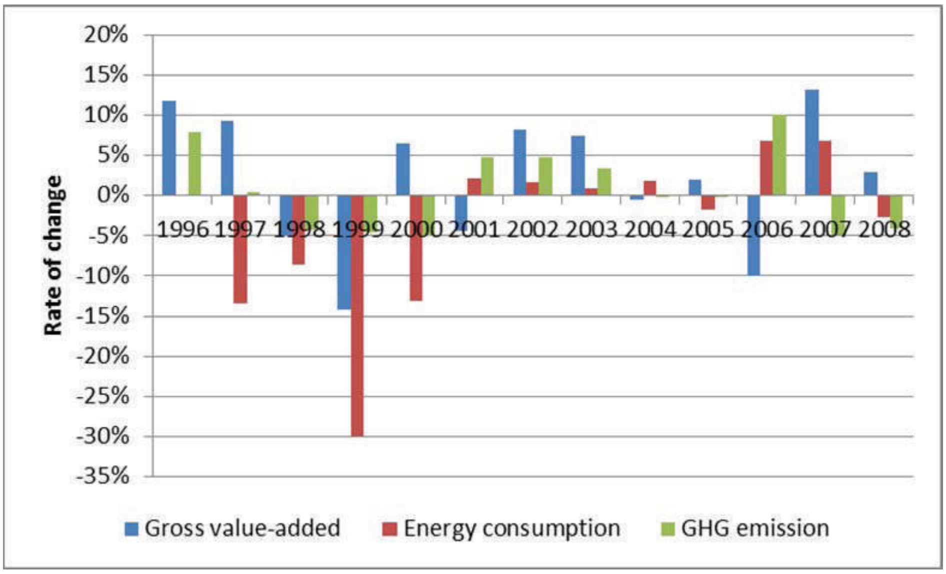

Figure 3. The rates of change for gross value–added, energy consumption, and GHG emission in the agricultural sector, 1995–2008

To conclude, it is important to apply the index decomposition analysis and thus identify the underlying factors and trends of energy–related indicators. The next section handles the issue.

3. The index decomposition analysis of changes in energy consumption and GHG emissions

The simplified LMDI method was applied for chain–linked index decomposition analysis. Hence, equations (4) and (5) were applied for additive decomposition, whereas equations (6) and (7) – for multiplicative decomposition. The data presented in Table 1 were used for analysis. Consequently, the obtained results, presented in Table 2, will be discussed in this section. The first sub–section is focused on energy consumption in the Lithuanian agricultural sector, whereas the second one is focused on GHG emissions.

3.1. Energy consumption

The energy consumption in the Lithuanian agricultural sector has declined by 4 252 TJ during 1995–2009 (Table 2). Furthermore, the increased economic activity in that sector required an additional volume of energy equal to 1 537.7 TJ. The increased energy efficiency, however, reduced the need by 5 789.7 TJ. As a result, the energy consumption had decreased in the Lithuanian agricultural sector by 2009. We can describe the two trend breaks in energy consumption, namely those in 1999 and 2007 (Fig. 4). Until 1999 the energy consumption had been suppressed by increasing energy efficiency and, since 1998, by the subdued activity of the agricultural sector. However, the activity effect became positive in 2000 and the absolute change in energy consumption fluctuated thereafter in the interval of –74 to 89 TJ. The changes in energy consumption gained momentum in 2006. In 2006 the growth in energy consumption was mainly driven by increased energy intensity. Contrary, the activity effect has been positive since 2007; but it has been declining gradually. In 2008, the increasing energy efficiency and decreasing economic activity resulted in decrease in energy consumption.

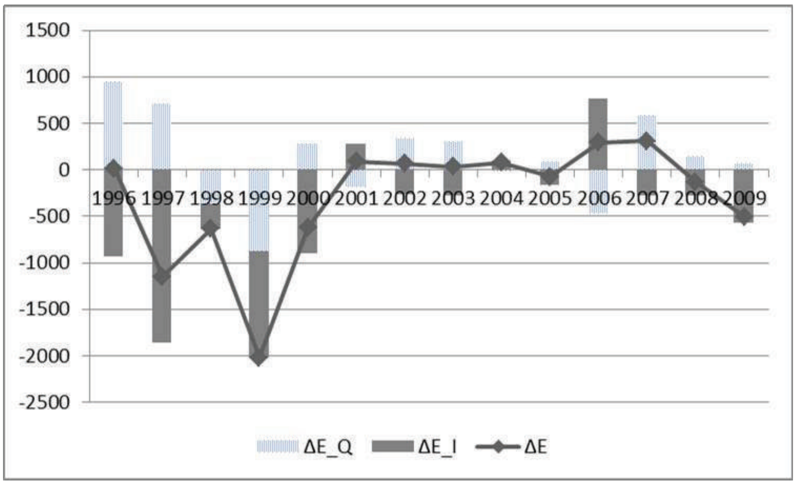

Figure 4. The additive LMDI decomposition of energy consumption changes (TJ), 1995–2009.

The multiplicative index decomposition of energy consumption changes enabled to assess the relative impact of activity and intensity effects on the total changes in energy consumption. As Fig. 5 demonstrates, the decrease in energy consumption was mainly driven by increasing energy efficiency (intensity effect). More specifically, the increasing energy efficiency caused increase in energy consumption in years 2001, 2004, and 2006. At the other end of spectrum, the most significant reduction of energy intensity was observed in 1997, when the increased energy efficiency caused decline in energy consumption by some 21%. As to activity effect, it has always been a driving force for growth in energy consumption with the exception of years 1998–1999, 2001, 2004, and 2006. While the first period can be explained by the Asian–Russian crisis, the later periods could be perceived as those of serious structural transformations caused by a variety of pre– and post–accession to the EU policies.

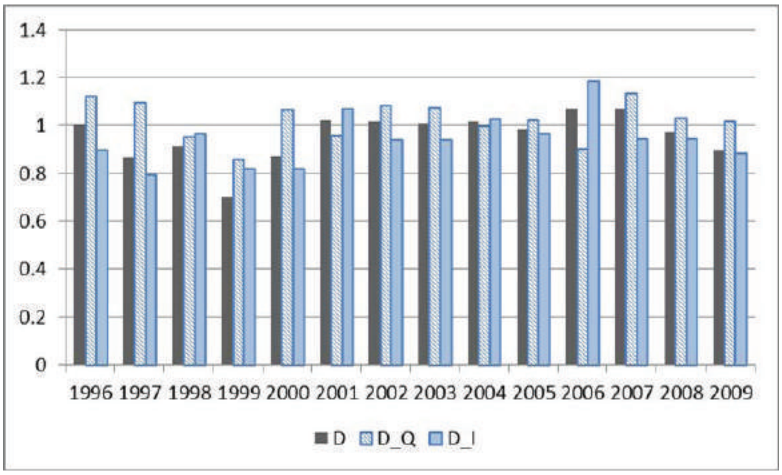

Figure 5. The multiplicative LMDI decomposition of energy consumption changes, 1995–2009.

To conclude, energy consumption in the Lithuanian agricultural sector had declined in 1997–1999 due to the economic crisis, whereas the later decreases were mainly driven by increasing energy efficiency. However, the agricultural sector experienced another downturn in year 2006. The current economic crisis, nevertheless, did not make a significant impact: the decrease in energy consumption was mainly driven by the increasing energy efficiency (i. e. intensity effect) during 2008–2009.

3.2. GHG emissions

The results of additive index decomposition of changes in GHG emission are presented in Fig. 6. Given the data from Table 2, the overall GHG emissions from agricultural sector grew by 312 million t CO_2 eq. during 1995–2008. Although the intensity effect exhibited a negative value of -835.6 million t CO_2 eq., the activity effect caused an increase by some 1 147.6 million t CO_2 eq. The implementation of novel means for reducing GHG emissions (e.g. appropriate manure management systems), therefore, remains an important issue for the agricultural sector.

As we can see (Fig. 6), the volume of GHG emissions was increasing in reducing rates until 1998. Since year 1998, however, the volume of GHG emissions began to diminish and recovered only in the year 2001. As for years 1998–1999, the decline in GHG emissions can be attributed to activity effect, i. e. a subdued economic activity in the agricultural sector.

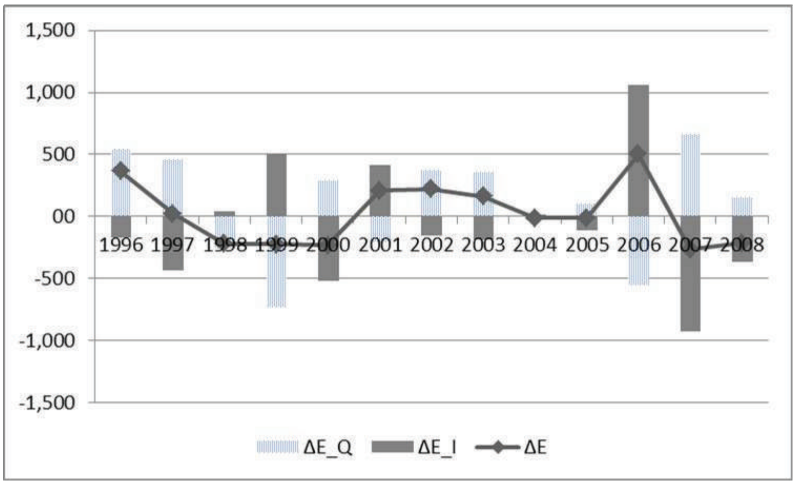

Figure 6. The additive LMDI decomposition of GHG emission changes (millions t CO_2 eq.), 1995–2008.

The increase in intensity effect was observed for years 1998–1999, 2001, and 2006. However, it was compensated by declined economic activity in 1998–1999. Contrary, in 2001 and 2006 the growth in GHG emissions was observed. The year 2006, therefore, became that of the greatest increase in GHG emissions (502 million t CO_2 eq.). Although the economic activity has been increasing in 2007–2008, the intensity effect caused the reduction of GHG emissions.

The results of multiplicative index decomposition (Fig. 7) suggest that activity effect has been stimulating the GHG emission from agriculture, whereas intensity effect mainly suppressed these emissions. For mean value of the activity index during 1995–2008 was 1.02 (i. e. 2% increase in GHG emissions), whereas that of intensity index was 0.941 (i. e. 5.9% decrease in GHG emissions).

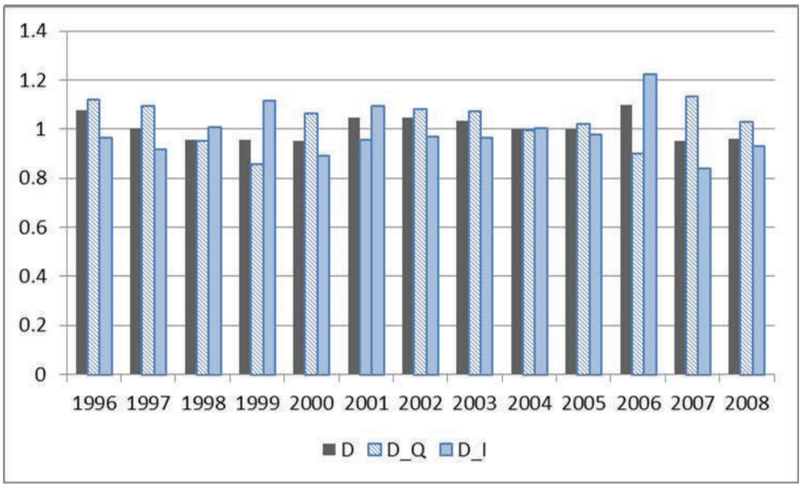

Figure 7. The multiplicative LMDI decomposition of GHG emission changes, 1995–2008.

The most significant in relative terms decrease in GHG emissions was that of year 1997 when the volume of emissions dropped by 30%. At the other end of the spectrum, relatively the largest increases in GHG emissions were observed during 2006–2007 (6.7%). Interestingly, the Asian crisis of 1997–1999 has also affected the GHG emissions from Lithuanian agricultural sectors, whereas the current economic downturn did not make such an impact. These differences might be explained by shifts in the fuel structure as well as improved technological basis. Considering the intensity effect, one can observe a break in 2006, followed by a serious decrease in 2007.

Given the data of index decomposition analysis, it is important to consider the changes in GHG emission intensity during the transformation periods (namely years 1999 or 2006 for Lithuanian agriculture). The interested state agencies, hence, should take into account the possible outcomes of the applied policies, both at micro and macro levels.

Concluding remarks

Our analysis demonstrated that the volume of gross value added created in the Lithuanian economy has doubled since 1995, whereas the energy consumption remained virtually at the same level. In 2008, about 4.2% of the total value–added was generated in the Lithuanian agricultural sector. However, this sector produced some 21% of the total greenhouse gas emissions and consumed 2.3% of the total energy input. These findings suggest that the Lithuanian economy has undergone some transformations, both intensive and extensive. In addition, energy consumption and GHG emission are the two closely interrelated phenomena, for GHG emission heavily relies on the pattern of the energy sources (e. g. different sorts of combustion fuels). Our study, therefore, was aimed at further analysis of the energy and GHG intensity trends in the agricultural sector. The index decomposition analysis was employed for that purpose.

The investigation results show that the energy consumption in the Lithuanian agricultural sector has declined by 4 252 TJ during 1995–2009. On the one hand, the increased economic activity in that sector required an additional volume of energy equal to 1 537.7 TJ. The increased energy efficiency, on the other hand, reduced the need by 5 789.7 TJ. As a result, the energy consumption had decreased in the Lithuanian agricultural sector mainly due to increased energy efficiency. The mean energy consumption in agriculture accounted for 5 341.3 TJ. The value of energy intensity indicator fell from 3.5 thousand TJ per LTL in 1995 to 1.38 thousand TJ per LTL in 2009 (mean value – 2.0 thousand TJ per LTL). Hence, the energy intensity has been decreasing in the agricultural sector. The further reductions, however, remain important, for Lithuania is still above the EU level.

The results of additive index decomposition of changes in GHG emission suggest that the overall GHG emissions from agricultural sector grew by 312 million t CO_2 eq. throughout 1995–2008. Although the intensity effect exhibited a negative value of -835.6 million t CO_2 eq., the activity effect caused an increase by some 1 147.6 million t CO_2 eq. The mean volume of GHG emission was 4 928.1 6 million t CO_2 eq. GHG emission intensity declined from 1.93 t CO_2 eq. per LTL in 1995 to 1.64 t CO_2 eq. per LTL in 2008 (mean value was 1.8 t CO_2 eq. per LTL). The implementation of novel means for reducing GHG emissions (e.g. appropriate manure management systems), therefore, remains an important issue for the agricultural sector.

The performed analysis has proved the presence of differences between trends of GHG emissions and energy consumption as well as between respective intensities. The energy and GHG intensity demonstrated shocks in the same periods. The energy intensity trend, nevertheless, was peculiar with negative slope and thus higher value of coefficient of variation (0.32). GHG intensity (coefficient of variation was 0.07) did not decline as intensively as energy intensity did. Moreover, the multiplicative index decomposition analysis suggested that energy consumption decreased by 50%. The indexes of activity and intensity effects were 1.27 and 0.4, respectively. Thus, the reduced energy intensity caused the decline in energy consumption by some 60%. Alternatively, the volume of GHG emission increased by 7%. The activity effect and intensity effect for GHG emission were 1.25 and 0.85, respectively. To conclude, similar values of activity effect for energy consumption and GHG emission indicate the close relationship between the economic activity and the latter two phenomena. The large difference between figures of intensity effect, however, demonstrated that there had been more serious transformations in the area of energy consumption compared to that of GHG emission. This difference particularly can be attributed to the need of GHG inventory revision (Štreimikienė, Pušinaitė, 2006). The interested state agencies, hence, should apply appropriate policies, both at micro and macro levels, for reducing GHG emission intensity.

The carried out research identified generally positive trends of energy consumption and GHG emissions. The GHG emission reporting and mitigation, however, remain an especially important issue for Lithuanian agricultural sector. The 20% reduction of GHG emission required by the strategy *Europe 2020* is likely not to be achieved by 2020 without implementation of additional means. Further studies can be focused on revealing the impact of energy sources mix and livestock structure on the GHG emission.

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Darnios energetikos plėtra: energijos vartojimo ir šiltnamio efekto dujų emisijos tendencijos Lietuvos žemės ūkyje

Santrauka

Energijos vartojimo ir šiltnamio efekto dujų emisijos intensyvumo rodikliai yra svarbūs atliekant regioninius integruotus darnaus vystymosi vertinimus bei palyginimus (Ciegis et al., 2009a, 2009b; Štreimikienė, Mikalauskienė, 2009; Jasaitis, 2010). Darnaus žemės ūkio vystymo procesų vertinimas buvo atliktas nacionaliniame ir tarptautiniame lygmenyje (Baležentis, Baležentis, 2010, 2011), tačiau energetinis efektyvumas bei šiltnamio efekto dujų emisijų tendencijos žemės ūkyje yra mažai mokslinėje literatūroje nagrinėta tema. Kaip bebūtų, energetinis efektyvumas, kaip ir kitos efektyvumo rūšys, yra svarbus tarptautinio konkurencingumo veiksnys žemės ūkyje. Tinkamas energijos intensyvumo valdymas yra vienas iš svarbiausių šiuolaikinės energetikos politikos uždavinių, nes energija yra svarbus bet kurios valstybės socialinio – ekonominio vystymosi veiksnys (Tolon-Becerra et al., 2010; Omer, 2008). Taigi tvari energetinė politika leidžia užtikrinti energetinį saugumą, ekonominį konkurencingumą ir aplinkosaugą (Ang et al., 2010). Energijos šaltinių, naudojamų pagaminti reikiamą energijos kiekį, struktūra savo ruožtu daro įtaką šiltnamio efektą (ŠE) sukeliančių dujų emisijoms. Lietuva, kaip Jungtinių Tautų bendrosios klimato kaitos konvencijos valstybė, yra įsipareigojusi kasmet parengti ir tobulinti Nacionalinę šiltnamio dujų inventorizacijos ataskaitą (Štreimikienė, Pušinaitė, 2006).

Tyrimo aktualumas. Lietuva, 2004 m. priimta į Europos Sąjungą (ES), vis dar išlieka santykinai didelio energijos intensyvumo valstybe (Baležentis et al., 2010; Streimikiene et al., 2008). Daugelis strateginių ES teisės aktų, tarp jų ir naujoji strategija „Europa 2020“ (European Commission, 2010), pabrėžia energetinio efektyvumo svarbą. Vadinamoji „20/20/20“ strategija apibrėžia šiuos tikslus: 1) ŠE dujų emisijos sumažinimas 20 proc., 2) atsinaujinančių energijos šaltinių dalies galutiniame energijos suvartojime padidinimas iki 20 proc., 3) energetinio efektyvumo padidinimas taip sutaupant 20 proc. energijos. Taigi yra aktualu ištirti energijos vartojimo ir ŠE dujų emisijos pokyčius bei jų priežastis Lietuvos žemės ūkio sektoriuje.

Tyrimo problema. Energijos intensyvumas Lietuvos ekonomikoje aptartas įvairiuose darbuose (Streimikiene et al., 2007, 2008; Streimikiene ir Šivickas, 2008; Klevas ir Minkstimas, 2004). Iki šiol moksliniuose tyrimuose nepritaikytas indeksinio išskaidymo analizės metodas ir nenagrinėtas žemės ūkio sektorius. Pridėtinės vertės, sukuriamos žemės ūkyje, apimtis padvigubėjo nuo 1995 m., tuo tarpu ŠE dujų emisija praktiškai liko nepakitusi, o energijos suvartojimas sumažėjo perpus. 2008 m. žemės ūkyje buvo sukurta 4,2 proc. bendrosios pridėtinės vertės. Tuo pačiu laikotarpiu šis sektorius suvartojo 2,3 proc. visos energijos ir buvo 21 proc. visos ŠE dujų emisijos šaltinis. Taigi 1995–2008 m. žemės ūkio sektoriuje įvyko reikšmingi intensyvūs ir ekstensyvūs pokyčiai, kurie iki šiol yra mažai nagrinėti. Atsižvelgiant į strategijos „Europa 2020“ energetinius tikslus, yra svarbu įvertinti energijos vartojimo ir ŠE dujų emisijos pokyčius bei jų priežastis, taip pat įvertinti minėtų tikslų įgyvendinimo galimybes.

Tyrimo objektas – Lietuvos žemės ūkio sektorius. Tyrimo dalykas – energijos suvartojimo ir ŠE dujų emisijos rodikliai Lietuvos žemės ūkyje.

Tyrimo tikslas – ištirti energijos vartojimo ir ŠE dujų emisijos Lietuvos žemės ūkyje pokyčius bei įvertinti jų priežastis. Tyrimo periodas – 1995–2009 m.

Tyrimo uždaviniai: 1) aptarti indeksinio išskaidymo analizės metodiką; 2) nustatyti pagrindinių energetinių rodiklių kitimo tendencijas; 3) naudojantis indeksinio išskaidymo analizės rezultatais įvertinti energijos vartojimo ir ŠE dujų emisijos pokyčių veiksnius.

Tyrimo metodai. Tyrimo metu naudojami šie metodai: statistinė analizė, logaritminis vidurkinis Divisia indeksas.

Tyrimo rezultatai. Atliktas tyrimas parodė, kad tyrimo metu energetinis efektyvumas žemės ūkio sektoriuje didėjo. Tuo tarpu ŠE dujų emisijos intensyvumas sumažėjo žymiai mažesniu tempu nei energijos intensyvumas. Taigi siekiant strategijoje „Europa 2020“ numatytų ŠE dujų emisijos mažinimo tikslų, žemės ūkiui turėtų būti skiriamas ypatingas dėmesys ir parama.

Pagrindiniai žodžiai: energijos intensyvumas, energetinis efektyvumas, šiltnamio dujų emisija, darnus vystymas, Lietuva, žemės ūkis.

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