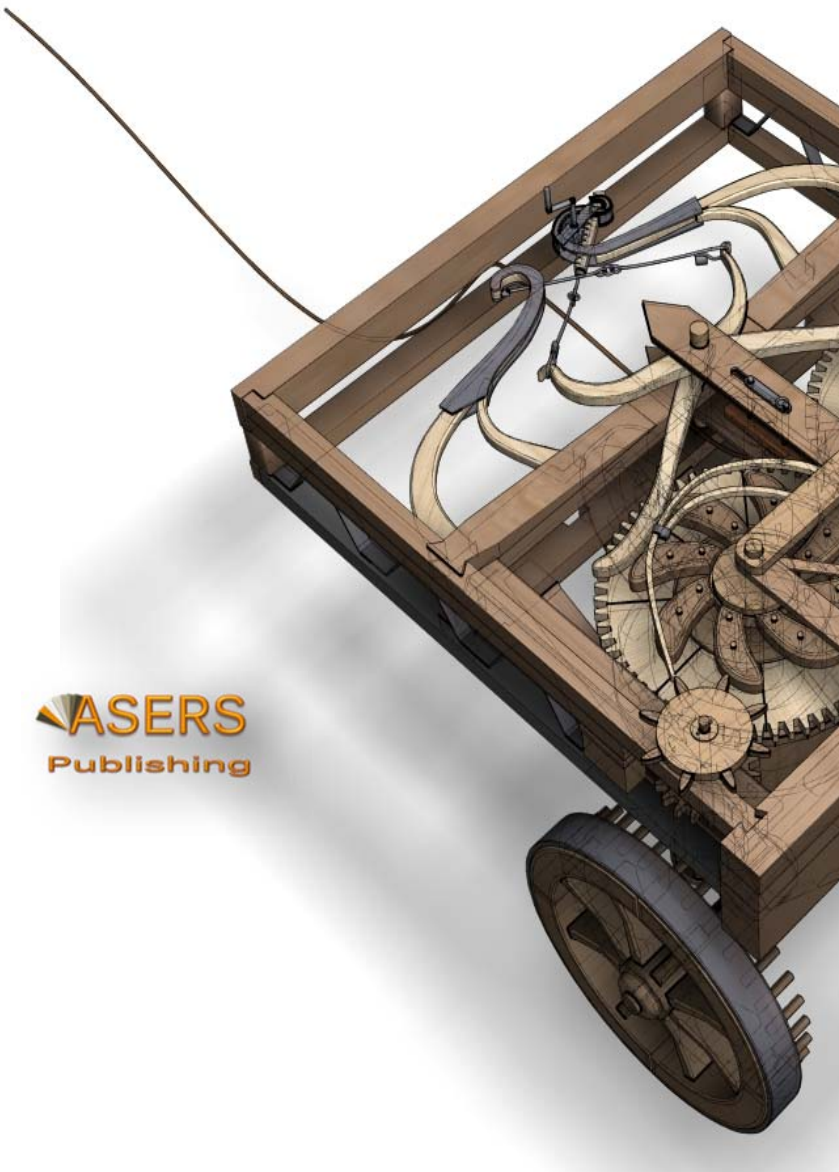
ASERS

Journal of Environmental Management and Tourism



Quarterly
Volume X
Issue 3(35)
Summer 2019
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

Summer 2019
Volume X
Issue 3(35)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

Table of Contents:

Summer 2019
Volume X
Issue 3(35)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

Call for Papers
Fall Issues 2019
Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is an interdisciplinary research journal, aimed to publish articles and original research papers that should contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences.

Journal will publish original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modeling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies, etc. This topic may include the fields indicated above, but are not limited to these.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in environmental management.

Journal of Environmental Management and Tourism is indexed in SCOPUS, RePEC, CEEOL, ProQuest, EBSCO and Cabell Directory databases.

All the papers will be first considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

Deadline for submission: 25th August 2019
Expected publication date: September 2019
Website: https://journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu

To prepare your paper for submission, please see full author guidelines in the following file: JEMT_Full_Paper_Template.docx, then send it via email at jemt@aserspublishing.eu.

DOI: https://doi.org/10.14505/jemt.v10.3(35).01

Public Policy and Biofuels: Energy, Environment and Food Trilemma

Hryhorii KALETNIK
Department of Administrative Management and Alternative Energy Sources
Vinnytsia National Agrarian University, Ukraine
kaletnik@vsau.vin.ua

Viktor PRYSHLIAK
Department of Agroengineering and Technical Service
Vinnytsia National Agrarian University, Ukraine
viktor.prishlyak@i.ua

Natalia PRYSHLIAK
Department of Administrative Management and Alternative Energy Sources
Vinnytsia National Agrarian University, Ukraine
natalka.vinn@gmail.com

Suggested Citation:

Kaletnik, H., Pryshliak, V., Pryshliak, N. (2019). Public Policy and Biofuels: Energy, Environment and Food Trilemma. *Journal of Environmental Management and Tourism,* (Volume X, Summer), 3(35): 479 - 487. DOI:10.14505/jemt.v10.3(35).01

Article's History:

Received March 2019; *Revised* April 2019; *Accepted* May 2019.

Abstract:

Current policies in energy sector address issues including environmentally friendly technologies, clean and renewable energy supplies and encourage more efficient energy use. The biofuel policy aims to promote production and consumption of fuels made from biomass. Despite the presence of both positive and negative effects of biofuels the world production and consumption of biofuels have been increasing significantly. To a large extent, this is due to an active public policy in the field of stimulating the production and consumption of biofuels. The volume of biofuel production in the leading countries (USA, Brazil and the EU) has been analyzed. The influence of public policy in the sphere of biofuel production and consumption on energy, environment and food security of the state has been examined. Multivariable and paired correlation as well as regression analysis aimed to determine the price dependence of the main crops used as feedstock for biofuels production, the volume of their production or processing for biofuels and the volumes of biofuel production have been carried out. As a result of this analysis the impact of the public policies in biofuels on the energy, environment and food security has been identified.

Keywords: public policy; biofuels; energy; ecology, environment; emissions; food security.

JEL Classification: O32; Q16.

Introduction

Governmental authorities around the world especially in the countries that have limited reserves of energy resources are paying much attention to the development of alternative energy and strengthening energy security. Such countries are developing favorable public policy with the aim to increase the use of renewable energy and biofuels. Scientists and governments prove that biofuels have several advantages over traditional fuel that include minimizing carbon emissions, reducing dependence on oil-export, providing additional financial income and saving costs for users, rural development. It is expected that biofuels will provide us with clean and renewable energy that can reduce dependence on imported fossil fuels and strengthen political and economic security, revitalize the economy by increasing demand for agricultural products and promoting rural development. At the

same time biofuels are produced from biomass and can threaten food security influencing the price and demand for some agricultural commodities.

1. Literature Review

A significant number of scientists have devoted their works to the research on the potential of the world alternative energy and bioenergy industry in particular.

Demirbas A. (2009) emphasizes that economic advantages of the biofuel industry would include value added to the feedstock, an increased income taxes, investments in plant and equipment, reduced greenhouse gas emissions and other advantages in labor market and agriculture.

Abayomi K. *et al.* (2011) analyze the effect of ethanol production on competing uses for corn through a case study of U.S. corn production. In their study the evidence of competition among the constituents of corn yield, particularly with respect to ethanol production was found.

It is worthwhile to mention the contribution of such scientists as Vimmerstedt L.J. *et al.* (2015), whose studies presented a detailed model representing the dynamics of biofuel production based on different scenarios according to the state policies of the leading countries in the field of biofuel production.

The Irish scientists Murphy F. *et al.* (2013) have also addressed the development of the biofuels market. In their works they have determine the current status and forecasted the biofuel production prospects until 2020. In 2012, mixed fuels reached 3% of total consumption, which accounted approximately for 70 million liters of biodiesel and 56 million liters of bioethanol. In 2013, the use of mixed fuels in Ireland was for biodiesel – 2.3%, and for bioethanol – 3.7%. The target for 2020 will remain at 10%, which is approximately 420 million liters".

Beckman J. (2015) discusses the biofuel production development in Brazil, the EU and the US comparing with its growth in China and India where the biofuel market growth targets are articulate. The results of the investigation suggest a few options to relieve the pressure on agricultural commodity prices under conditions achieving the targets of biofuel market development.

Cheteni P. *et al*. (2016) analyzed the sustainability and possibility to achieve it with the use of biofuels. The author convinced that sustainability could be achieved with a strong focus on renewable energy. The growing South Africa energy needs, policy debate and the likely impacts on the society wellbeing of the biofuels production development were described during the investigation.

Scientists have also paid significant attention to the development of the second-generation biofuels production. Nguyen Q. and Bowyer J. (2017) summarize in their study the growth of the second-generation biofuels production starting from 2009 and analyze the state policy of biofuel producing countries, which contributes to this growth.

The importance and economic efficiency of biofuel production is also presented in the works of Yarovoy N. *et al*. (2017) who note that "Ukraine is able to satisfy the demand for energy resources by means of alternative energy sources ...", and Zulauf C. *et al.* (2018) who give an assessment of the potential for a biofuels industry in Ukraine and evaluate the amount of land needed to substitute a percentage of gasoline and diesel with biofuels. Berezyuk S. *et al.* (2019) suggest using agricultural and household waste as a resource for biofuels production.

The majority of currently investigations and research on the biofuel impact have only preliminary estimates. The in-depth analysis that would include advantages and disadvantages of biofuels and the impact of biofuel production policy on economic, environmental and food security is to be conducted. The structural relationships between the agriculture, energy sector, social sphere and environment in the context of biofuels production and its consumption are to be studied.

2. The Aim and Objectives of the Study

The aim of the study is to analyze of the governmental policy impact in the sphere of biofuels on the energy, environmental and food security in the major biofuel production countries.

To reach the aim of the research, the following objectives has been set:

- to analyze the volume of biofuel production in the leading countries in the field;
- to study political stimulation measures of the production and consumption of biofuels taking into consideration the consequences of the increasing demand for global and regional markets for bioethanol and biodiesel, as well as economic indicators of the biofuel market welfare;
- to conduct multivariable and paired as well as regression analysis to determine the price dependence of the main crops used as feedstock for biofuels production, the volume of their production or processing into biofuels and the volumes of biofuel production.

3. Methodology

The impact of public policy in support of biofuels production on energy, environment and food security of the state was conducted in the research. In this analysis such data sources as statistical and analytical data of international governmental institutions, organizations, associations, regulatory documents were used. To analyze data such methods as graphic processing, theoretical analysis, mathematical analysis (by methods of mathematical statistics, namely the pair and multiple correlation and regression analysis) were used.

4. Results of the Research

Countries that lack energy reserves, as well as those that are concerned about the negative impacts of the production and use of fossil fuels, actively stimulate the development, production and consumption of alternative energy in general and bioenergy, in particular, on the state level.

Current policy debate about biofuels is very much concerned with the discussion of optimal governmental instruments and regulations related to biofuels (mandates, taxes, subsidies). But an ultimate success or failure of biofuels will be determined by their technological and environmental properties and production, distribution and environmental management costs of biofuels as compared to other energy sources.

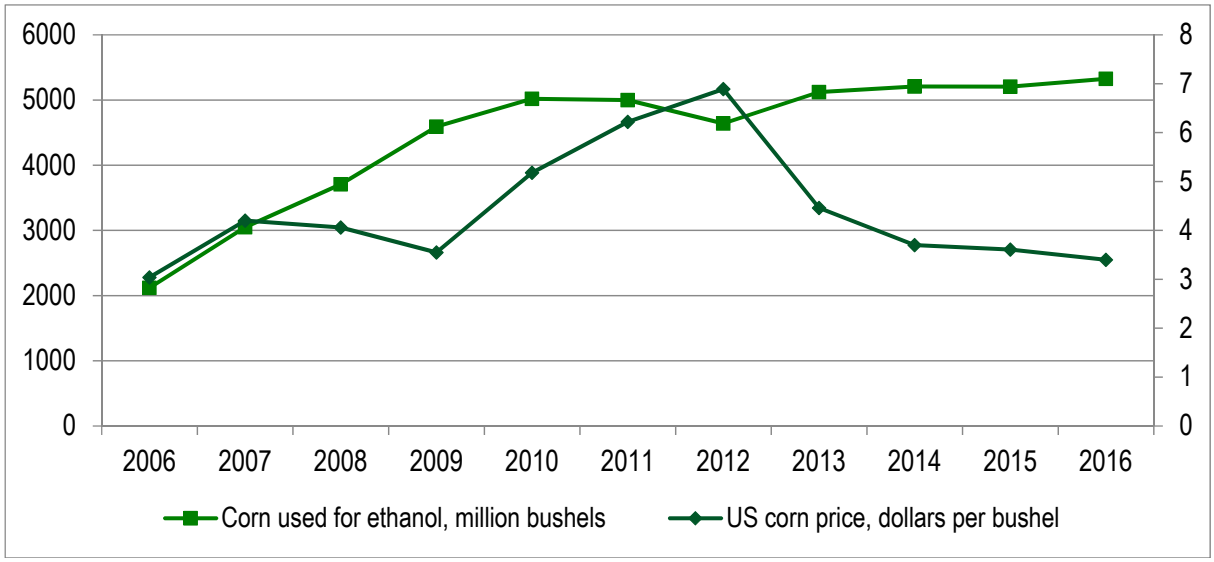
The US is a world leader in the field of biofuels production. The country has been the largest producer of bioethanol and biodiesel since 2005. The share of bioethanol in the market of gasoline in the US increased in volume from 1% in 2000 to 10% in 2018 (16 billion gallons).

In order to achieve such significant success in the sphere of biofuels the effective public policies in this direction were conducted. To stimulate production of cars that could run on alternative fuels, the Law "On Alternative Motor Fuels" was adopted in 1988. The main purpose of the law was to encourage the producers of biofuels to provide preferential loans for the production of cars that could run on a certain type of alternative fuel. Numerous interests including the desire to reduce dependence on imported fossil fuels, to lower the emissions of the greenhouse gases, and to increase the demand for agricultural commodities used as a feedstock for biofuels stimulated government measures in the sphere of renewable energy. The current governmental biofuel policies in the US consist of three main spheres in particular output-connected measures, support for input factors and consumption subsidies. Mandates and tariffs benefit biofuel producers through direct or indirect support.

While the mandates are indirect subsidies and do not provide direct price support, the tax credits serve as the largest direct subsidies (Janda *et al.* 2012).

Since the adoption of the stimulating policies, the success of the US in the field of bioenergy has been ambiguous. At the same time, as corn is the main feedstock for bioethanol production of, the volumes of this crop used for bioethanol production are constantly growing. The trend of changes shown in Fig. 1 makes it possible to follow the increase in the volume of corn used for the bioethanol production and the growth of corn prices.

Figure 1. Percentage of US corn used for ethanol production and the price of corn per bushel, 1980-2016



Source: formed by the authors on the basis of the data from U.S. Department of Agriculture

To determine the tightness of the connection between the price of corn, the total corn production and the volume of bioethanol production, a multi-factor correlation-and-regression analysis was carried out using a data analysis package. As a result of the mathematical analysis, the coefficient of multiple correlation (R) is determined and equals 0.9851. The obtained result indicates a direct close correlation between the price of corn, total corn production and volume of bioethanol production. The coefficient of multiple determination (r) is 0.97043, therefore the resulting indicator (the price of corn) depends on two factors (corn production and bioethanol production) by 97.043%.

The price increase for corn can be considered both as a positive and negative phenomenon. The positive effect of rising corn prices is that commodity producers can get higher incomes, and the government can save money by lowering subsidies for farmers under federal programs. At the same time, an increase in the price of corn can lead to an increase in the cost of food that causes negative socio-economic effect.

Brazil is the second largest world producer of ethanol and the largest exporter of the ethanol fuel in the world is. The ethanol-use mandate has been mandatory since 1977 when the legislation required a 4.5 percent blend of ethanol to gasoline. According to the legislation and market situation, the ethanol mandatory blend can vary during the year from 18 to 30 percent.

At the initial stage, the Brazilian government provided three important tools for the production of bioethanol, in particular guaranteed purchases by the state oil company, low interest loans for agro-industrial ethanol producers and fixed prices for gasoline and ethanol, for which ethanol is sold for 59% of the price of gasoline set by the government at gas stations. Subsidizing the production of ethanol and setting low price for the users have made ethanol a competitive alternative to gasoline.

The next step for Brazil was the production of flex-fuel engine vehicles, which could run on any fuel blend – from 100 percent ethanol to 100 percent gasoline, started in 2003 and as the result became very attractive for consumers who owned these cars, as ethanol and gasoline became perfect substitute goods. Currently more than 90 percent of all vehicles sold in Brazil use flex-fuel technology and, as a result, there has been a very rapid increase in ethanol demand.

In Brazil production of ethanol is based mostly on the use of sugar cane as a feedstock. It requires about 1 ton of cane to produce 120 kg of sugar or 85 liters of ethanol. According to numerous researches, Brazilian ethanol is produced at low costs and currently its feasibility does not depend on subsidies (Brinkman *et al.* 2018, Taylor-de-Lima 2018).

However, the claim made by several researchers is at the center of the controversy that concerns ethanol expansion. Regardless its economic feasibility, Brazilian ethanol production has been criticized for its potential environmental and social impact which includes a) direct and indirect land use changes; b) potential impacts on water availability and quality; c) impacts of the application of fertilizers and agrochemicals on biomass production; d) soil impacts; e) biodiversity loss.

Figure 2. Bioethanol production of in Brazil and deforestation

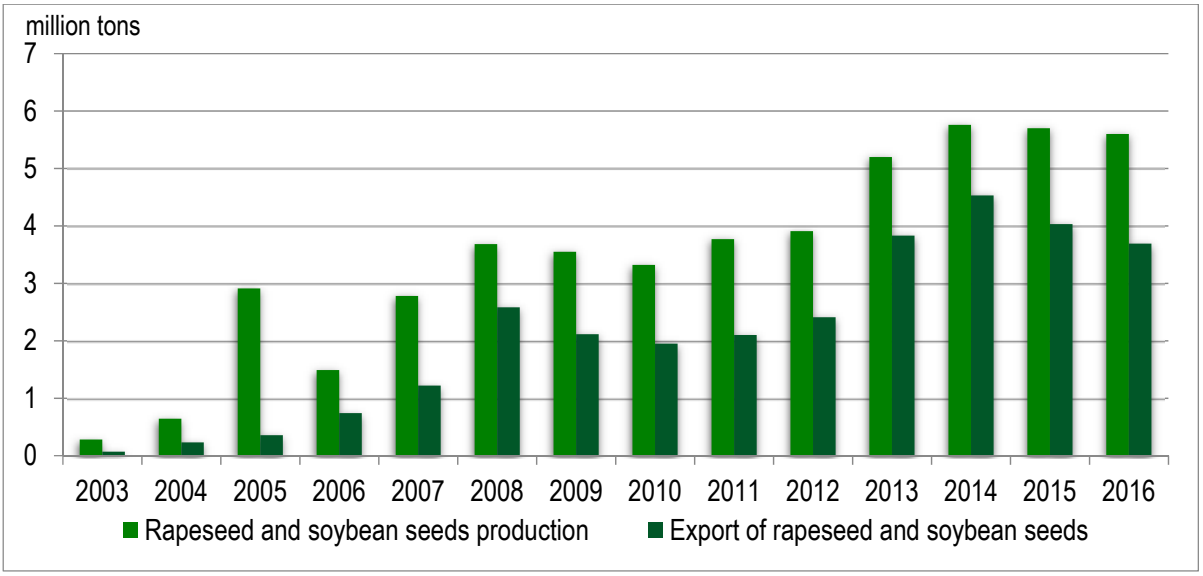
Source: formed by the authors on the basis of USDA Foreign Agriculture Service, Biofuels annual report Brazil, 2016

In Brazil and other tropical countries that grow sugar cane in the large extent the increased demand for bioethanol may lead to increased deforestation, as farmers may convert tropical forestland into agricultural areas for biofuels feedstock production. However, the graphic analysis of the ethanol production in Brazil and the area of deforestation show that there is no connection between them. Graphically, the dynamics of bioethanol production and deforestation is shown in Figure 2.

The available comparison shown in Figure 2 does not provide support to the argument that the expansion of sugarcane production may lead to food supply disruption. At the same time the analysis of recent trends in land use changes shows that the increase of sugarcane areas has not occurred to the detriment of subsistence crops. Therefore, sugarcane expansion does not seem to represent a potential source of deforestation pressure in the Amazon areas.

European Union (EU) is the third largest producer of biofuels is the world. The EU policy in the sphere of biofuels was conducted primarily in order to meet obligations made under the commitment to the Kyoto targets of GHG emissions The Paris Agreement within the United Nations Framework Convention on Climate Change and to meet pressure from the EU population to address environmental issues. The governmental policy on stimulating the production and use of biofuels in the EU involves of a combination of several instruments that include tax exemption on fuel made from renewable feedstock; mandatory addition of a fixed percentage of biofuels to the composition of traditional oil fuel; loans and subsidies for producers of energy crops (payments to farmers, compensation in case of failure); fines for failure to meet the established indicators; preferential loans and subsidies for plants engaged in biofuels production.

Figure 3. Production and export of rapeseed and soybean in Ukraine



Source: formed by the authors on the basis of Ministry of Agrarian Policy and Food of Ukraine

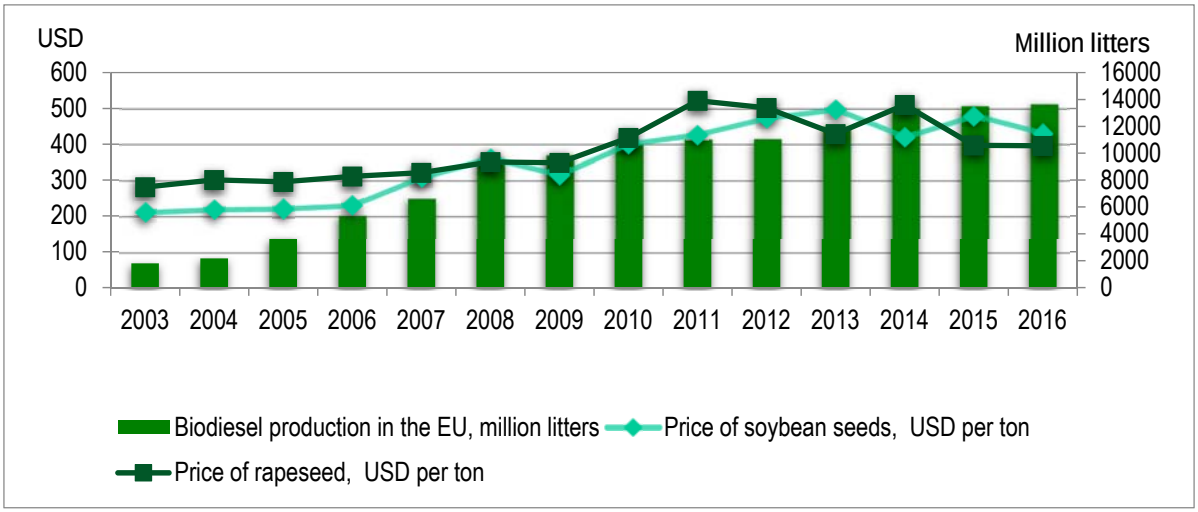
In 2009, "20-20-20 Policy" was adopted by the EU Renewable Energy Directive (2009/29) established for the post Kyoto period beyond 2012, which included the targets on the biofuel consumption. Under "20-20-20 Policy", the share of renewable energy in the total EU energy consumption is set at 20% by 2020. This includes 10% share in the transport sector of each EU Member Country. The other part of "20-20-20 Policy" is the reduction of GHG emissions by 20% from the level of 1990 and 20% reduction of the total energy consumption in the EU-27 by 2020.

Due to the effectiveness of government policies on biofuels production, the EU countries were able to achieve significant growth in the sphere of bioenergy. However, considering the limitations of domestic agricultural lands, a significant portion of feedstock for biofuels production has been imported from neighboring developing countries, therefore the biofuel production policy affects both the agriculture in the EU countries and also neighboring countries.

In particular, the growth of demand for the oil feedstock for biodiesel production led to a considerable increase of oilseeds production in Ukraine. Currently, almost all rapeseed and soybean grown in Ukraine are being exported abroad (figure 3). Most of the Ukrainian rapeseed and soybean oils that are exported are used not for the food industry, but as feedstock for biodiesel production in the EU.

In addition to the growth in soybean and rapeseed production in Ukraine, there is also an increase in price of these commodities. As a result of the graphical analysis of biodiesel production in the EU and the prices of soybean and rapeseed in Ukraine, the interdependence between these characteristics can be observed (Figure 4). To determine the tightness of the connection between the price of soy, volume of soybean production and volume of biodiesel production, the multiple correlation coefficient (R) is determined. As a result of the correlation analysis, it is determined that R = 0,931594. The obtained result indicates on the direct close connection between the price of soybean, the volume of soybean production and volume of biodiesel production. The coefficient of multiple determination is 0,86866, therefore the effective indicator (the price of soybeans) depends on two factors (volume of soybean production and volume of biodiesel production) by 86.786%. At the same time, the coefficient of pairwise linear correlation (r = 0.73247) between the price of soybean and production of soybean shows that connection is somewhat higher than average. Between the production of biodiesel and production of soybean, the connection is close (r = 0.83195).

Figure 4. Dynamics of biodiesel production in the EU, soybean seeds price, rape seeds price



Source: formed by the authors on the basis of Ministry of Agrarian Policy and Food of Ukraine, EU Biofuels Annual 2016

The coefficient of multiple correlation (R), which was determined by the correlation analysis of the connection between the price of rapeseed, production of rapeseed and volume of biodiesel production equals, 0.66046. The obtained result indicates the average connection between the price of rapeseed, volume of rapeseed production and the volume of biodiesel production.

Table 1. Jobs provided in the field of alternative energy production

Type of alternative energy	World	Country						EU countries		
		China	Brazil	USA	India	Japan	Bangladesh	Germany	France	Other EU countries
	Jobs, thousands									
Solar energy	2,772	1,652	4	194	103	377	127	38	21	84
Liquid biofuels	1,678	71	821	277	35	3	0	23	35	47
Wind energy	1,081	507	41	88	48	5	0.1	149	20	162
Solar heating / cooling	939	743	41	10	75	0,7	0	10	6	19
Solid biofuels	822	241	0	152	58	0	0	49	48	214
Biogas	382	209	0	0	85	0	9	48	4	14
Hydropower	204	100	12	8	12	0	5	12	4	31
Geothermal energy	160	0	0	35	0	2	0	17	31	55
Other	14	0	0	4	0	0	0	0,7	0	5
Total	8,053	3,523	918	769	416	388	141	355	170	644

Source: formed by the authors on the basis of Renewables 2016 Global Status Report

The coefficient of multiple determination is 0.43621, therefore, the effective indicator (the price of rapeseed) depends on two factors (amount of rapeseed production and volume of biodiesel production) by 43.621%.

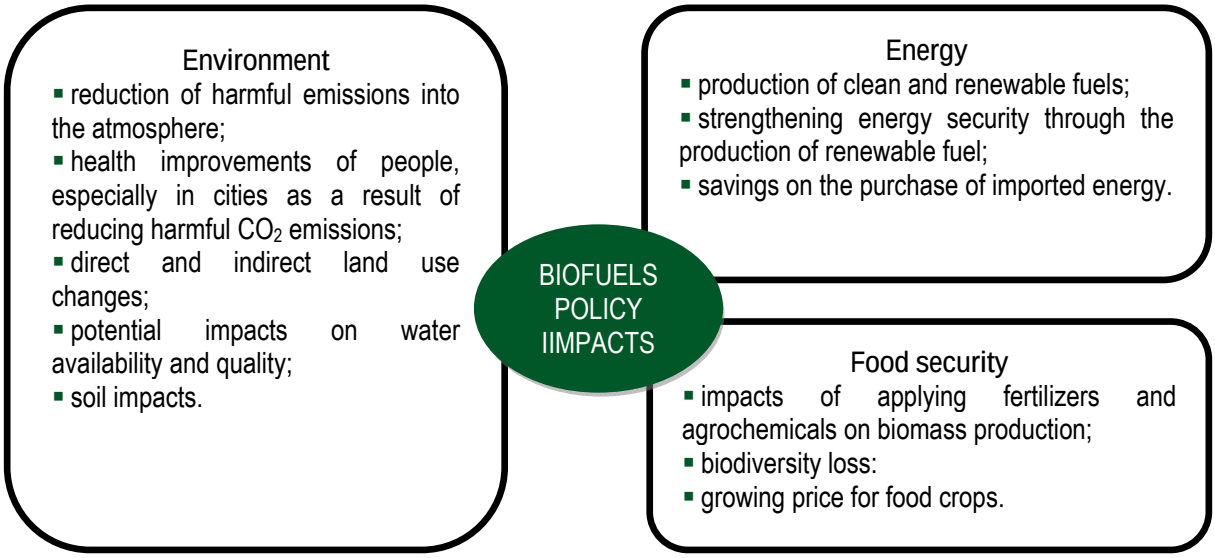
Between the rapeseed price and rapeseed production, the coefficient of pair linear correlation (r) is 0.517524. Between the production of rapeseed and the production of biodiesel, the coefficient of pair correlation (r) is 0.71365, indicating a connection above average. Because of the correlation-and-regression analysis, it can be concluded that the growth of biodiesel production in the EU causes an increase in prices for the main types of feedstock for its production (soybean and rapeseed) in neighboring countries.

Research on the social impact of the development of the biofuels industry can be presented through world experience. So, in the US in 2016, bioethanol production provided 85,967 direct jobs in alternative energy and agriculture sector, and 271,440 indirect jobs in all sectors of the economy. The number of jobs provided by the development of alternative energy in different countries is presented in the table 1.

5. Discussion

In general biofuels can provide great opportunities both for developed and developing countries. The biofuels production and consumption have a strong correlation with a number of social, economic, energy, environmental and technical issues. The effect of short-term impact focuses on the support biofuels development and technologies that have the potential to eliminate the harmful effects of fossil fuels and to overcome the energy dependence of oil importing countries. However, along with short-term, there is also a long-term effect that emerge in related areas.

Figure 5. The impact of biofuels production on the energy, environment and food security



Source: formed by the authors

Economic benefits from biofuels industry would include added value for the feedstock processing, an increased income from taxes, investments in plant and equipment, reduced a country's reliance on crude oil imports and development of rural areas by providing a new job places and market opportunities for agricultural commodities.

The ecological effect of production and consumption of biofuels is the decrease of gas emissions into the atmosphere that come from the production, processing and transportation of oil and its derivatives. Consumption of biofuels in agriculture and in cities will have a positive impact on the environment and public health, reduce the costs of combating negative environmental changes and will save the population's funds for medicines.

The socio-economic effect from biofuels includes the creation of additional jobs, as a consequence, reduction of the number of unemployed people and developing rural areas. In addition, the production of biofuels helps to reduce dependence on the import of fossil fuels by replacing them with alternative biofuels. Reducing the volume of imported fuel will strengthen the energy security of the state, avoid unnecessary spending of the national currency.

Generalizing all the phenomena arising from the implementation of the active public policy on the production and consumption of biofuels, a block diagram was formed to generalize impacts of public policy in biofuels production on energy, environmental and food security (Figure 5).

Conclusion

As a result of the performed analysis, the authors have come to the following conclusions: public policy on biofuels production have a range of impacts on environment, food system, social-economic conditions, energy sector and environment. The positive effects of production and use of biofuels vary significantly and depend on the market conditions, political and socio-economic situation in the country. Despite the fact that the increase of biofuel production has positive impact on the energy security and environmental safety and improves the welfare of farmers, it has a significant negative impact on food consumers, especially among poor people, because of the growth of agricultural feedstock cost. The various governmental policies have been implemented in the sphere of biofuels, including subsidies, mandates, fines etc. The study of biofuel policies is likely to continue in the near future, and the ecological, economic, food and political aspects of biofuel production and consumption should be analyzed by the countries when planning the public policy in the sphere of biofuels and other alternative sources of energy.

Consequently, the development of the biofuels industry under conditions of the domestic shortage of energy resources and a significant energy dependence is a decisive necessity of the present, capable of making a significant positive impact on the development of the economy as a whole, increasing the level of produces commodities with high added value, and stimulating the development of related industries and agricultural production in particular. In addition, as the world practice shows, a significant social effect from the development of biofuel production is represented by the creation of additional jobs and improvement of the living standards of the population. Countries that were the first on their way in research and production of bioethanol and biodiesel feedstock that also can be used as food should pay more attention and policies in favour of second-generation biofuels produced from non-food crops and other sources of renewable energy. The next generation of biofuels that are made from cellulose (not edible) feedstock can provide improved benefits, but will require significant technological breakthroughs in order to achieve economic and technical feasibility.

References

[1] Abayomi, K., Luo, D., and Thomas, V. 2011. Statistical evaluation of the effect of ethanol in us corn production: A flexible test for independence on a constrained sum. *Int. J. Ecol. Econ. and Stat.,* 22: 105-126. Available at: http://www.ceser.in/ceserp/index.php/ijees/article/view/1940

[2] Beckman, J. 2015. *Biofuel use in international markets: The importance of trade*. United States Department of Agriculture, Economic Research Service. Available at: http://agricultura.gencat.cat/web/.content/de_departament/de02_estadistiques_observatoris/27_butlletins/02_butlletins_nd/documents_nd/fitxers_estatics_nd/2015/0163_2015_ERenovables_Agrocarburants_Agrocombustibles-Mercats-Mon.pdf.

[3] Berezyuk, S., Tokarchuk, D., and Pryshliak, N. 2019. Economic and Environmental Benefits of Using Waste Potential as a Valuable Secondary and Energy Resource. *Journal of Environmental Management and Tourism*, (Volume X, Spring), 1(33): 149 - 160. DOI:10.14505/jemt.v10.1(33).15

[4] Biofuels annual report Brazil, 2016. Available at: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_8-12-2016.pdf.

[5] Brinkman, M. L., da Cunha, M. P., Heijnen, S., Wicke, B., Guilhoto, J. J., Walter, A. and van der Hilst, F. 2018. Interregional assessment of socio-economic effects of sugarcane ethanol production in Brazil. *Renewable and Sustainable Energy Reviews*, 88: 347-362.

[6] Cheteni, P. 2016. Youth Participation in Agriculture in the Nkonkobe District Municipality, South Africa. *Journal of Human Ecology*, *55*(3): 207-213.

[7] Demirbas, A., 2009. "Political, economic and environmental impacts of biofuels: a review". *Applied energy*, 86: 108-S117.

[8] EU Biofuels Annual 2016. Available at: https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Biofuels%20Annual_The%20Hague_EU-28_6-29-2016.pdf.

[9] Janda, K. *et al.* 2012. Biofuels: Policies and impacts. *Agricultural Economics,* 58(8): 372-386. Available at: http://www.agriculturejournals.cz/publicFiles/71534.pdf.

[10] Ministry of Agrarian Policy and Food of Ukraine. Available at: http://www.minagro.gov.ua/.

[11] Murphy, F. *et al.* 2013. Biofuel Production in Ireland – An Approach to 2020 Targets with a Focus on Algal Biomass. *Energies,* 6: 6391-6412. DOI:10.3390/en6126391

[12] Nguyen, Q. *et al.* 2017. Global Production of Second-Generation Biofuels: Trends and Influences. *Dovetail Partners.* Available at: http://www.dovetailinc.org/report_pdfs/2017/dovetailbiofuels0117.pdf.

[13] Taylor-de-Lima, R. L., da Silva, A. J. G., Legey, L. F., and Szklo, A. 2018. Evaluation of economic feasibility under uncertainty of a thermochemical route for ethanol production in Brazil. *Energy*, 150: 363-376.

[14] U.S. Department of Agriculture. Available at: https://www.usda.gov/.

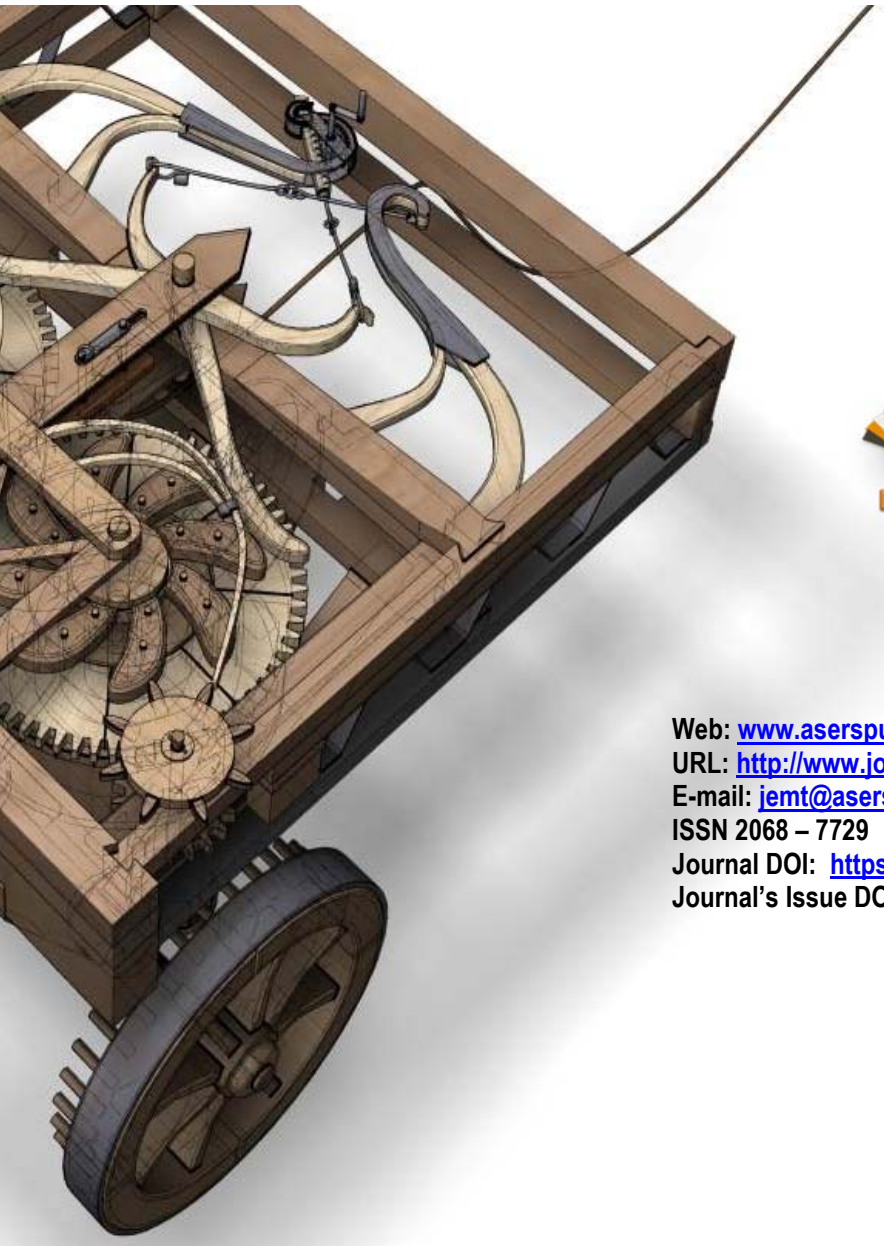
[15] USDA Foreign Agriculture Service. Available at: https://www.fas.usda.gov/.

[16] Vimmerstedt, L. J. *et al.* 2015. Maturation of biomass-to-biofuels conversion technology pathways for rapid expansion of biofuels production: a system dynamics perspective, *Biofuels, Bioprod. Bioref*, 9: 158-176. DOI: 10.1002/bbb.1515

[17] Yarova, N. *et al.* 2017. Economic assessment of the alternative energy sources implementation for port enterprises / *Economic Annals-XXI,* 166(7-8): 46-50. DOI:10.21003/ea.V166-09.

[18] Zulauf, C., Prutska, O., Kirieieva, E. and Pryshliak, N. 2018. Assessment of the potential for a biofuels industry in Ukraine. *Problems and Perspectives in Management*, 16(4): 83-90. DOI:10.21511/ppm.16(4).2018.08.

ASERS



ASERS Publishing

Web: www.aserspublishing.eu
URL: http://www.journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v10.3(35).00