International Journal of Contemporary Research in Agriculture and Environmental Sciences
ISBN (eBook): 978-0-6481172-4-7
Year: 2019 , Volume: 01, Issue: 01

EX-POST ECONOMIC IMPACT ASSESSMENT OF AGRI-ENVIRONMENTAL MEASURE "ORGANIC FARMING": CASE STUDY OF LITHUANIA

Aiste Galnaityte[a], Virginia Namiotko[b], Lina Novickyte[c]
[abc]Lithuanian Institute of Agrarian Economics, Vilnius, Lithuania.
Corresponding Email: aiste.galnaityte@laei.lt

Abstract

Impact assessment is an important tool for policymakers. Pursuing sustainable farming development, it is important to analyse and evaluate possibilities and obstacles of the implementation of sustainable farming practices. The development of new policies requires in-depth analysis and a thorough assessment of the impact of already implemented policy measures (*ex-post* evaluation).This article aims to assess the *ex-post* economic impact of the agri-environmental measure "Organic farming" on the performance of farming indicators. One of the counterfactual *ex-post* impact assessment methods – Propensity score matching (PSM) analysis – was used to achieve the goal set. This method allows assessing the effectiveness of the implemented measure and adapting to research-based policy decisions considering the possibilities of applying this measure in the future. We used Farm Accountancy Data Network (FADN) – the most comprehensive economic information about the activities of farms – data to evaluate an *ex-post* economic impact of the agri-environmental measure "Organic farming" in Lithuania. The results of the research support us with new knowledge about the effectiveness of the agri-environmental measure "Organic farming" in Lithuania and suggest the ways of their improvement in the future. The research has revealed that organic farms became more extensive, while conventional farms became more intensive during the period of 2007–2013.

Keywords: Agri-Environmental Measure "Organic farming", Propensity Score Matching, Sustainable Farming.

1.Introduction

Scientific society acknowledges that agricultural activity and environmental protection are closely related. Agriculture, as compared with other economic activities, has been and continues to be the largest user of nature and natural resources. While producing output, the agricultural sector has the potential positively or negatively affect the natural environment. Agricultural production affects water, air and soil quality influences eco-systems and biodiversity and shapes rural landscapes. Many of these environmental effects –can be considered either negative or positive externalities or as public goods (Vojtech 2010). Agri-environmental policy measures have been developed to reduce negative and to strengthen positive environmental effects.

Lithuanian scientists in the field of ecology and environment have noticed the tendency that in recent years farmers have been trying to intensify production or, conversely, refuse to farm. Scientists note that both of these tendencies are dangerous in terms of biodiversity conservation, as they lead to ecosystem transformations and the loss of the most valuable species (Žekonienė 2002; Ignatavičius, Ložytė 2010; Agroekosistemų 2010; Kurlavičius 2010; Novikova*et al*. 2017). Therefore, sustainable farming and the prudent use of natural resources are crucial for the provision of safe food for the present and future generations and for their quality of life.

As it is outlined in the OECD-FAO Agricultural Outlook 2016-2025 (2016), the food and agriculture systems fulfil a wide range of functions vital to the well-being of humanity. The agricultural sector is expected to fulfil a variety of goals. First of all, it has to provide adequate and reliable supplies of safe, healthy and nutritious food. The agricultural sector has to ensure sufficient income for farmers. The society also expects to receive public goods, such as preserved landscape and biodiversity, clean air, soil, and water. Agriculture is a key sector for the achievement of many goals in the 2030 Agenda for Sustainable Development, which aims to end poverty and hunger and promote prosperity and people's wellbeing while protecting the environment (OECD-FAO 2016). Governments of many countries in the world and international organizations are interested in coordination of the above-mentioned objectives (Dėl Nacionalinės 2003; Atnaujinta 2006; Lietuvos Kaimo Plėtros 2007; Natural Resources 2010; Europos Sąjungos Sutarties 2012; Dėl paramos 2013; Europos Komisija 2014; United Nations 2015a; United Nations 2015b)

According to the recent FAO prospects (2017) (medium variant), the world's population is expected to grow to 9.7 billion by 2050 and 11.2 billion by 2100, while in 2015 it was – 7.3 billion. As a consequence, it will boost agricultural demand – in a scenario of modest economic growth – by some 50 percent compared to 2013. Such an increase in food demand poses a challenge for agriculture to feed the World. It requires commensurate shifts in agricultural output and adding pressure on natural resources. Satisfying increased demands on agriculture with existing farming practices are likely to lead to more intense competition for natural resources, increased greenhouse gas emissions, and further deforestation and land degradation (FAO 2017). Politicians and scientific society are looking for the ways to solve the problems occurred.

Sustainable farming from the natural environment point of view is vital for providing the current and future generations with safe food products and the quality of life in general. The relevance of the research is supported by the Agenda on "Transforming Our World: the 2030 Agenda for Sustainable Development" adopted in 2015 at a special UN Summit on Sustainable Development (United Nations 2015b; United Nations 2015c), which refine the 2000 Millennium Development Goals (United Nations 1992). Sustainable development strategies of the EU and Lithuania focus on the reduction of impact on the environment in the key sectors of the economy, including agriculture, by increasing eco-efficiency and integrating other measures contributing to the preservation of the environment (Dėl Nacionalinės 2003; Atnaujinta ES 2006). The EU and Lithuanian documents regulating rural development are also being developed and the provided measures are implemented in accordance with the principles of sustainable development. The importance of agri-environmental measures is legitimized in the EU regulations: from 2014 EU Member States must allocate at least 30 percent of total European Agricultural Fund for Rural Development (EAFRD) contribution to the program.

Scientific discussion concerning the most appropriate farming practices in terms of sustainability has become significant among policy decision-makers and practitioners in recent years. One of the most widely applied sustainable farming practices is organic farming.Organic farming is not the only farming practice that is sustainable, but others are relatively new, rare and still, there is a problem with a shortage of data. Therefore, agri-environmental measure "Organic farming" was selected for this research. Organic farming practices arewell known and considered as a promising option to sustain both agricultural productivity and environment (Delmotte *et al.* 2016; Jouzi*et al.* 2016; Kirchmann *et al.* 2016; Tasca 2017). Organic farming offers innovative conservation agriculture principles, including minimal soil disturbance (reduced tillage, no-tillage, green manures), permanent soil cover and long crop rotation mean duration of six years (Peigné *et al.* 2016). This helps to reduce the use of mineral fertilizers, control weeds without the use of herbicides, without losses of yield. Organic farming is more energy efficient compared to conventional almost for all types of crops when expressed in a unit of area. Results are more variable per unit of a product because of lower organic yields (Smith *et al.* 2015). Although organic agriculture produces lower yields than conventional agriculture, it better unites human health, environment, and socioeconomic objectives than conventional farming practice (Crowder & Reganold 2015).

Compared with 1999, when 11 million hectares were organic, the organic land has increased almost fivefold. In 2015, 6.5 million hectares, or almost 15 percent, more were reported compared with 2014. This is mainly due to fact that 4.4 million additional hectares were reported from Australia (FAO 2017). According to FAO (2017), 50.9 million hectares were under organic agricultural management worldwide in 2015. Australia is the country with the most organic agricultural land (22.7 million ha in 2015). It accounts for 44.6 percent of all organic agricultural land in the world. It is worth to mention, that 97.0 percent of the farmland is extensive grazing areas. The share of the organic agricultural land in the world was 1.1 percent in 2015. In Australia, the organic share of the total agricultural land in the same year was 5.6 percent, in the European Union – 6.2 percent and in Lithuania – 7.1 percent (FAO 2017,Willer, Lernoud 2017, Eurostat 2018).

2.Data and Methodology

The main element of the *ex-post* impact assessment is to create the opposite of the current situation by using counterfactual analysis methods, such as propensity score matching analysis, double difference analysis, combined propensity score matching and double difference analysis. The essence of the matching methods is to construct counterfactual by creating control group from a large group of non-participants that is as similar to the treatment group in terms of observed characteristics not affected by the program. Each participant is matched with an observationally similar nonparticipant, and then the average difference in outcomes across the two groups is compared to get the program treatment effect (Khandker *et al.* 2010). Matching estimators aim to overcome selection bias on observables by matching each treated individual with one or more non-treated individuals that have similar observed characteristics, the covariates X(Smith &Todd 2005, Arata & Sckokai 2016).

Ex-post economic impact assessment of the agri-environmental measure “Organic farming” is carried out by comparing farms participating in the agri-environmental measure “Organic farming” and not participating.

By the purpose to develop an *ex-post* economic impact assessment methodology of agri-environmental measures, we have examined three most common in the literature usedmethods of counterfactual analysis (Table 1). Most counterfactual methods require a decent amount of quality data for proper analysis, which remains a key challenge for evaluations (Artell *et al.* 2013). Therefore, we first examine if Lithuanian FADN data satisfies obligatory requirements.

Propensity score matching (PSM) is a useful approach when only observed characteristics are believed to affect program participation. This method requires sufficient data on all factors affecting participation in the policy measures of both participants and non-participants. It is recommended to use the data from one source, ideally, if available pre-program baseline data on participants and nonparticipants can be used (Khandker *et al.* 2010). Unfortunately, in Lithuania pre-program baseline data on participants and nonparticipants is not available. On the other hand, it is worth to mention that entering organic farming measure is not immediate, but gradual – it has a transitional period of two years.As PSM analysis does not necessarily require a baseline survey, this method can be used to evaluate *ex-post* economic impact assessment of agri-environmental measure “Organic farming” in Lithuania.

The double-difference estimation technique (DID) typically uses panel data. The DID estimator relies on a comparison of participants and non-participants before and after the intervention.

For this reason, it cannot be used to evaluate *ex-post* economic impact assessment of agri-environmental measure “Organic farming” in Lithuania.

Table 1:Data requirements for the counterfactual analysis methods in the scientific research

No	Method	Authors	Data requirements	Fulfilment (Lithuania)
1.	Propensity score matching (PSM)	Khandker *et al.* 2010, Sauer *et al.* 2012.	Sufficient data on all factors affecting participation in the policy measures of both participants and non-participants;	+
			Data on both participants and non-participants from one source of data.	+
2.	Difference in differences (DID)	Khandker *et al.* 2010, Sauer *et al.* 2012, Udagawa *et al.* 2014.	Detailed panel data on participants and non-participants groups characteristics;	+
			Participants and non-participants remain consistent over the time;	+
			Data on participants and non-participants before and after implementation of the policy measures is compulsory.	-
3.	Combined propensity score matching and difference in differences (PSM-DID)	Pufahl, Weiss 2009, Michalek 2012, Sauer *et al.* 2012, Udagawa *et al.* 2014, Bartova, Hurnakova 2016.	All above listed features.	-

Source: compiled by authors.

The combined propensity score matching and difference in differences (PSM-DID) method cannot be used to evaluate net benefits between participants and non-participants of the agri-environmental measure “Organic farming” in Lithuania. As far as Lithuanian FADN database provide not a sufficient number of the farms entered into the Organic Farming measure during the period of 2007–2013, it is not possible to compare counterfactual of the same farms before and after implementation of the Organic Farming measure. In our case, the sample of organic farms entered the measure during 2007–2013 in fully balanced panel database, is too small – 7(10) farms only. Therefore, propensity score matching analysis method was used to achieve the objective of the article.

Fully balanced panel farm-level data from the Farm Accountancy Data Network (FADN) was used for this research. The data covers Rural Development Programme implementation period of 2007–2013. Lithuanian FADN supply detailed data from 1 300 farms; however balanced panel data is available from 279 farms, 31 of them were participating in the Organic Farming measure.

When assessing the impact of policy measures, it is necessary to evaluate the results that would have been achieved if participants (T=1)of the measure were non-participants(T=0). The individual treatment effect Δ is calculated as a difference between potential outcomes of treated Y_1 and non-treated Y_0 farms:

$$\Delta = Y_1 - Y_0 \qquad (1)$$

The logit model of program participation was constructed and value of propensity score was derived from it, where participation in agri-environmental measure “Organic farming” appears as an endogenous variable. After the participation equation is estimated, the predicted values of T from the participation equation can be derived. It is notable (Khandker *et al.*2010)that the participation equation is not a determinants model, therefore estimations such as t-statistics and the adjusted $R^2$are not informative and may be misleading. For this stage of PSM, causality is not of as much interest as the correlation of X with T. While selection of X variables are likely data driven and context specific, we follow Heckman, Ichimura, and Todd (1997, 1998) suggestions: 1) the same survey instrument or source of data should be used for participants and nonparticipants, if possible, 2) a representative sample survey of participants and non-participants can greatly improve the precision of the propensity score, and 3) the larger sample of non-participants is, the more good matching will be facilitated. Nevertheless, including too many X variables in the participation equation should also be avoided (Khandker *et al.* 2010).Also, it is important to identify the factors driving program participation (e.g. surveys).Therefore, we use six main participation determining factors,proposed by Kriščiukaitienė *et al.*(2013): utilised agricultural area, labour input, livestock units, land quality, farmer's age, and buildings and equipment.

The most common evaluation parameter is mean the impact of treatment treated (TT), which estimates the average impact of the policy measure among those participating in it (Smith, Todd 2005):

$$TT = E(Y_1|X, D = 1) - E(Y_0|X, D = 1) \quad (2)$$

The treatment effect of the program using these methods can either be represented as the average treatment effect (ATE) or the average treatment effect on the treated (ATT). Typically, researchers and evaluators can ensure only internal as opposed to the external validity of the sample, so only the ATT can be estimated. The difference of the mean outcomes of the treated and matched non-treated control group –PSM estimator for ATT – in general, can be written as (Khandker *et al.* 2010; Caliendo & Kopeinig 2005; Arata & Sckokai 2016):

$$ATT_{PSM} = E_{P(X)|T=1}\{E(Y_1|T = 1, P(X)) - E(Y_0|T = 0, P(X))\} \quad (3)$$

To assign participants to non-participants single nearest-neighbor matching without replacement technique was used.

The non-participant with the value ofP_j that is closest to$P_i$is selected as the match(Caliendo & Kopeinig 2005; Smith & Todd 2005,Bartova & Hurnakova, 2016):

$$C(P_j) = \min_j \|P_i - P_j\| \quad (4)$$

We compare farming results of participants and non-participants groups over the period. Software "R" package "MatchIt" was used for PSM evaluation (Stuart *et al.* 2011).

3. Results and Discussion

After the matching procedure conventional and organic farms "became similar" in terms of utilised agricultural area, labour input, livestock units, land quality, farmer's age, and buildings and equipment. These factors in the literature (Kriščiukaitienė *et al.* 2013) are excluded as determining farmers' decisions to farm organically.

After the data analysis, we have noticed substantial structural changes in conventional and organic farms during the period of 2007–2013. Conventional farm size in terms of the area has decreased by 5.4 percent, but increased by 47 percent in terms of economic farm size (Table 2).

Organic farm size in terms of the area has increased by a quarter, but only by 17 percent in terms of economic farm size.

Table 2: Comparison of selected indicators in conventional and organic farms after the matching procedure in 2007 and 2013

Indicator	2007 Conventional farms	2007 Organic farms (TT)	2013 Conventional farms	2013 Organic farms (TT)
Economic farm size, EUR	80 259	70 527	117 853	82 273
Utilised agricultural area, ha	184	150	174	186
Rented land share, percent	52.6	45.8	50.0	41.9
Labour input, h	6 519	6 011	6 366	5 961
Livestock units	39.5	32.8	67.9	60.4
Meadows and pastures, ha	13.1	6.5	14.8	19.7
Share of mineral fertilizers in variable costs, percent	37.3	10.5	36.1	4.4
Share of organic fertilizers in variable costs, percent	1.9	2.2	1.2	0.4
Share of crop protection products in variable costs, percent	11.2	3.0	13.4	2.0
Buildings and equipment, EUR	130 435	101 166	194 351	181 012
Depreciation, EUR	12 807	12 455	32 318	26 471
Farm income, EUR per AWU	24 396	14 336	42 524	17 946
Farm income, EUR per ha	588	395	876	356

Source: authors calculations based on FADN data.

Considerable livestock units increased72 percent in conventional and 84 percent in organic farms. Consequent expansion of meadows and pastures by 3.0 times in organic farms during the period of 2007–2013 was observed, while livestock production became more intensive in conventional farms. The increase of livestock units also caused buildings and equipment value augmentation by1.8 times in organic farms and by 1.5 times in conventional farms. Consequent increases of depreciation by 2.5 and 2.1 times respectively, was observed. These changes are mostly related to the policy aims to strengthen agricultural competitiveness in the livestock sector.

Labour input decrease of 2.3 percent in conventional and 0.8 percent in organic farms, and investments increase led to generate higher farm income per AWU by three quarters in conventional and by a quarter in organic farms. A significant decrease of mineral (6.1 percent points), organic (1.8 percent points) fertilizers, and crop protection products (1.0 percent point) shares in variable costs during the period of 2007–2013 was observed in organic farms. This fact together with a considerable increase of meadows and pastures in organic farms could lead farm income per hectare decrease of 10 percent. In contrary, farm income per hectare increase by 1.5 times in conventional farms. Conventional farms farmers can generate higher income by increasing productivity when allocating substantial shares of mineral fertilizers, crop protection products in variable costs, and intensify livestock production.

Average treatment effect on the treated (ATT), i. e. effect of organic farming on farming results was negative. Farm incomes were lower in organic farms than in conventional farms by 200 EUR/ha in 2007 and 493 EUR/ha in 2013. Overall average treatment effect on treated was -293 EUR/ha.

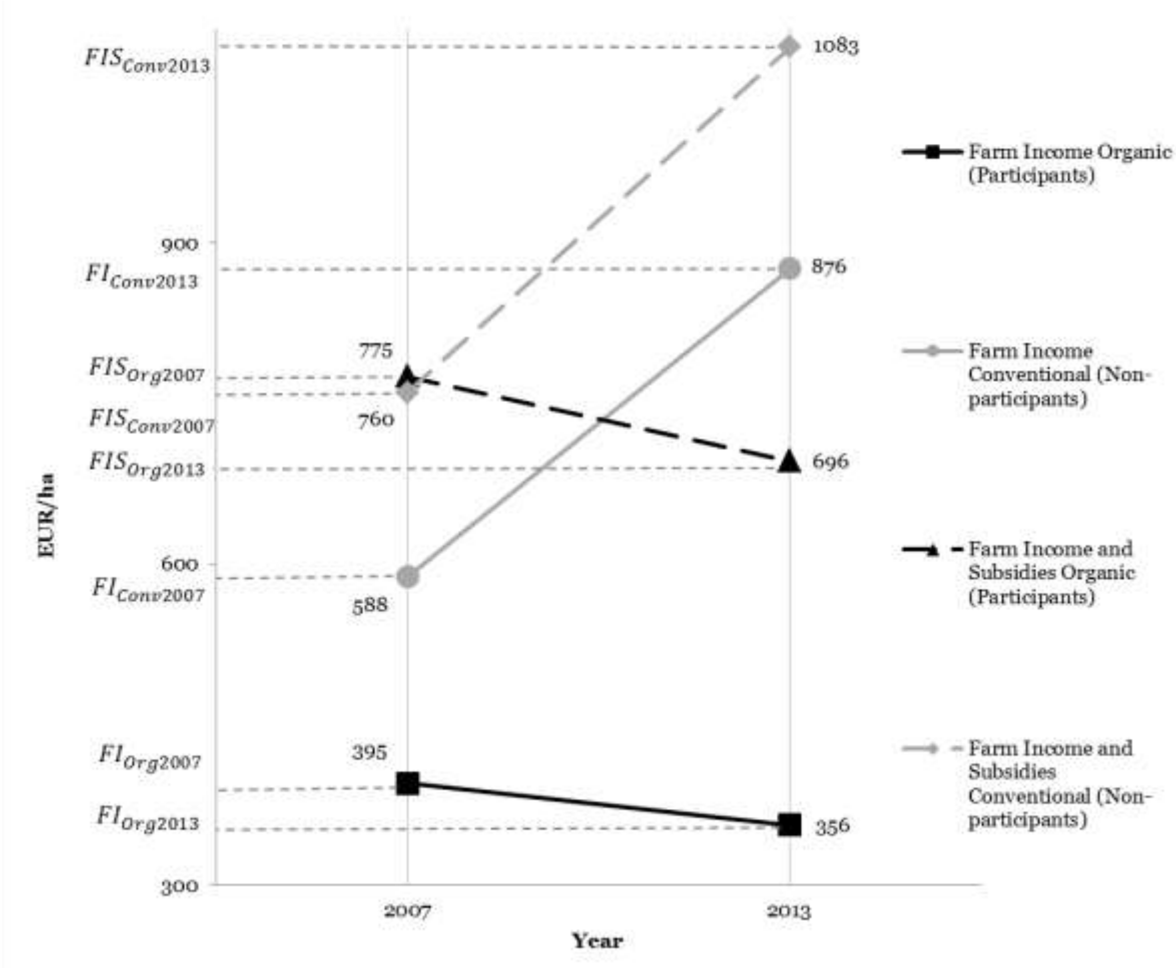

Figure 1: Comparison of Farm incomes in conventional and organic farms after the matching procedure in 2007 and 2013, EUR per ha

It is worth to mention that subsidies had different trends in conventional and organic farms during the period of 2007–2013 (Figure 1). Subsidies amount per UAA hectare during the period in conventional farms has increased by 20 percent from 172 to 207 EUR/ha, while in organic farms subsidies have decreased by 11 percent from 380 to 340 EUR/ha.

In 2007, farm incomes with subsidies (FIS) in conventional and organic farms were similar: in organic farms, they were by 15 EUR/ha (2.0 percent) higher than in conventional farms. But during the period, together with different trends in farm income (FI) and subsidies (S) in conventional and organic farms, the gap between farm incomes with subsidies (FIS) altogether has emerged and has reached 387 EUR per UAA hectare. Such a development of FIS raises a question: whether farmers will continue to develop organic farms when they are able to increase their income per hectare more than by one third? The question should be dedicated to policy-makers. As possible decisions could be named revision of compensatory payments amounts and promotion of the implementation of technological innovations of organic farms.

It is obvious that organic farming is less profitable and the gap between farm income in organic and conventional farms has increased during the period of seven years. Even farm income without subsidies in conventional farms in 2013 became higher by 180 EUR/ha (25 percent) than farm income with subsidies in organic farms.

Farmers are seeking to maximize profits (Bertoni & Olper 2012), and the society would like to consume high-quality and healthy food products at reasonable prices, preserve the unique landscape and avoid air pollution. It is a fundamental challenge – to produce more for less (Europos Komisija 2014, 2017).

It could be concluded, that in Lithuania increasing share of agricultural land occupied by organic farming positively contributes to climate change, sustainable management of natural resources, and countryside, but organic farming is not capable to ensure viable food production that would contribute to feeding growing world's population. We must accept the idea that is suggested by Campbell *et al.* 2017 and Muller *et al.* 2017, that the problem needs interventions inthe broader food system, such as food wastagereduction, dietary changes reducing animal number and animal product consumption.

Conclusion

Propensity score matching (PSM) analysis was used to evaluate the *ex-post* economic impact of agri-environmental measure "Organic farming" on the performance of farming indicators in Lithuania, as far as other methods analysed did not satisfy data requirements.

Data analysis showed substantial structural changes in conventional and organic farms during the period of 2007 2013. Conventional farm size in terms of the area has decreased by 5.4 percent, but increased by 47 percent in terms of economic farm size. Organic farm size in terms of the area has increased by a quarter, but only by 17 percent in terms of economic farm size.

The research has revealed that organic farms became more extensive, while conventional farms became more intensive during the period of 2007–2013. The problem lies in the structure and technologies of the organic farming.

Intensification of conventional farms is clearly visible in live stock production: livestock units increase is 72 percent during the period of 2007–2013, but the area of meadows and pastures has increased only by 13 percent.

Policy-makers should encourage livestock breeders to implement farming practices that reduce the impact on the environment and climate change in the future.

Continuous annual *ex-post* economic impact assessment of the agri-environmental measure "Organic farming" on the performance of farming indicators would be desirable and could reveal more facts concerning possibilities and obstacles of the implementation of sustainable farming practices development.

References

i. *Agroekosistemų komponentų valdymas. Ilgalaikių agrocheminių tyrimų rezultatai: monografija*. 2010. Autorių kolektyvas: Tripolskaja, L. – sudarytoja... [*et al.*]. Akademija, Kėdainių r.: AB „Spauda". P. 568.

ii. Arata, L., Sckokai, P. 2016. The impact of Agri-environmental schemes on farm performance in five EU member states: a DID-matching approach. *Land Economics*, vol. *92, no.* 1, pp.167-186.

iii. Artell, J., Aakkula, J., Toikkanen, H. 2013. *Review of counterfactual methods*. [Online] Available at: <http://www.envieval.eu/fileadmin/redaktion/Dissemination/ Deliverables/ D3.1_website.pdf>

iv. Atnaujinta ES tvaraus vystymosi strategija. 2006. *Europos Sąjungos Taryba*. [Online] Available at:<http://www.am.lt/VI/files/0.207844001174307767.pdf>

v. Bartova, L., Hurnakova, J. 2016. Estimation of Farm Investment Support Effects: A Counterfactual Approach. *Quantitative Methods in Economics Multiple Criteria Decision Making* vol. *XVIII*, p. 19.

vi. Bertoni, D., Olper, A. 2012. The political economy of agri-environmental measures: An empirical assessment at the eu regional level, *APSTRACT: Applied Studies in Agribusiness and Commerce vol.* 6, no. (3–4), pp. 71–82.

vii. Caliendo, M., Kopeinig, S. 2005. *Some Practical Guidance for the Implementation of Propensity Score Matching. IZA Discussion Paper No. 1588.* The Institute for the Study of Labor. Bonn.

viii. Campbell, B. M., D. J. Beare, E. M. Bennett, J. M. Hall-Spencer, J. S. I. Ingram, F. Jaramillo, R. Ortiz, N. Ramankutty, J. A. Sayer, D. Shindell. 2017. Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*vol. 22, no. 4, p. 8.

ix. Crowder, D. W., Reganold, J. P. 2015. Financial competitiveness of organic agriculture on a global scale. *Proceedings of the National Academy of Sciences*, vol. 112, p. 24, pp. 7611–7616.

x. *Dėl Nacionalinės darnaus vystymosi strategijos patvirtinimo ir įgyvendinimo*. 2003 m. rugsėjo 11 d. *Lietuvos Respublikos Vyriausybės nutarimas Nr.* 1160.

xi. Dėl paramos kaimo plėtrai, teikiamos Europos žemės ūkio fondo kaimo plėtrai (EŽŪFKP) lėšomis, kuriuo panaikinamas Tarybos reglamentas (EB) Nr. 1698/2005, *2013 m. gruodžio 17 d.* Europos Parlamento ir Tarybos reglamentas (ES) Nr. 1305/2013.

xii. Delmotte, S., Barbier, J.-M., Mouret, J.-C., Le Page, Christophe., Wery, J., Chauvelon, Ph., Sandoz, A., Lopez Ridaura, S. 2016. Participatory integrated assessment of scenarios for organic farming at different scales in Camargue, France. *Agricultural Systems*, vol. 143, pp. 147-158.

xiii. Europos Komisija. 2014. *Apie Europos Sąjungos politiką. Žemės ūkis*. [Online] Available at: <http://europa.eu/pol/pdf/flipbook/lt/agriculture_lt.pdf>

xiv. Europos Komisija. 2017. *Apie Europos Sąjungos politiką. Žemės ūkis*. [Online] Available at: <https://publications.europa.eu/en/publication-detail/-/publication/f08f5f20-ef62-11e6-8a35-01aa75ed71a1/language-lt/format-PDF>

xv. Europos Sąjungos oficialusis leidinys 2012. *Europos Sąjungos sutarties ir Sutarties dėl Europos Sąjungos veikimo suvestinės redakcijos* /C 326/01. [Online] Available at: <https://www.ecb.europa.eu/ecb/legal/pdf/c_32620121026lt.pdf>

xvi. Eurostat. 2018. *Organic crop area by agricultural production methods and crops (from 2012 onwards)*. [Online] Available at: <http://ec.europa.eu/eurostat>

xvii. FAO. 2017. *The future of food and agriculture – Trends and challenges*. Rome. [Online] Available at: http://www.fao.org/3/a-i6583e.pdf

xviii. Heckman, J. J., Ichimura, H., Todd, P. E. 1997. Matching as an econometric evaluation estimator: Evidence from evaluating a job training programme. *The review of economic studies*, vol. *64, no.* 4, pp. 605-654.

xix. Heckman, J. J., Ichimura, H., Todd, P. E. 1998. Matching as an econometric evaluation estimator. *The review of economic studies*, vol. *65, no.* 2, pp. 261-294.

xx. Ignatavičius, G., Ložytė, A. 2010. Agrarinės veiklos įtaka pievų ekosistemų biologinės įvairovės pokyčiams Lietuvoje, *Žemės ūkio mokslai* 17(1–2): 47–55.

xxi. Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S., Lebailly, P. 2017. Organic Farming and Small-Scale Farmers: Main Opportunities and Challenges. *Ecological Economics*, 132, 144–154.

xxii. Khandker, S. R., Koolwal, G. B., Samad, H. A. 2009. *Handbook on impact evaluation : quantitative methods and practices (English)*. Washington, DC: World Bank. [Online] Available at: <http://documents.worldbank.org/curated/en/650951468335456749/Handbook-on-impact-evaluation-quantitative-methods-and-practices>

xxiii. Kirchmann, H., Kätterer, T., Bergström, L., Börjesson, G., and Bolinder, M. A. 2016. Flaws and criteria for design and evaluation of comparative organic and conventional cropping systems. *Field Crops Research*, vol. 186, pp. 99–106.

xxiv. Kriščiukaitienė, I., Eirošius, Š., Namiotko, V. 2013. Ekologinės gamybos būdo pasirinkimą lemiančių veiksnių vertinimas. *Ekonomika ir vadyba: aktualijos ir perspektyvos.*Vol. 2, no. 30, pp. 37–43.

xxv. Kurlavičius P. 2010. *Agrarinė aplinkosauga*. Vilnius: Lietuvos ornitologų draugija, Baltijos aplinkos forumas. P. 180.

xxvi. Lietuvos kaimo plėtros 2007–2013 metų programa. *Konsoliduota 2014 12 22 versija*. 2007. [Online] Available at: <http://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Veiklos_sritys/Kaimo_pletra/Lietuvos_kaimo_pletros_2007%E2%80%932013%20m._programa/KPP20072013LT20141222.pdf>

xxvii. Michalek, J. 2012. *Counterfactual impact evaluation of EU rural development programmes – Propensity Score Matching methodology applied to selected EU Member States. Volume 1: A micro-level approach*. [Online] Available at: <http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/26499/1/jrc71977.pdf>

xxviii. Muller, A., Schader, C., Scialabba, N. E. H., Brüggemann, J., Isensee, A., Erb, K. H., Smith P., Klocke P., Leiber F., Stolze M., Niggli, U. 2017. Strategies for feeding the world more sustainably with organic agriculture. *Nature communications*, vol. *8, no.* 1, p. 1290.

xxix. Natural Resources Management and Environment Department Food and Agriculture Organization of the United Nations. 2010. *Relevance of OECD agri-environmental measures for remuneration of positive externalities / payments for environmental services*[Online] Available at: <http://www.fao.org/docrep/013/al921e/al921e00.pdf>

xxx. Novikova, A., Rocchi, L., Vitunskienė, V. 2017. Assessing the benefit of the agroecosystem services: Lithuanian preferences using a latent class approach. *Land Use Policy*, vol. *68*, pp. 277-286.

xxxi. OECD-FAO. 2016. OECD-FAO Agricultural Outlook 2016-2025. Paris: OECD Publishing. [Online] Available at: <http://dx.doi.org/10.1787/agr_outlook-2016-en>

xxxii. Peigné, J., Casagrande, M., Payet, V., David, C., Sans, F. X., Blanco-Moreno, J. M., Cooper, J., Gascoyne, K., Antichi, D., Bàrberi, P.,Bigongiali, F., Surböck, A.,Kranzler, A., Beeckman, A., Willekens, K., Luik, A., Matt, D., Grosse, M.,Heß, J., Clerc M., Dierauer H., andMäder, P. 2016. How organic farmers practice conservation agriculture in Europe. *Renewable Agriculture and Food Systems*, vol. 31, no. 1, pp. 72–85.

xxxiii. Pufahl, A., Weiss, C. R. 2009. Evaluating the effects of farm programmes: results from propensity score matching, *European Review of Agricultural Economics* vol. 36, no. 1, pp. 79–101.

xxxiv. Sauer, J., Walsh, J., Zilberman, D. 2012. *Producer behaviour and agri-environmental policies: A directional distance based matching approach*. 2012 Annual Meeting, August 12–14, 2012, Seattle, Washington (124877): Agricultural and Applied Economics Association.

xxxv. Smith, J. A., Todd, P. E. 2005. Does matching overcome LaLonde's critique of nonexperimental estimators? *Journal of econometrics*, vol. *125, no*. 1-2, pp. 305-353.

xxxvi. Smith, L. G., Williams, A. G., and Pearce, B. D., 2015. The energy efficiency of organic agriculture: A review. *Renewable agriculture and Food systems*, vol. 30, no. 3, pp. 280–301.

xxxvii. Stuart, E. A., King, G., Imai, K., Ho, D. E. 2011. MatchIt: nonparametric preprocessing for parametric causal inference. *Journal of Statistical Software*, vol. *42, no*. 8.

xxxviii. Tasca, A. L., Nessi, S., and Rigamonti, L. 2017. Environmental sustainability of agri-food supply chains: An LCA comparison between two alternative forms of production and distribution of endive in northern Italy. *Journal of Cleaner Production*, vol. 140, pp. 725–741.

xxxix. Udagawa, C., Hodge, I., Reader, M. 2014. Farm level costs of Agri-environment measures: The impact of entry level stewardship on cereal farm incomes. *Journal of Agricultural Economics*, vol. 65, no. 1, pp.212–233.

xl. United Nations. 1992. *Agenda 21.United Nations Conference on Environment and Development*[Online] Available at: <https://sustainabledevelopment.un.org/content/documents/ Agenda21.pdf>

xli. United Nations. 2015a. *World population prospects*. [Online] Available at: <http://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf>

xlii. United Nations. 2015b. *Transforming our world: the 2030 Agenda for Sustainable Development*. [Online] Available at: <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E>

xliii. United Nations. 2015c. *Adoption of the Paris Agreement. Proposal by the President*. [Online] Available at: <http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf>

xliv. Vojtech, V. 2010. *Policy measures addressing agri-environmental issues*. OECD Food, Agriculture and Fisheries Papers No. 24. Paris: OECD Publishing. 42 p.

xlv. Willer, H.,Lernoud, J. (Eds.) 2017. *The World of Organic Agriculture. Statistics and Emerging Trends 2017*. Research Institute of Organic Agriculture (FiBL), Frick, and IFOAM – Organics International, Bonn.

xlvi. Žekonienė, V. 2002. *Tausojamoji žemdirbystė*. Vilnius: UAB „Tiražas“. P. 137.