ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF BIOMASS ON BIOENERGY PRODUCTION

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Research problem.

1. What is the agro-waste biomass utilization potential for bioenergy production in the agricultural sector ?

2. What is the nexus between environmental and agriculture activities ?

The aim of this study – to carry out an environmental impact assessment of the agro-waste biomass use on bioenergy production.

Data sources: Eurostat, Lithuanian Department of Statistics, Lithuanian Energy Institute (LEI), Renewable Energy Statistics (RES), Lithuanian Biomass Energy Association (Litbioma).

Acknowledgements

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Methodology of research. The exploratory study consists of 2 main characteristics: assessment of the potential of agro-waste biomass and the environmental impact of agricultural activities.

According to a technical mathematical formulation, agro-waste biomass bioenergy yield is assessed using three kinds of second-generation biofuel: bioethanol, biodiesel and biogas in Lithuania during the period 2017-2021. Each type of biofuel includes a variety of plant species wastes such as strew, stems, hulls, grain, grass/forages and others.

The effect between environmental and agricultural activities is analysis from four positions, such as fertilization, irrigation, chemical inputs and mechanized machinery. These activities are intensively is used in agriculture to increase biomass bioenergy yields.

THE AGRO-WASTE BIOMASS OF SECOND-GENERATION BIOFUEL

Bioethanol	Wheat, Triticale, Rye, Barley, Oats, Buckwheat, Maize, Sugar beet, Legumes beans, Pea, Lentil, Jerusalem artichokes	Straw, pods/straw, stems /leaves, hulls, grass biomass
Biodiesel	Rape, Soybean, Fiber hemp, Flax, Sunflowers	Straw, stems, hulls
Biogas	Switchgrass, Goat's-rue, Sativa, Miscanthus, Sugar beet, Maize, Lupin, Millet, Sorghum, Honey clover, Lucerne, Serradella	Grass/forages, stems, leaves, hulls, stalk, grain

TOTAL CONSUMPTION OF BIOFUELS AND BIOGAS (TJ), 2017–2020 IN LITHUANIA

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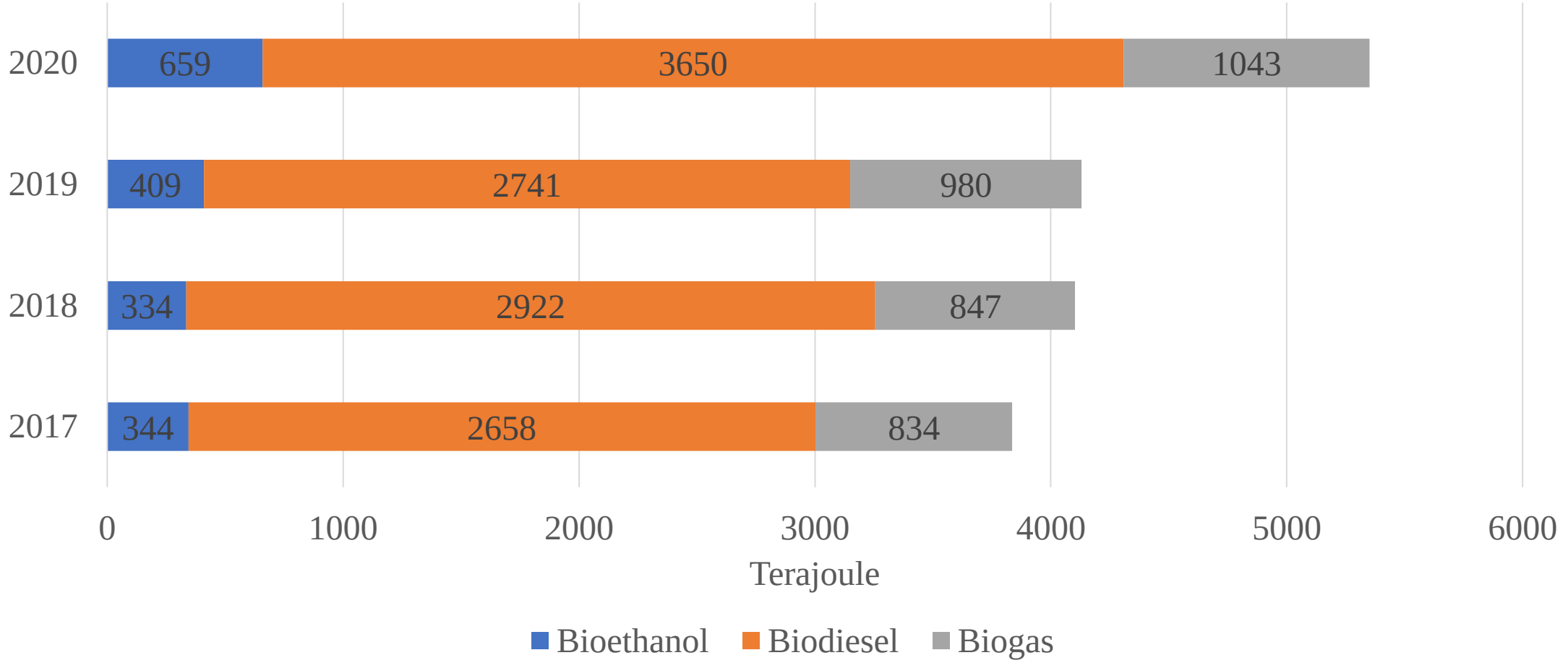

THEORETICAL AND TECHNICAL FORMULATION POTENTIAL OF BIOENERGY YIELD FROM THE AGRO-WASTE BIOMASS

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The overall theoretical biomass energy potential (Q) is estimated as the sum of potential associated with each biomass category, $Q_{AR} - agriculture\ residue$; $Q_{AW} - animal\ waste$; $Q_F - forestry$; $Q_U - urban\ waste$, see (1). Similarly, the technical biomass energy potential (Q^T) is calculated by using (2):

$$Q = Q_{AR} + Q_{AW} + Q_F + Q_U \qquad (1)$$

$$Q^T = Q_{AR}^T + Q_{AW}^T + Q_F^T + Q_U^T \qquad (2)$$

The energy potential associated with agriculture residues is calculated using the crop production $P_i = CA_i\ x\ AP_i$ CA_i – the cultivated area for i-th crop, in hectares (ha); AP_i – the agricultural production for the i-th crop, in tons per hectare (t ha1) by-product to crop ratio k_{ij}, moisture content M_{ij} and the lower heating value LHV_{ij}, as shown in (3) and (4).

$$Q_{AR} = \sum_{ij} P_i \cdot k_{ij} \cdot (1 - M_{ij}) \cdot LHV_{ij} \qquad (3)$$

$$Q_{AR}^T = \sum_{ij} P_i \cdot k_{ij} \cdot (1 - M_{ij}) \cdot LHV_{ij} \cdot a_{ij} \qquad (4)$$

MEAN VALUES OF QUALITATIVE CHARACTERISTICS OF AGRO-WASTE BIOMASS SOURCES (CALORIFIC VALUE, HUMIDITY)

Types of biomass	Type of agro-waste	Product to crop ratio	Lower Heating Value MJ kg^{-1}	Moisture Percentage (%)
Bioethanol				
Wheat winter/summer	straw	1,7	13,63	9,8
Triticale	straw	1,2	13,63	14
Rye	straw	1,5	13,63	14
Barley	straw	1	13,63	10,6
Oats	straw/hulls	1,3	13,63	14
Buckwheat	straw	1,1	13,63	14
Maize/Corn	stalk/cobs	2,5	17,48	7
Legumes beans	pods/straw	2,1	19,04	6,3
Pea	stems/leaves	1,3	17,48	14
Lentil	stems/leaves	1,7	17,48	14
Jerusalem artichokes	Grass/forages	1	16,08	9,5
Biodiesel				
Soybean	hulls	2,5	18,03	6,2
Sunflowers	hulls	2,2	20,04	6,2
Fiber hemp	stems	1,1	16,85	8,2
Flax	straw	0,3	17,48	5,6
Rape	straw	2	13,63	12
Biogas				
Switchgrass	Grass/forages	1	15,63	8
Sugar beet	leaves	0,6	17,83	12
Goat's-rue	stems	1	17,48	12
Sativa	stems	1	17,48	12
Miscanthus	Grass/forages	1	19,04	9,9
Lupin	grain	1	14,73	14
Millet	stalk	1,83	17,48	14
Sorghum	stalk	2,5	17,03	12
Honey clover	stems	1	17,48	12
Lucerne	hulls	2	15,63	12
Serradella	stems	1	17,48	12

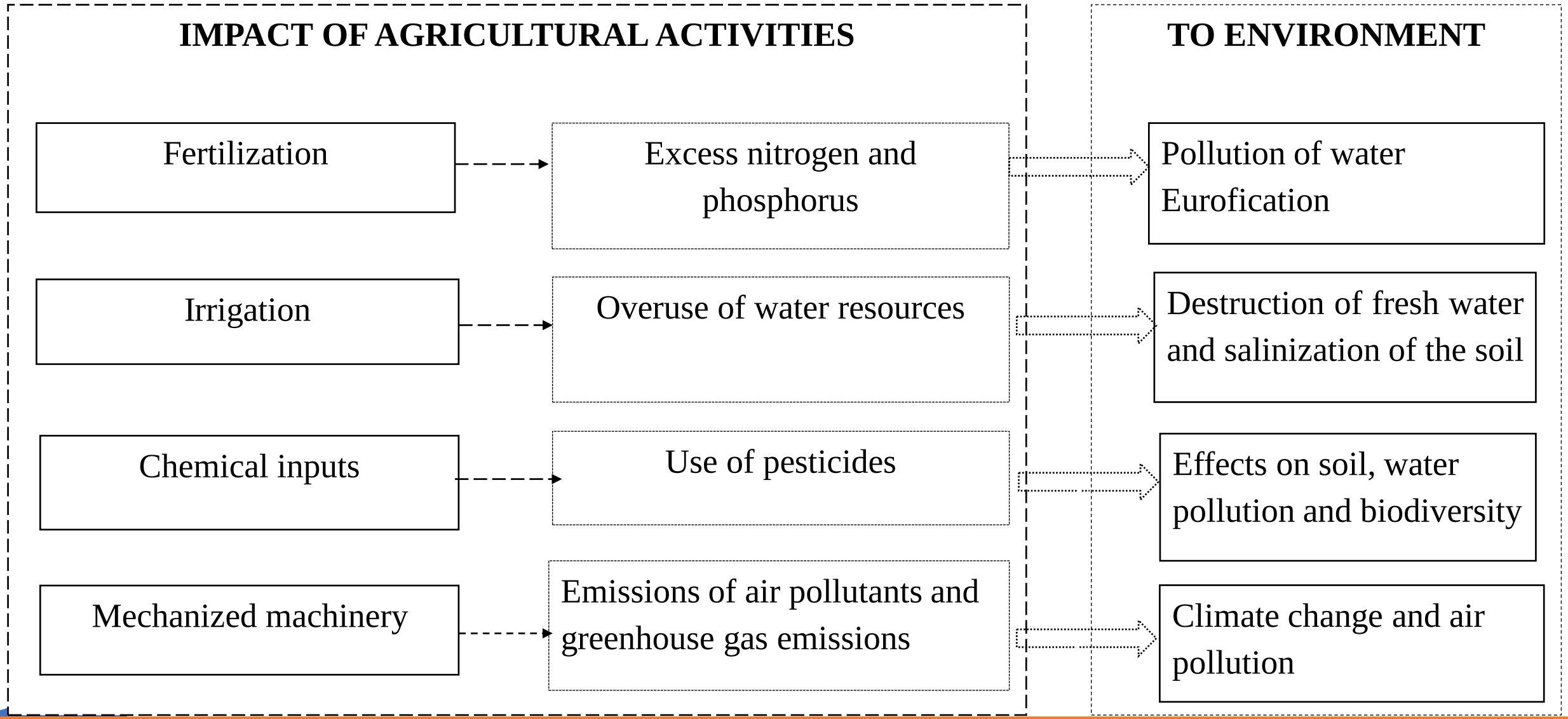
TECHNICAL POTENTIAL OF BIOENERGY YIELD FROM THE AGRO-WASTE BIOMASS IN LITHUANIA DURING THE PERIOD 2017-2021

Types of Biomass	Agriculture residues of second-generation biofuel *, tons per year	Bioenergy yield (output)	
		GJ/yr	%
Bioethanol			
Winter wheat	17 396 710	5 106 869	55,5
Winter triticale	939 260	262 885	2,9
Winter rye	361 039	101 049	1,1
Winter barley	342 490	99 647	1,1
Summer wheat	2 454 533	720 537	7,8
Summer barley	2 445 045	711 386	7,7
Summer triticale	114 268	31 982	0,3
Summer rye	1 796	503	0,01
Oats	1 121 351	313 849	3,4
Buckwheat	155 428	43 502	0,5
Maize/Corn	2 309 446	896 868	9,8
Legumes beans	1 321 704	563 079	6,1
Pea	938 895	337 173	3,7
Lentil	78	28	0,0003
Jerusalem artichokes	13 588	4 723	0,05
Total:	***29 915 628***	***9 194 080***	***100***

TECHNICAL POTENTIAL OF BIOENERGY YIELD FROM THE AGRO-WASTE BIOMASS IN LITHUANIA DURING THE PERIOD 2017-2021 (2)

Types of Biomass	Agriculture residues of second-generation biofuel *, tons per year	Bioenergy yield (output)	
		GJ/yr	%
Biodiesel			
Soybean	20 997	8 483	0,6
Sunflowers	236	106	0,01
Fiber hemp	24 573	9 080	0,7
Linseed	205	83	0,01
Winter rape	4 173 353	1 195 223	91,5
Summer rape	327 020	93 657	7,2
Total:	***4 546 384***	***1 306 632***	***100***
Biogas			
Switchgrass	5 014 918	1 722 338	55,8
Sugar beet	1 842 043	690 470	22,4
Goat's-rue	221	81	0,003
Sativa	259	95	0,003
Miscanthus	4 521	1 852	0,1
Lupin	12 386	3 747	0,1
Millet	1 471	528	0,02
Sorghum	1 066	382	0,01
Honey clover	1 229 034	451 631	14,6
Lucerne	652 990	214 467	7,0
Serradella	71	26	0,001
Total:	***8 758 979***	***3 085 617***	***100***

THE AGRICULTURE ACTIVITIES–ENVIRONMENT NEXUS



ESTIMATED MINERAL FERTILIZER CONSUMPTION BY AGRICULTURE (THSD. TONNE), 2014-2019 IN LITHUANIA

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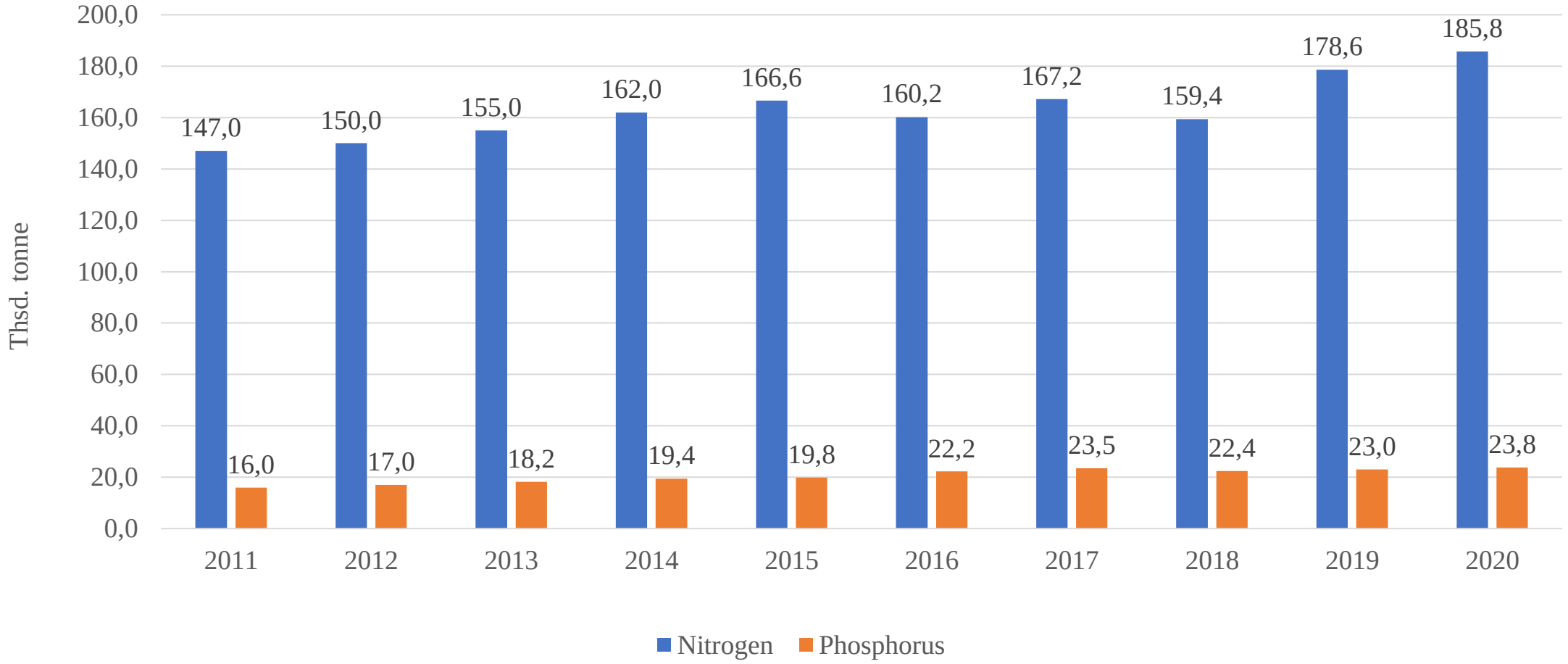

WATER CONSUMPTION IN AGRICULTURE, MILLION M³, 2015-2019 IN LITHUANIA

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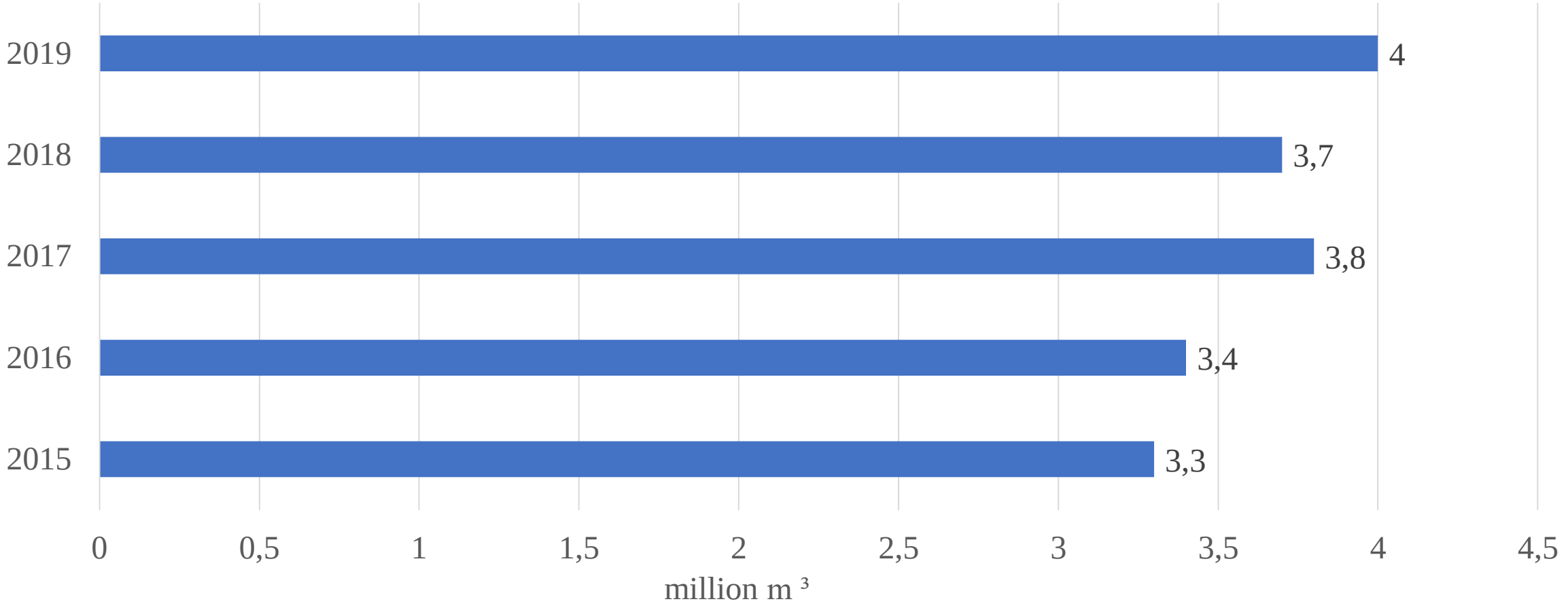

SALE OF PESTICIDES (THSD. KILOGRAM), 2011 -2019 IN LITHUANIA

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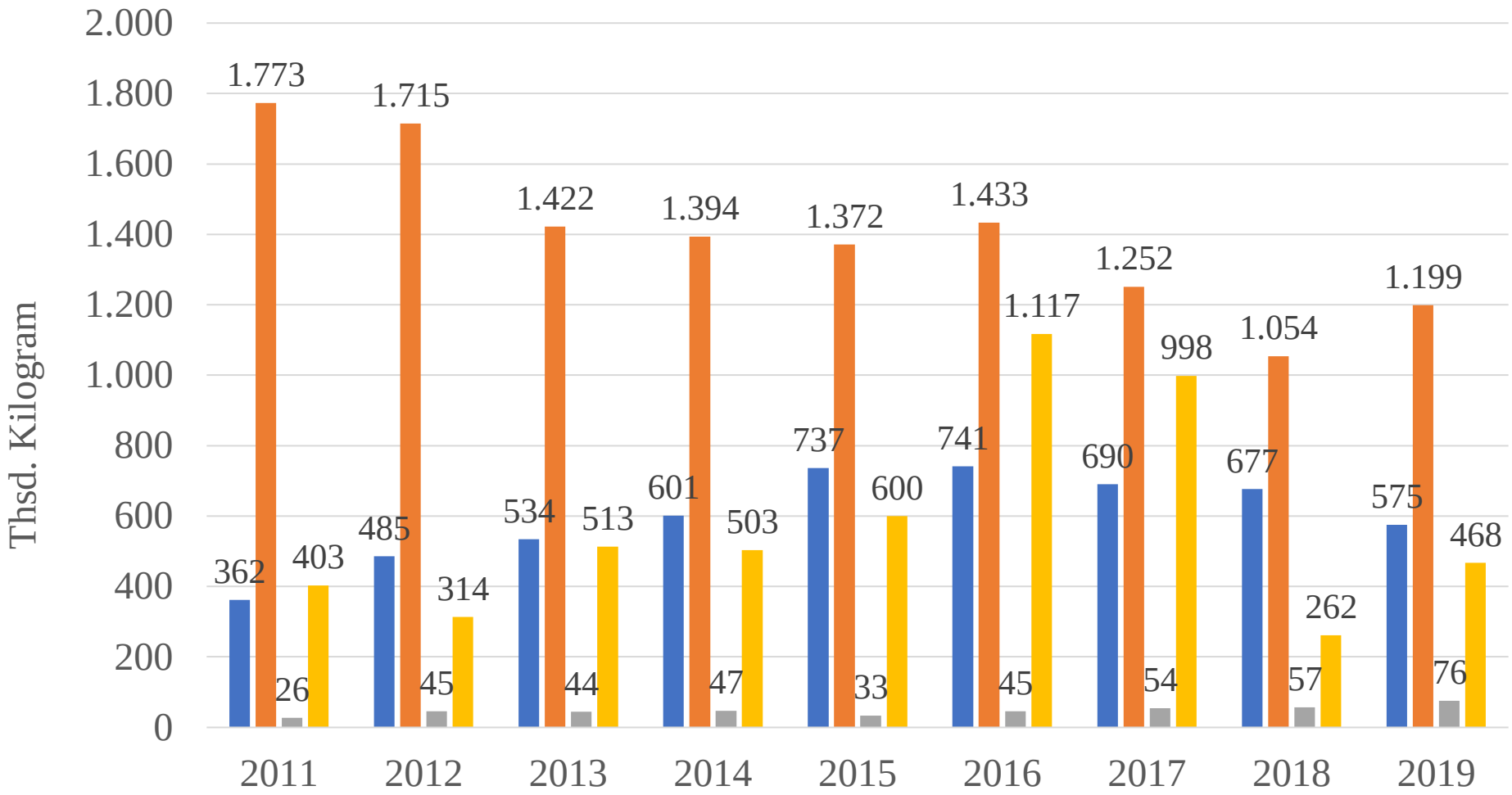

EMISSIONS OF AIR POLLUTANTS IN AGRICULTURE (THSD. TONNE), 2014-2019 IN LITHUANIA

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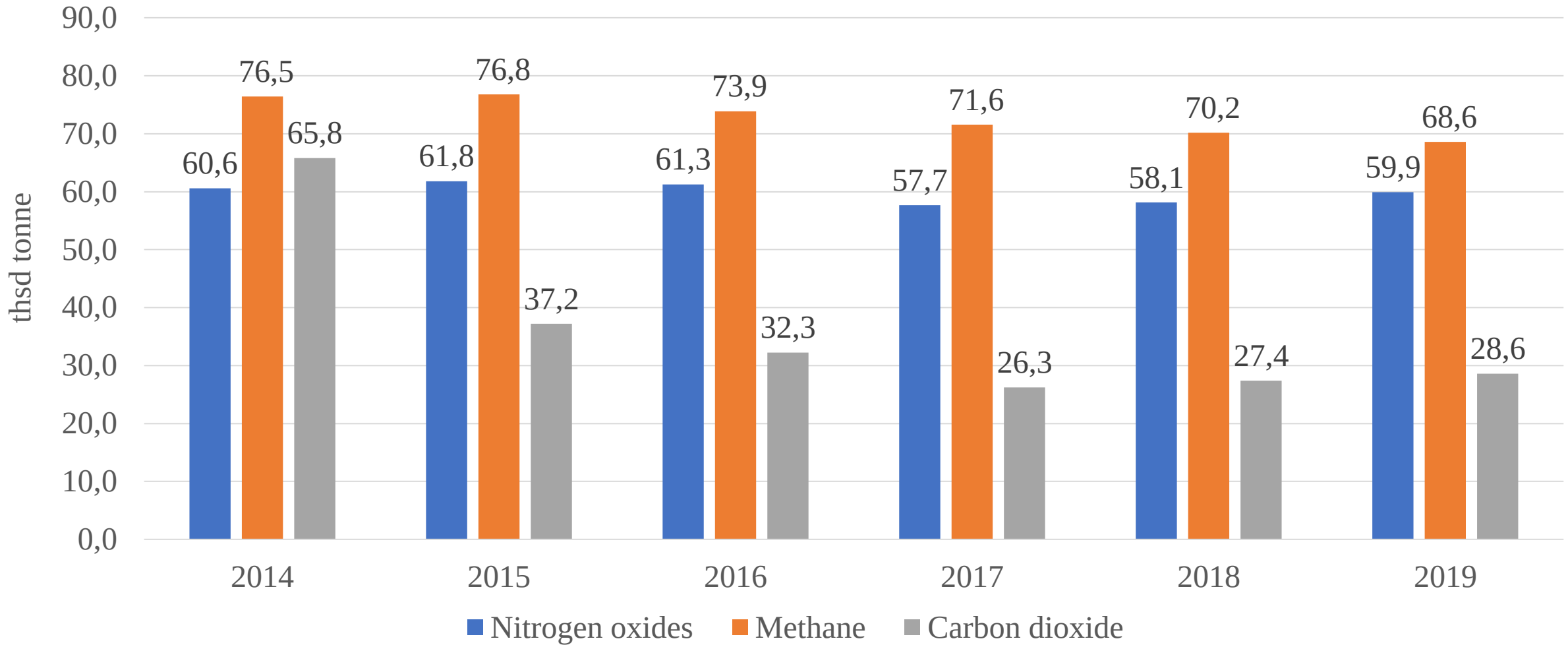

CONCLUSIONS

The results of agro-waste bioenergy yield showed, that the most significant to produce bioethanol production from the straw of winter/summer wheat, straw of summer barley, also a stalk of maize, pods/straw of legumes beans and stems/leaves of a pea. The most popular agro-waste for biodiesel production is the straw of winter rape. Biogas production is more useful to produce bioenergy production from switchgrass and leaves of sugar beet.

The nexus between agriculture activities and the environment is expressed in the fact for the high use of nitrogen fertilizers causes eutrophication of aquatic and terrestrial ecosystems and the high use of phosphorus fertilizers causes eutrophication of groundwater and freshwater occurs. Irrigation indicates that overuse of freshwater causes salinization of the soil and the destruction of freshwater ecosystems. Chemical inputs expressed by the use of pesticides cause the loss of biodiversity. Mechanized machinery is related to the changes in climate conditions to decrease air pollutants and greenhouse gas emissions.

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THANKS FOR YOUR ATTENTION !