IMPACT OF AGRICULTURE ON AIR POLLUTION

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Abstract: Air pollution is of major importance to the environment. Last years the findings related to air pollution of the agricultural sector and the impact on it are crucial for the future development of plant and livestock breeding sectors. The main purpose of this paper is to identify, analyze and assess, on the one hand, the impacts of agriculture on air pollution and, on the other, agriculture as a pollutant. The conclusions drawn will serve as suggestions for the introduction of practices and mechanisms in agriculture that will contribute to the improvement of the environment and in particular the quality of the air.

The object of the survey is the agrarian sector, and the subject of the research is 1) the impact of air pollution on the agrarian sector and 2) the effects of agrarian activities on air pollution. The paper is based on the following sequence: theoretical framework, analysis of statistical information and a survey of agrarian, environmental and agroecology experts. The survey is made under the scientific project DN 15/8 11.12. 2017 Sustainable multifunctional rural areas: reconsidering agricultural models and systems with increased demands and limited resources.

Introduction

Bulgaria is known for its agricultural traditions, which make this field of research important and very actual. Theories connect the two aspects of the agriculture - as a pollutant and affected by pollution. The sustainability of the sectors is a priority for the country, and this should be combined with measurements for reducing the air pollution which can cause damages on the environment and on the sector as well.

Literature review

Achieving sustainability in agriculture is of a great importance for Bulgaria and is related to reducing air pollution levels in the country. At this stage, major environmental weaknesses in the agrarian sector are related to deforestation; excessive exploitation of the destruction of natural plant resources and the fragmentation of natural habitats; intensive forestry; a change in the way the land is used; use of fertilizers and pesticides in agriculture; excessive grazing or abandonment of pastures and meadows; distribution of invasive and imported species; drainage, water use, river bed correction, etc. The relationship between the agrarian sector and air pollution is bilateral. Air pollution issues are addressed, such as how agriculture is polluting the environment as well as how it is under the influence of pollution (Harizanova, 2015; Mukherjee, 2017). A number of authors attempt to produce an assessment of the impact of agricultural sectors in the countries of Central and Eastern Europe using comparative statistics on air pollution and out-of-the-box industrial models (Szuba-Barańska & Mrówczyńska-Kamińska, 2016).

Some authors (Unsworth & Ormrod, 1982) study the impact of air pollution on agricultural produce by offering options for separating farmland into places where there are no potential air pollution hazards and thus no effect on the growth of (Kozioł & Whatley, 1984) their biotechnology (Omasa, et al., 2012), physiological characteristics, pigment, biomass, yield (Agrawal et al, 2003) and damage to crops. Most crops are exposed to ozone concentrations that go beyond the EU's long-term goal of protecting vegetation. This includes, in particular, a significant part of rural areas, primarily in southern, central and Eastern Europe (Tietenberg & Lewis, 2016). The negative effects of air pollution can be overcome by policies to control air pollution that are adequate to the pollution control costs incurred (Heagle et al., 1973). The influence of the agricultural sector on reducing the negative impact of agriculture on the environment (especially air pollution), through diversification of production, good agricultural research (Doitchinova et al., 2017; Doitchinova, 2005; Kirechev, 2014; Metodieva & Metodiev, 2014) practices, better resource utilization, crop rotation, soil quality improvement, soil erosion reduction technologies, efficiency of the activity, etc.

In the grain sector, the hypothesis of farmers reacting to the introduction of restrictive measures to reduce air pollution is explored (Harizanova, 2015). The possible limitations have been tried such as a 5% environmental tax (on each unit polluter) had a severe negative impact on farms from an economic

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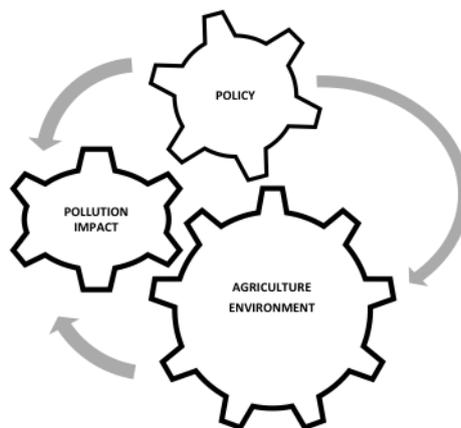[2] Business faculty, University of National and World Economy, Bulgaria, zstoyanova@unwe.bg

point of view but, had a very positive impact on the environment. The main consideration for farmers is that the weight of tax enforcement must be paid by the state, end-users, and sellers of raw materials. Some weight producers are willing to pay only 5% of the tax.

Some authors (Kirechev, 2014; Zhecheva-Radeva, 2008) set out a model that proposes options for farmers to implement sustainable farming schemes based on certain aspects of sustainable development. The proposed systems are: agroecology; integrated farming; biodynamic farming; organic farming; conservation agriculture; and precision farming. It also proposes the term "sustainable intensity", which aims to revile the possibility of increasing agricultural production while at the same time helping to protect the production of the environment.

The general model of the theoretical revision of the impact of air pollution on the agricultural sector and the impact between agriculture and air pollution is presented in Figure 1.

Figure: 1 Theoretical model of air pollution and agriculture
Source: authors

Data and Methodology

According to the setup aims of the article, the obtained methodology is divided into several parts. Each part contributes and collaborates with the main findings and conclusions. In the first part of the paper are revealed the theories related to air pollution. There are two main theories. The first one is: air pollution and the impact of the agriculture, and the second: agriculture as a contributor to the air pollution. The findings are gathered in the literature review. The second part of the paper is related to the impact of agriculture on air pollution in Bulgaria. The analysis is based on national statistical data. The third part of the article is based on data from a survey. The survey was conducted in the period of December 2017- February 2018. The respondents are experts from the following groups: agriculture, environmental and agroecology. The sample includes 33 expert interviews with closed and open questions. The survey was conducted as part of the scientific project DN 15/8 11.12. 2017 Sustainable multifunctional rural areas: reconsidering agricultural models and systems with increased demands and limited resources (Doitchinova et al., 2017).

The paper aims to collect information connected with the subsectors of agriculture related to air pollution activities. The participants of the survey evaluate a) the level of pollution practices related to plant and livestock breeding sub sectors and b) the impact on the sub sectors on the environment (air pollution). The main practices in agriculture are evaluated and ranked as a possible negative impact and influence on the environment. There are two possible directions of measures related to reducing the impact of agricultural activities, voluntary and restricting. Both types are evaluated by the experts. On the bases of this part of the article are prepared the main conclusion and recommendations.

Impact of agriculture on air pollution

The highest level of pollutions from the agriculture sector is by methane, ammonia and carbon dioxide.

Ammonia in the atmosphere emitted by agricultural activities was 83% of total agricultural air pollution in 2015. The decomposition of manure under anaerobic conditions results in CH_4 and NO_2

emissions that participate in the global warming effect. They also increase the unpleasant odor in the air. The percentage change in the total of the released quantities in the atmosphere by type of pollutants are presented in Table 1.
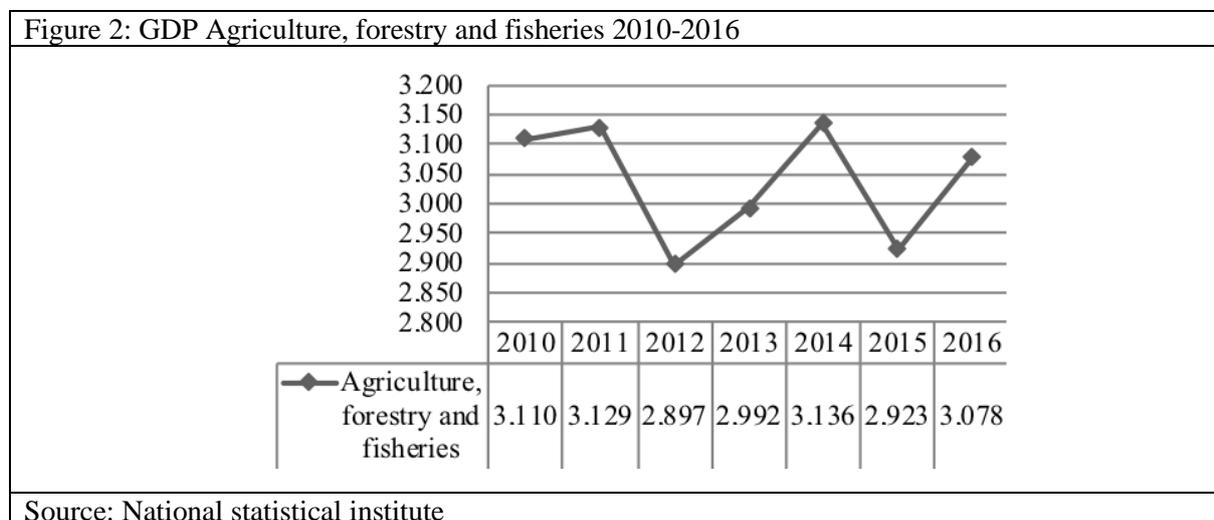
Table 1: Emissions of harmful substances in the atmosphere from agriculture 2010-2015							
Pollutants	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
Nitrogen oxides (Nox)	3840	3354	3538	3793	3780	3248	
Non-Methane Volatile Organic Compounds (NMVOCs)	32558	30611	31039	31610	23866	22640	
Methane (CH4)	93383	91505	89128	90766	84166	82000	
Carbon monoxide (CO)	1997	1744	1840	1972	1966	1689	
Carbon dioxide (CO2)	4608497	4024642	4246043	4551000	4535814	3897759	
Double nitrogen oxides (N2O)	24607	23555	23765	23210	15263	15085	
Ammonia (NH3)	36371	35124	34435	32490	27792	26270	
1 Emissions are calculated according to the latest edition of the CORINAIR methodology.							
Source: National Statistical Institute, Emissions of harmful substances in the atmosphere from agriculture 2007-2015							

Based on the data in Table 1, the conclusion can be made that the level of emissions of all indicators in Bulgaria are decreasing. To confirm that conclusion we can compare that statement with the GDP of the sector.

GDP of the agricultural sector in the period 2010-2016 fluctuates around 3 000 Mln. BGN (1 BGN=0,511081712 EURO) measured by comparable prices (2010). If we assume that GDP is relatively stable, we can confirm that the change of air pollution is not connected with a reduced GDP of the sector (Figure 2). This conclusion does not take into consideration that it is a possible internal restructuring of agricultural sectors which may lead to the lower level of pollution. The team of the paper considers in the future conducting a deeper study connected with agricultural restructuring and impact of the pollution, including air pollution.

Figure 2: GDP Agriculture, forestry and fisheries 2010-2016

	2010	2011	2012	2013	2014	2015	2016
Agriculture, forestry and fisheries	3.110	3.129	2.897	2.992	3.136	2.923	3.078

Source: National statistical institute

Data and results of the conducted survey

There is no statistical information for the elements of agroecology in the field of air pollution by subsectors of agriculture in Bulgaria. Due to this reason, empirical material was collected to reveal the main pollutants of agriculture and which subsectors are affected by air pollution.

In 2018, a survey was conducted which ranks agricultural sectors according to their pollutants and how they are affected by pollution. The most vulnerable sector which is affected by air pollution is vegetables, followed by medical and aromatic crops (the difference in the rank is under 10%). Technical crops and grains are evaluated as less affected by air pollution.

The agricultural sector is a pollutant of the environment and from the highest pollutant is shown by experts as being grain and oil crops. This can be explained by intensive agriculture practices and the

mechanization of the processes (burned fuel, oils, prepares). A relatively low level of impact on the air pollution are the subsectors of perennials, vineyards, and vegetables. The interviewees are of an opinion that in this sector many of the practices are related to the agricultural workers and this explains the low level of influence. Medical and aromatic crops are on the bottom of the ranking and they do not contribute to air pollution.

Table 2: Sector ranking of sectors- pollutants and affected by pollution- plants		
Sector	Rank- influenced by air pollution	Rank influence on air pollution
Vegetables	1	4
Medical and aromatic crops	2	6
Perennials and vines	3	3
Oil crops	4	2
Grain production	5	1
Technical cultures	6	5
Source: Authors		

Table 3: Ranking of sectors- pollutants and affected by pollution- livestock breeding		
Sector	Rank (influenced by air pollution)	Rank influence on air pollution
Beekeeping	1	6
Sheep and goat breeding	2	2
Cattle-breeding and buffalo-breeding	3	1
Poultry rising	4	4
Horse breeding	5	5
Rabbit breeding	6	6
Pig breeding	7	3
Source: Authors		

Table 3 presents the ranking of stockbreeding subsectors of agriculture. Beekeeping is the sector that is not affecting air pollution but is highly negatively responding to it. Cattle-breeding, buffalo-breeding, sheep and goat farming have the highest environmental impact on air pollution. Pig and hatching sectors are relatively lowly affected by air pollution, but the pig sector is in third place as the highest pollutant from its practices.

Figure 3: Practices related with air pollution connected with agricultural activities
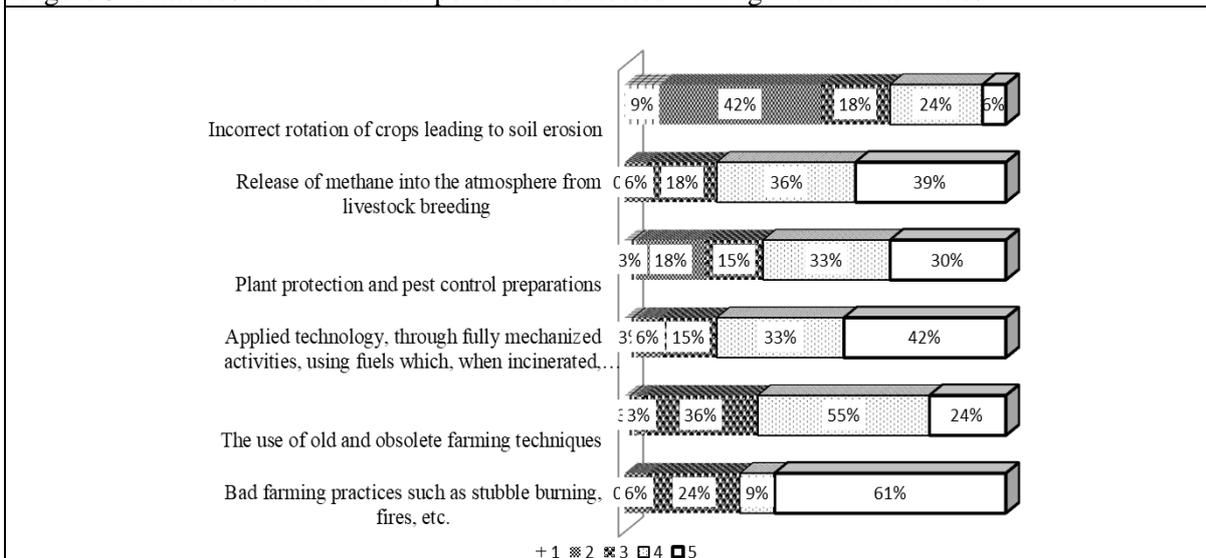
Source: Authors

In the Figure 3 are presented the answers from the experts on the possible sources of air pollutions from agricultural activities. In first place are bad farming practices which lead to straight smoke in the air (61%) such as a stubble burning, control fires, etc. Second place are polluters relates to applied

technology, high level of mechanized activities, usage of fuels which emit harmful gasses into the atmosphere etc. (42%). The release of methane into the atmosphere is connected with stock breeding and is evaluated as very high. The negative impact is 75% of total agricultural air pollution which can conclude that the livestock breeding effect on air pollution is higher than the plant sector. The lowest relevant impact on air pollution are suggested by the survey the incorrect rotations of the crops which leads to soil erosion.

The experts had to evaluate two types of mechanisms which could be undertaken to reduce air pollution of agricultural activities. One group of the mechanisms is restrictive, and the other type is voluntary.

The voluntary mechanisms are summarized in the table below:

Table 4: Voluntary mechanisms in agriculture related to reducing the impact of agricultural activities on air pollution

Mechanism/ impact	1	2	3	4	5
Agrarian policy related with upgrading the MTP	3%	12%	36%	33%	15%
Polices which motivate the application of ecological practices	3%	6%	21%	39%	30%
Usage of new technologies	0%	3%	24%	24%	48%
Usage of environment friendly preparations	6%	3%	15%	27%	48%
Subsidizing bio products	21%	15%	21%	6%	36%
Environmental practices beyond the standards of traditional agriculture	9%	15%	39%	15%	21%

1-low impact to 5 high impact

Source: Authors

The usage of new technologies and environmentally friendly preparations will contribute mostly as a mechanism connected with reducing air pollution of agricultural activities. Subsidizing of agriculture splits the experts into two groups- 42% have the opinion that the bio subsidy will be helpful for reducing levels of pollution, while 36% of them are of the opposite opinion. Motivating policies can as well contribute to less air pollution (69% relevant evaluation).

Table 5: Restrictive mechanisms in agriculture related to reducing the impact of agricultural activities on air pollution

Mechanism/impact	1	2	3	4	5
Enhanced control over applied farming practices	3%	6%	45%	18%	27%
Increasing fines for non-compliances with good agricultural practices	9%	3%	24%	21%	42%
Fuel ecotax (paid by producer)	9%	18%	9%	27%	36%
Preparation ecotax (paid by producer)	6%	21%	15%	33%	24%
Profit ecotax	12%	27%	12%	27%	21%
Eco requirements of the MTP	6%	15%	12%	36%	30%

1-low impact-5 high impact

Source: Authors

The restrictive measurement as well would bring effects on the environment. According to the data in Table 5 all proposed measurement would support the environment. First place was ranked the increasing of fines for non-compliances with agricultural practices (42%), followed by Fuel eco tax (36%), and third place relates to an eco-requirement of MTP. Profit ecotax is evaluated in the last place of influence. 21% of the respondents consider that profit ecotax will have a very high influence on air pollution in order to reduce it and 27% share the view that the impact will be high.

Conclusions & recommendations

The agricultural sector is an environmental pollutant. The highest level of pollutions from the sector is by methane, ammonia and carbon dioxide.

Over the last years the level of air pollution produced by the agricultural sector is decreasing till the GVP is relatively stable.

The agricultural sector is affected by the level of air pollution and some sectors are in danger. The most vulnerable sector which is affected by air pollution is vegetables and this is followed by medical

and aromatic crops (the difference in the rank is under 10%). The experts evaluate technical crops and grains as less affected by air pollution.

The biggest polluters in livestock are cattle-breeding, buffalo-breeding, the pig sector, and sheep and goat farming. They have the highest environmental impact on air pollution. Beekeeping is the sector that is not affecting air pollution but is highly negatively responding to it.

Air pollutions from agricultural activities as a source come mostly from bad farming practices, applied technology, high level of mechanized activities, usage of fuels which emit harmful gasses into the atmosphere etc. The release of methane by stock breeding into the atmosphere is evaluated as the most negative source.

The incorrect rotations of the crops which can lead to soil erosion is the lowest relevant impact on air pollution.

The tested voluntary mechanisms will affect the air pollution indirectly, mostly these ones which are related to new technology and new machines in the agricultural sector.

The restrictive mechanisms would bring stronger effects, mostly through raising fines for non-compliances with good agricultural practices and fuel ecotax paid by the farmers.

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