Environmental responsibility as a prerequisite for sustainable development of agricultural enterprises

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CHRONICLE	ABSTRACT
	This paper deals with the pressing challenge of raising the level of environmental responsibility of agricultural enterprises in order to ensure their sustainable development. It has long been established that agricultural activity is accompanied by a significant negative anthropogenic impact on the environment. Therefore, globally, the trend is towards the development and implementation of the principles of environmental responsibility of businesses, which contributes to increasing the competitiveness of businesses, and improving product quality and living conditions of the people. The paper suggests that the environmental responsibility of an agricultural enterprise has to be assessed based on key criteria including the intensity of the use of natural and biological resources, the environmental management system, and business's participation in solving environmental problems of communities. The paper presents the results of the assessment of the level of environmental responsibility of large, medium and small agricultural enterprises of Ukraine. The results suggest that medium and small agricultural enterprises are predominantly at the initial stage of applying the principles of environmental responsibility in their operations. Moreover, the paper presents the findings of a survey aimed to identify major hindering factors to the observance of the principles of environmental responsibility. These factors include the risk of a decreased business profitability, limited financing, lack of knowledge and shortage of professional staff, insufficient guidelines on the incorporation of principles of environmental responsibility. The paper suggests a mechanism for introducing environmental responsibility at agricultural enterprises that encompasses the governmental, local, and organizational levels. To introduce environmental responsibility at the organizational level, the authors recommend developing and implementing corporate green development strategy, incorporating sustainable procurement, training personnel, and engaging in voluntary public reporting on compliance with the principles of corporate social and environmental responsibility.

1. Introduction

By joining the UN 2030 Agenda for Sustainable Development, Ukraine is set to continue the country's active integration into the global economy and trade, the social and political space. Thus, government agencies and businesses have committed to contribute to the achievement of the sustainable development goals outlined in the document - overcoming poverty, ending hunger, protecting gender equality, ensuring efficient and responsible use of water and energy sources, etc. Corporate social

responsibility (CSR) represents an effective tool for implementing the principles of sustainable business development. It contributes to improving the competitiveness of companies, improving social security and living conditions of the people. For agricultural companies facing the growing risks of climate change, dropping water supply and deterioration of land quality, the introduction of environmental responsibility as an essential component of corporate social responsibility is essential.

2. Literature review

Taking into consideration its relevance and the commitment of many companies to implement its principles in various fields corporate social responsibility (CSR) is widely studied. Pimentel et al. (2016) were engaged in international comparisons of corporate social responsibility in different countries. Their results show that among the selected economies, namely the ones of the United States, France, Norway and Italy - the economy of Norway had the highest rates of CSR, and the United States had the lowest. Countries with the highest CSR values probably have the lowest social inequalities. Overall, the research is a step forward in understanding how CSR practices are integrated and developed in different countries, as they create value for both companies and society. Flammer (2013) examines shareholders' sensitivity to environmental liability and argues that environmental CSR is a resource with reduced marginal returns and insurance characteristics. Gao and Hafsi (2015) consider government intervention in the corporate social responsibility of small and medium-sized enterprises in China, concluding that CSR in enterprises should be formed independently. Karassin and Bar-Haim (2016) in their study proposed a model of the main driving factors influencing corporate environmental responsibility (CEP) as a measure of CSR. Wan et al. (2020) in their work explored the impact of a culture of integrity on social responsibility. Jiang et al. (2019) study the relationship between investment sensitivity and corporate culture in their research. Based on expert assessment, it is concluded that firms with a focused culture were less sensitive to investment and cash flow. Kucharska and Kowalczyk (2019) investigate the structure of the relationship between company culture, productivity, corporate social responsibility (CSR) and reputation, as seen from the employee's point of view, to determine which factors of company culture most influence CSR practice, and as a result , support the development of the company and increase its efficiency. Kowalczyk and Kucharska (2020) propose a model that examines the impact of CSR pressure, culture and practices on stakeholders and concluded that stakeholder pressure can lead to a stable CSR-oriented system in the business environment. Aljarah and Ibrahim (2020) prove that the overall size of the effect of CSR and brand loyalty is positive and gives an average size of the effect. Karassin and Bar-Haim (2019) view how regulation affects corporate social responsibility at the institutional, organizational, and individual levels. Ketprapakorn and Kantabutra (2019) consider the role of CSR of small and medium enterprises from the standpoint of sustainable development. Scientists have concluded that the human factor plays a crucial role in the formation of CSR. Ievdokymov et al. (2020) argue that it is the human, its intellectual and social capital that are the catalysts for change. Andrusiv et al. (2020) agree with this hypothesis, pointing out that it is the human who is the engine of innovative change. Hryshyna (2016) studies both international and Ukrainian experience in implementing corporate social responsibility. The author draws an interesting conclusion about the existence of two opposite trends in the development of corporate social responsibility. According to her, on the one hand, there is a tendency to unify the requirements for corporate social responsibility through the development and implementation of international initiatives, standards and indices. On the other hand, there is a significant influence of national characteristics, and, as a consequence, the formation of regional models of corporate social responsibility. In addition, we can identify a group of studies on the features of development and implementation of corporate social responsibility in the agricultural sector in general and its environmental component in particular. For example, Hohulia and Kudinova (2011) investigate the main components of social responsibility in agricultural business and determine the conditions for the introduction of social responsibility among agricultural enterprises in Ukraine. Frother (2019) develops a set of organizational and economic recommendations for improving the system of social responsibility of agricultural businesses, where the author pays special attention to the environmental component. Lunkina et al. (2018) classify the internal and external aspects of local social responsibility of agricultural enterprises. External aspects relate to interaction with the community, impact on the environment and society, while internal aspects include interaction with employees, changes to make production facilities more environmentally friendly, the use of resource-saving technologies and more. Hasii and Potravnyi (2011) explore the issues of environmental responsibility of business in a public-private partnership. However, many issues related to the environmental responsibility of agro-industrial enterprises remain unexplored. The purpose of the article is to consider the issue of environmental responsibility in the context of sustainable development.

3.   Research methodology

The theoretical and methodological background of this study is built on the traditional and specific cognitive methods of examining the phenomena and processes. We apply dialectic and logical methods, as well as analysis and synthesis, to explore the principles of corporate social and environmental responsibility and study the main aspects and features of its implementation. The use of comparison and classification method enabled us to study the levels of environmental responsibility of agricultural enterprises varying in size. The analysis of the anthropogenic impact of the agricultural businesses on the environment is carried out using dynamic series and indexing research method. We use sociological methods - a questionnaire and an expert survey - to identify the key factors that, according to the top management of businesses, are impeding the growth in the environmental responsibility of the agricultural enterprises. To design a tool for the development of environmental responsibility of a business, the method of logical modeling is used.

4. Results and discussion

Corporate social responsibility is actively implemented by business structures to increase competitiveness in the market (Cherchata et al., 2020; Dovgal et al., 2017), ensure product quality, environmental friendliness of economic activity. Since 2015, the number of enterprises that have implemented the principles of corporate social responsibility has been steadily increasing (Table 1).

Table 1
The number of socially responsible large, small and medium-sized enterprises in selected world regions in 2015-2017, units

Region	Large enterprises				Small and medium-sized enterprises			
	2015	2016	2017	2017/ 2015,%	2015	2016	2017	2017 /2015, %
Europe	1015	1169	1286	126.6	4611	5363	5704	123.7
North America	445	524	572	128.5	778	992	1065	136.9
Latin America	90	129	122	135.6	733	1026	909	124.0
China	292	325	415	142.1	1054	1231	1647	156.3
AMEA excluding Greater China Area	269	394	478	177.7	1200	1375	1765	147.1

CSR Statement, 2018, 16.

Thus, the most active among the regions of the world in terms of introducing corporate social responsibility are large and small enterprises of the European Union - 1286 and 5704 enterprises, respectively. However, the highest growth rates of socially responsible enterprises are observed in the AMEA region excluding Greater China Area - 77.7% growth in large enterprises and 47.1% in small and medium-sized enterprises. According to international practice, the main components and at the same time the ultimate goal of corporate social responsibility are: ensuring (raising) social standards for employees, environmental protection, development of social infrastructure, development of territorial communities, business ethics, etc. (Kinash et al, 2019). Thus, environmental responsibility is an essential element of social responsibility of the business in terms of environmental protection and reducing the anthropogenic impact of business entities (Table 2).

Table 2
The share of small and medium-sized enterprises that implemented socially responsible measures in the field of ecology, protecting the rights of workers, 2015-2017, %

Sphere	Small and medium-sized enterprises			
	2015	2016	2017	2017 vs 2015, +/-percent units
Overall	41.5	42.8	43.4	+ 1.9
Environment	42.1	43.5	44.3	+ 2.2
Labor & Human Rights	42.3	44.5	45.0	+ 2.7
Business Ethics	36.8	40.8	41.4	+ 4.6
Sustainable Procurement	36.2	38.4	39.0	+ 2.8

Source: CSR Statement, 2018, 16.

Thus, in 2017, 44.3% of enterprises that introduced the corporate social responsibility system implemented measures to reduce their environmental impact, which is 2.2 p.u. more than in 2015. The agricultural sector is one of the main environmental pollutants due to the active involvement of land, water and forest resources in the production process, and the use of living organisms. Almost 6.2 million waste is generated annually in Ukrainian agriculture, and about 3196 million m^3 of water are consumed (Table 3).

Table 3
Dynamics of indicators of the anthropogenic impact of the agricultural sector on the environment in the countries of the European Union and in Ukraine, 2015-2017.

Country	Waste generation, million tons				Air pollutant emissions, thousand tons				Water consumption, million m^3			
	2015	2016	2017	2017 vs 2015, %	2015	2016	2017	2017 vs 2015, %	2015	2016	2017	2017 vs 2015, %
Great Britain	18.5	19.2	16.3	88.1	111.2	109.6	101.5	91.3	6541	6245	6354	97.1
Germany	12.6	12.8	12.5	99.2	115.6	118.6	118.5	102.5	6875	6548	6441	93.7
Poland	9.3	9.6	9.4	101.1	99.8	98.8	95.6	95.8	4571	4687	4879	106.7
Romania	8.8	8.4	8.0	90.9	78.5	77.6	77.2	98.3	3658	3541	3521	95.6
Hungary	6.3	6.5	6.9	109.5	69.8	65.8	65.2	93.4	3251	3654	3510	108.0
Ukraine	8.7	8.7	6.2	71.0	75.5	79.6	80.3	106.4	2989	3156	3196	106.9

Source: Statista, 2019; Statistical Digest «Environment of Ukraine in 2017», 2018.

Agriculture, despite a slight decrease in its anthropogenic impact, still significantly pollutes the environment. This requires the use of effective management methods taking into account environmental factors. Increasing environmental responsibility as an element of the corporate culture of agricultural enterprises involves the development and implementation of a set of organizational, methodological and managerial tools aimed at the economical use of natural resources, improving the socio-ecological living conditions of the rural population and the environmental characteristics of the environment. However, the ecological responsibility of agricultural enterprises of Ukraine is not implemented actively enough in economic activity. It depends on the productivity of production, including land resources, technological modernization of production and the state

of agricultural markets. Only a part of the enterprises comprehensively implements the principles of organic farming, purchases equipment with improved ecological characteristics, certifies production in accordance with international standards. Other enterprises are limited to compliance with certain requirements of legislation in the field of environmental protection (impact on air, water use and sewerage, waste management). A number of enterprises do not pay enough attention to environmental aspects of economic activity. They use intensive farming methods that deplete the biological potential of land, water and other resources.

In order to identify the main trends in the introduction of environmental responsibility in the agricultural sector, in 2019 the authors conducted a sample survey and analysis of environmental and economic activities of 150 agricultural enterprises in different administrative regions of Ukraine. The sample included large, medium-sized and small enterprises. The classification of enterprises into large, medium-sized and small was carried out in accordance with the provisions of the Economic Code of Ukraine. Large enterprises are subjects of any type of economic activity, the average number of employees for the reporting period (calendar year) exceeds 250 people, and the annual income exceeds the amount equivalent to 50 million euros at the rate of the National Bank of Ukraine (NBU). As a rule, this group includes enterprises with an area of arable land of more than 10,000 hectares. Small enterprises are business entities with an average number of employees for the reporting period (calendar year) exceeding 50 people, and the annual income exceeds the amount equivalent to 10 million euros at the rate of the NBU. This group includes farms that cultivate 20 to 50 hectares of land. Medium-sized enterprises are those that are not included in the previous groups. According to the results of the survey, the authors grouped enterprises by stages of implementation of environmental responsibility, namely: development, implementation and certification. Development is the initial stage, which involves the formation of environmental policy of the enterprise, justification of strategic goals and objectives in the field of environmental protection, assessment of the amount of necessary resources and sources of their formation. At the implementation stage, measures are implemented to reduce the anthropogenic impact on the environment, strategic environmental goals and objectives are adjusted. The final stage of implementation of environmental responsibility is the certification procedures for obtaining a certificate of compliance with standards, in particular ISO 14001 "Environmental Management Systems" (Table 4).

Table 4
Distribution of agricultural enterprises in Ukraine by stages of implementation of environmental responsibility policy according to the size of enterprises, 2018

Index	Stage of implementation:			In total
	development	realization	certification	
		Small enterprises		
Quantity, units	30	34	11	75
Share, %	40.0	45.3	14.7	100.0
		Medium-sized enterprises		
Quantity, units	8	36	11	55
Share, %	14.5	65.5	20.0	100.0
		Large enterprises		
Quantity, units	-	13	7	20
Share, %	-	65.0	35.0	100.0
		In total		
Quantity, units	38	83	29	150
Share, %	25.3	55.4	19.3	100.0

Thus, the results of the sample survey showed that in general 25.3% only develop provisions on environmental liability; more than half (55.3%) of the surveyed enterprises were at the stage of implementing corporate social responsibility, and 19.3% already received certificates of compliance with standards (ISO 14001 "Environmental Management Systems". At the same time, the level of activity of implementation and observance of the principles of environmentally responsible business differs significantly depending on the size of the enterprise. Among small enterprises (mostly farms), 40% develop the basics of environmental responsibility policy, and 45.3% are in the process of implementing it. However, it should be noted that about every seventh enterprise (14.7%) conducts organic farming and adheres to a high level of environmental responsibility. This is due to such motivating factors as the increasing demand of the population for environmentally friendly products, the ability to perform labor-intensive technological operations on small plots of land. At the same time, among medium-sized enterprises, 14.5% are at the initial stage of environmental policy formation, 65.5% are implementing environmental responsibility in economic activities and 20% have confirmed the compliance of corporate policy with international or national standards. Most medium-sized enterprises are mainly limited to compliance with established environmental legislation. They have not yet formed a strategic vision of their role in ensuring the environmental safety of the countryside, community, district and place of business. Workers and the rural population do not have sufficient information, knowledge about the principles of sustainable development, methods and ways to promote and implement environmental initiatives. Large agricultural enterprises of Ukraine have already passed the stage of developing environmental responsibility of business, are actively implementing it. Currently, one in five of them has land certified for organic farming. The high level of their environmental responsibility is first of all due to the export orientation of production, strong financial condition, the ability to attract qualified specialists to develop and implement the principles and tools of corporate social responsibility. Taking into account the previously obtained results of the analysis, we formulated a working hypothesis about the relationship between the size of

enterprises and their activity in the implementation of environmental responsibility. To confirm it, 94 typical small and medium-sized agricultural enterprises of Ukraine specializing in crop production were grouped (Table 5).

Table 5
Dependence of activity of introduction of ecological responsibility by the enterprises of Ukraine depending on the size of agricultural lands

Group of enterprises by area of agricultural land, ha	Average area in group, ha	Average amount of workers, persons	Enterprises in total		Eco responsible enterprises of them	
			од.	%	од.	%
Less than 20	12.5	13	24	25.5	21	26.9
20-70	40.8	20	43	45.8	32	41.0
More than 70	169.7	62	27	28.7	25	32.1
In total and in average	70.6	31	94	100.0	78	100.0

Source: Statista, 2019; Statistical digest "Environment of Ukraine in 2017", 2018

Thus, it can be seen that larger enterprises (on average more than 40 hectares) are more actively implementing corporate social responsibility. It can be concluded that the main reserve for increasing the environmental responsibility of agricultural business in Ukraine are medium-sized and small farms. To increase the level of environmental responsibility of small and medium-sized agricultural businesses, it is advisable to identify the factors that influence this process. With this purpose in 2019 we conducted a survey of 215 managers of the above-mentioned agricultural enterprises of Ukraine, the results of which are shown in table 6.

Table 6
Distribution of answers of managers of agricultural enterprises of Ukraine to the question "What factors prevent the introduction of environmental responsibility in economic activities?", 2019, units.

No.	Factor	Answers		Range
		quantity	%	
1	Increase in costs, decrease in income	55	25.6	1
2	Weak government regulation and insufficient support	42	19.5	2
3	Lack of knowledge	35	16.3	3
4	Lack of regulatory framework and guidelines	32	14.9	4
5	Lack of financial resources	30	14.0	5
6	Unprepared personnel	21	9.7	6
	In total	215	100.0	x

No less significant factor (19.5% of responses), which hinders the increase in the level of environmental responsibility of agricultural producers, is the lack of state regulation. The activity of agricultural enterprises is also affected by the lack of appropriate legal framework and guidelines (16.3% of responses), as well as low qualifications (14% of responses), lack of necessary knowledge of business leaders and specialists in corporate social and environmental responsibility, green economy, modern green technologies (9.7% of answers). In the conditions of constant shortage of working capital, rising prices for fuel and seeds, high interest rates for loans, agricultural enterprises do not have sufficient funds to implement innovative environmental projects and the implementation of environmental responsibility policy (14.9% of responses). The authors' approach to situational analysis contributed to a comprehensive strategy in research. An association analysis is one of the techniques used in data mining (Aguinis et al., 2013; Kaur & Kanwalpreet, 2014). The term 'data mining' itself refers to the process of exploring large data sets to discover patterns and extract meaningful information. Frawley et al. (1992) define data mining as the process of extracting hidden, previously unknown and potentially useful information from data. Hand et al. (2001) use the term to refer to the process of extracting information from large data sets or databases. It means that data mining covers various groups of data exploration techniques, such as classification, clustering, regression, discrimination analysis and methods based on association rules. A more in-depth analysis was performed using simulation methods, in order to scientifically justifications the most significant factors that the heads of agricultural enterprises factored into decision making on the implementation of measures in the field of ecological responsibility. The results of the analysis confirmed the influence of such factors as government regulation, size and costs of the enterprise on the decision to conduct environmentally responsible business.

Association Rules find all sets of items that have **support** greater than the minimum support and then using the large itemsets to generate the desired rules that have **confidence** greater than the minimum confidence. The **lift** of a rule is the ratio of the observed support to that expected if X and Y were independent. A typical and widely used example of association rules application is market basket analysis. We have used association rules algorithm which is realized in *StatSoft Statistica 10* for extraction knowledge from our dataset that represents our survey results in binary form (Yes -1; No – 0). We have provided mining procedure with such constrains: minimal support=50%, minimal confidence=50%, minimal correlation=50%, maximal size of body =10, max size of head = 8. Results of association analysis represented in table 7.

Table 7
Summary of association, %

№	Body	=>	Head	Support	Confidence	Correlation
1	Risk of increased production costs and decreased profitability =0	=>	Lack of governmental support = 0,	54	77,14	70,42
2	Shortage of funding = 0	=>	Lack of governmental support = 0	50	80,65	69,28
3	Responsibility =0	=>	Lack of governmental support = 0	54	87,10	74,83
4	Insufficient awareness on the issue = 0	=>	Lack of effective regulations and guidelines =0	52	76,47	76,47
5	Insufficient awareness on the issue = 0	=>	Lack of governmental support == 0	54	79,41	71,45
6	Low-qualified workforce = 0	=>	Lack of governmental support == 0	60	85,71	78,25
7	Lack of effective regulations and guidelines == 0,	=>	Insufficient awareness on the issue = 0	52	76,47	76,47
8	Lack of effective regulations and guidelines = 0	=>	Lack of governmental support =0	54	79,41	71,45
9	Lack of governmental support =0	=>	Risk of increased production costs and decreased profitability =0	54	64,29	70,42
10	Lack of governmental support =0	=>	Shortage of funding =0	50	59,52	69,28
11	Lack of governmental support = 0	=>	Responsibility =0	54	64,29	74,83
12	Lack of governmental support =0	=>	Insufficient awareness on the issue =0	54	64,29	71,45
13	Lack of governmental support =0	=>	Low-qualified workforce = 0	60	71,43	78,25
14	Lack of governmental support =0	=>	Lack of effective regulations and guidelines =0	54	64,29	71,45

Calculated by authors by means of StatSoft Statistica 10

Due to the aim of analysis the most frequent item sets have been identified (Table 8).

Table 8
Frequent item sets computed

	Frequent itemsets	Frequency	Support(%)
1	Risk of increased production costs and decreased profitability =0,	35	70
2	Shortage of funding =0	31	62
3	Responsibility =0	31	62
4	Insufficient awareness on the issue =0	34	68
5	Low-qualified workforce =0	35	70
6	Lack of effective regulations and guidelines =0	34	68
7	Lack of governmental support =0	42	84
8	Risk of increased production costs and decreased profitability =0, Lack of governmental support =0	27	54
9	Shortage of funding = 0, Lack of governmental support = 0	25	50
10	Responsibility == 0, Lack of governmental support =0	27	54
11	Insufficient awareness on the issue =0, Lack of effective regulations and guidelines =0	26	52
12	Insufficient awareness on the issue =0, Lack of governmental support == 0	27	54
13	Low-qualified workforce =0, Lack of governmental support =0	30	60
14	Lack of effective regulations and guidelines = 0, Lack of governmental support =0,	27	54

Calculated by authors by means of StatSoft Statistica 10

Considering the applicability of intensifying the activities of small and medium-sized agricultural enterprises to implement corporate environmental responsibility, we will analyze the importance and direction of the impact of the most significant factors using specialized analytical methods. Namely, we determine the presence of a connection and measure the strength of the quantitative effect of the introduction of eco-responsibility (factor attribute) on the income level of small and medium enterprises with the help of variance analysis. The research was performed on the basis of 38 agricultural enterprises of Ukraine specializing in the cultivation of vegetables and fruits, of which 18 have implemented ecological responsibility, and 20 - have not implemented (Table 9).

Table 9
Area and income per 1 ha of agricultural land in small and medium enterprises of Ukraine, 2018

Enterprise	Area, ha	Income per 1 ha, thousand UAH		Estimated values	
	f	x	fx	X2	X2f
Ecological responsibility has been implemented					
1	85	238.3	20,259.0	56,806.5	4 828,553.9
2	102	295.9	30,180.0	87,546.4	8 929,729.4
3	170	554.6	94,280.0	307,568.1	52 286,578.8
4	15	709.3	10,640.0	503,153.8	7 547,306.7
5	75	246.8	18,510.0	60,910.2	4 568,268.0
6	100	302.5	30,250.0	91,506.3	9 150,625.0
7	30	475.0	14,250.0	225,625.0	6 768,750.0
8	285	347.2	98,950.0	120,543.0	34 354,745.6
9	70	291.6	20,410.0	85,013.9	950,972.9
10	127	335.8	42,650.0	112,779.6	14 323,011.8
11	46	645.1	29,675.0	416,165.2	19 143,600.5
12	70	185.7	13,000.0	34,489.8	2 414,285.7
13	18	420.9	7,576.0	177,147.5	3 188,654.2
14	115	188.2	21,646.0	35,429.1	4 074,341.9
15	72	322.7	23,232.0	104,113.8	7 496,192.0
16	65	375.0	24,375.0	140,625.0	9 140,625.0
17	33	450.0	14,850.0	202,500.0	6 682,500.0
18	29	438.5	12,717.0	192,297.4	5 576,623.8
Together	1,507	x	527,450.0	2 954,220.4	206 425,365.2
No ecological responsibility has been implemented					
1	24	174.2	4,180.0	30,334.0	728,016.7
2	78	243.6	19,000.0	59,336.0	4 628,205.1
3	85	185.7	15,784.5	34,484.5	2 931,181.7
4	45	166.3	7,483.0	27,652.0	1 244,339.8
5	49	241.2	11,817.0	58,159.7	2 849,826.3
6	61	154.3	9,411.0	23,801.9	1 451,916.7
7	40	213.5	8,540.0	45,582.3	1 823,290.0
8	82	105.5	8,647.0	11,120.0	911,836.7
9	54	320.9	17,330.0	102,993.4	5 561,646.3
10	43	118.2	5,084.0	13,978.9	601,094.3
11	42	192.6	8,090.0	37,102.1	1 558,288.1
12	55	160.0	8,800.0	25,600.0	1 408,000.0
13	75	113.1	8,484.0	12,796.1	959,710.1
14	100	100.0	10,000.0	10,000.0	1 000,000.0
15	52	158.5	8,243.0	25,128.3	1 306,674.0
16	65	450.0	29,250.0	202,500.0	13 162,500.0
17	135	296.3	40,000.0	87,791.5	11 851,851.9
18	45	106.7	4,800.0	11,377.8	512,000.0
19	70	345.9	24,215.0	119,666.6	8 376,660.4
20	55	218.9	12,040.0	47,921.2	2 635,665.5
Together	1,255	-	261,198.5	987,326.3	65 502,703.4
In total	2,762	-	788,648.5	3 941,546.8	271 928,068.6

Designation and calculations of indicators:

$\overline{x}$ - the average income per 1 ha for enterprises under research

$$\overline{x} = \frac{788648.5}{38} = 285.5$$

$\overline{X}_1$ - the grouped average income for enterprises that have implemented ecological responsibility

$$\overline{X}_1 = \frac{527450.0}{1507} = 350.0$$

$\overline{x_1^2}$ - the average square of characteristics variants for enterprises that have implemented ecological responsibility

$$\overline{x_1^2} = \frac{206425365.2}{1507} = 136977.7$$

σ_1^2 - the general variance for enterprises that have implemented ecological responsibility

$$\sigma_1^2 = 136977.7 - 350.0^2 = 14477.68$$

$\overline{X}_1$ - the grouped average for enterprises that have not implemented ecological responsibility

$$\overline{X}_1 = \frac{261198.5}{1255} = 208.1$$

$\overline{x_1^2}$ - the average square of characteristics variants for enterprises that have implemented ecological responsibility

$$\overline{x_1^2} = \frac{65502703.4}{1255} = 52193.4$$

σ_1^2 - the general variance for enterprises that have implemented ecological responsibility

$$\sigma_1^2 = 52193.4 - 208.1^2 = 8876.83$$

$\overline{\sigma_i^2}$ - the average of the grouped variances

$$\overline{\sigma_i^2} = \frac{\sum \sigma_i^2 f_i}{\sum f_i} = \frac{52193,4*1507+8876,83*1255}{1507+1255} = 11932,8$$

δ^2 - the between-group variance

$$\delta^2 = \frac{\sum (\overline{x}_i - \overline{x})^2 f_i}{\sum f_i} = \frac{(285,5-350,0)^2*1507+(350,0-208,1)^2*1255}{1507+1255} = 13782789,6$$

η^2 - determination coefficient

$$\eta^2 = \frac{\delta^2}{\sigma^2} = 0.705$$

In view of this, it is established, that the implementation of ecological responsibility in agricultural enterprises affects their economic efficiency, in particular, it is clearly manifested in vegetable growing and horticulture. However, contrary to popular opinion among agricultural management, enterprises that implement the principles of environmentally responsible business, receive more income than companies that do not take into account the environmental factors of economic activity. Thus, the degree of influence of the certified system of environmental responsibility on the level of income of the enterprise per 1 ha is 70.7%. The level of influence of other unaccounted factors is 29.3%. The closeness of the relationship between these factors is confirmed by the correlation (empirical). It shows that there is a substantial connection between environmental responsibility and the income of enterprises under research.

$$\eta = \sqrt{\frac{\delta^2}{\sigma^2}} = \sqrt{0.705} = 0.8404$$

Thus, the calculated determination coefficient indicates that their introduction of environmental responsibility significantly affects the income of enterprises.

We use Fisher's test to confirm the significance of the relationship:

$$F = \frac{\eta^2}{1-\eta^2} * \frac{k_2}{k_1}$$

where k_2 and k_1 are the number of degrees of freedom;
n is the number of population units;
m is the number of groups.

$$F = \frac{\eta^2}{1-\eta^2} * \frac{k_2}{k_1} = \frac{0.8404}{1-0.8404} * \frac{2760}{2} = 220.25.$$

We compare the obtained criterion with the critical value for the probability level of 0.95 with the help of the table of critical values of the F - criterion. For the significance level α =0.5 the tabular value does not exceed 2.99. Since the calculated value of Fisher's criterion is more critical (220.25 >2.99), this confirms the importance of the relationship between the implementation of ecological responsibility and corporate income. The results obtained above are confirmed by a more detailed study of 38 medium and small agricultural enterprises in Ukraine. For this purpose, such indicators as the area, the income on 1 ha of the area and implementation of the corporate social responsibility are chosen (Table 10).

Table 10
Descriptive Statistics of Values

	Valid N	Mean	Median	Mode	Frequency - of Mode	Min	Maximum	Std.Dev.	Coef.Var.
Area of farmland, ha	38	72,7	65	70	3	15	285	48,6	66,8
Profit per ha, thousands UAH	38	286,5	245,2	Multiple	2	100	709,3	149	52
Responsibility	38	-	0	0	20	-	-	-	-

Source: Calculated by authors by means of STATISTICA 10.

As we see from calculations (Table 10) profit of agrarian business enterprises is multimodal variable which indicates on heterogeneity of business effectiveness in analysed cohort of enterprises. The frequency table of value - Area of farmland (Table 11) shows that the biggest part of analyzed enterprises cohort have quite small areas (between 30 and 90 ha).

Table 11
Frequency table for value: Area of farmland

	Count	Cumulative - Count	Percent	Cumulative - Percent
0<x<=30	5	5	13,16	13,2
30<x<=60	12	17	31,58	44,7
60<x<=90	13	30	34,21	78,9
90<x<=120	4	34	10,53	89,5
120<x<=150	2	36	5,26	94,7
150<x<=180	1	37	2,63	97,4
180<x<=210	0	37	0,00	97,4
210<x<=240	0	37	0,00	97,4
240<x<=270	0	37	0,00	97,4
270<x<=300	1	38	2,63	100,0
Missing	0	38	0,00	100,0

Source: Calculated by authors by means of STATISTICA 10.

The frequency table of value – profit (Table 11) shows that the biggest part of analyzed enterprises cohort have quite small areas (between 30 and 90 ha). At the same time profit per ha (table 12) at 52% enterprises is lower than calculated mean of for this value.

Table 12
Frequency table for value: profit

	Count	Cumulative - Count	Percent	Cumulative - Percent
66,15 <x<=133,85	5	5	13,16	13,2
133,85 <x<=201,55	9	14	23,68	36,8
201,55 <x<=269,25	6	20	15,79	52,6
269,25 <x<=336,95	7	27	18,42	71,1
336,95 <x<=404,65	3	30	7,89	78,9
404,65 <x<=472,35	4	34	10,53	89,5
472,35 <x<=540,05	1	35	2,63	92,1
540,05 <x<=607,75	1	36	2,63	94,7
607,75 <x<=675,45	1	37	2,63	97,4
675,45 <x<=743,15	1	38	2,63	100,0
Missing	0	38	0,000	100,00

Source: Calculated by authors by means of STATISTICA 10

At the same time Table 13 shows us that responsibility concept is provided only by 47% of analyzed enterprises.

Table 13
Frequency table for value: Responsibility

	Count	Cumulative - Count	Percent	Cumulative - Percent
0	20	20	52,63	52,6
1	18	38	47,36	100
Missing	0	38	0	100

Source: Calculated by authors by means of STATISTICA 10

Because the two analyzed variables Area of farmland and profit are continuous variables whist Responsibility is dichotomous value. That's why we use logit (logistic) regression model in order to find out relations between dependent value Responsibility and two independent continuous values. We should mention that such models are appropriate when the response takes one of only two possible values representing success or failure, or more generally the presence or absence of an attribute of interest (Responsibility in our case). In our analysis of these data we will view current availability of Responsibility as the response or dependent variable of used area and desired profit per ha. The response has two categories: use and non-use, and all predictors are treated as continuous. We have done such regression analysis by means of STATISTICA 10 (Table 14).

Table 14

Model: Logistic regression (logit) N of 0's: 18 1's: 20 (farmers and responsibility) Dep. var: Responsibility Loss: Max likelihood Final loss: 1998,5 Chi2(2)=-p=1

	Const.B0	Area of farmland	Profit per ha, thousands UAH
Estimate	17	1,1	-0,9
Odds ratio (unit ch)	3712861	3	0,41

Source: Calculated by authors by means of STATISTICA 10.

The results of modeling shown at Table 14 prove our hypothesis. The odds ratios (OR) represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. The odds ratio can also be used to determine whether a particular exposure is a risk factor for a particular outcome, and to compare the magnitude of various risk factors for that outcome.

- OR=1 Exposure does not affect odds of outcome,
- OR>1 Exposure associated with higher odds of outcome,
- OR<1 Exposure associated with lower odds of outcome.
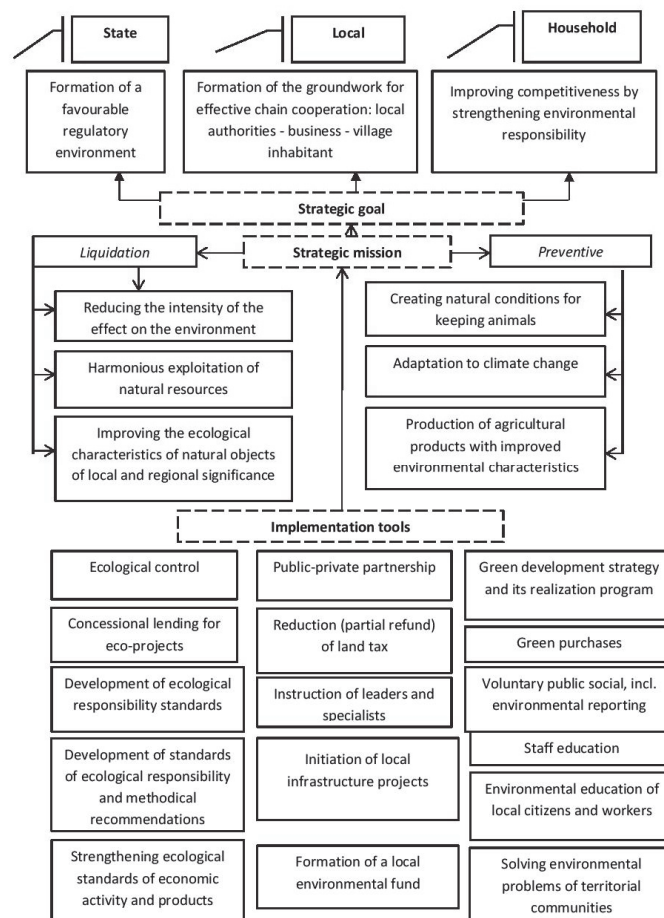
Fig. 1. Development mechanism of the system of ecological responsibility of agrarian business

We see that the implementation of responsibility is influenced by the area of farms. Thus, the implementation of the principles of ecological responsibility is hampered by the imperfection of the system of state regulation. This is manifested in the lack of proper environmental control and support from the state and local communities in a number of areas. First of all, it concerns the issues of observance of targeted, rational, technologically correct use of leased agricultural lands. Considering the importance of ensuring the ecological purity of land resources for the strategic development and competitiveness of farming communities, agricultural business, green tourism, it is important to increase the role of the state and local authorities in the development of environmental responsibility of agricultural enterprises. In our opinion, it is necessary to implement a comprehensive mechanism for the development of ecological responsibility of agrarian business that covers the state, local and organizational levels of government (Fig. 1). Implementation of the proposed mechanism for the development of the system of ecological responsibility of agrarian business will contribute to the formation and application of innovative approaches and tools of corporate social responsibility. They combine traditional values, interests of companies and the modern requirements of sustainable development of agriculture and local communities.

Conclusion

In the conditions of ecological crisis and climate change in the world practice the principles of corporate social responsibility of business are rapidly introduced and developed. These positive processes are most intense in Latin America, China and in the AMEA excluding Greater China Area. The most active in terms of corporate social responsibility are large and small enterprises of the European Union and the highest growth rates of socially responsible enterprises are observed in the region AMEA excluding Greater China Area - 77.7% growth in large enterprises and 47.1% in small and medium. The basic element of the corporate social responsibility system should be the environmental responsibility of business, considering activation of the world community's efforts to reduce the anthropogenic effect on the environment in order to prevent climate change and ensure the ecological well-being of the population. Agricultural production is one of the main sources of water consumption, emissions of pollutants into the atmosphere and waste generation due to the intensive involvement in the production process of land, water and forest resources, the use of living organisms, technical, chemical and other resources. In recent years, the anthropogenic impact on the environment in the agricultural sector of the European Union and Ukraine has been gradually declining. At the same time, it is necessary to apply effective methods of management of agricultural enterprises taking into account environmental factors for the full implementation of the principles of sustainable development. According to the results of a sample survey of agricultural enterprises in Ukraine, it was found that most medium-sized enterprises are at the initial stage of implementing ecological responsibility policy and are limited to compliance with environmental legislation. Almost two thirds of small enterprises (farms) have a low level of ecological responsibility, a quarter - medium and 9% - high. The main factors that hinder the implementation of the principles of ecological responsibility have been identified through a sociological survey of the heads of agricultural enterprises. The most significant of these are: the risk of increased production costs and reduced revenues, weak regulation and support from state and local authorities, deficiency of necessary funding, lack of knowledge, low staff skills. Analysis of respondents' answers using simulation methods showed that when making decisions about the introduction of environmental responsibility, the decisive factor for managers is the economic result, rather than the achieved environmental and social effects. Meanwhile, it has been established that the introduction of environmental responsibility in agricultural enterprises has a positive effect on their economic efficiency. Enterprises that implement the principles of ecological responsible business receive more income than others. Therefore, an important area of increasing the activity of small and medium-sized agricultural enterprises in the implementation of environmental responsibility is the provision of educational and consulting services, explanations to managers and specialists about the benefits of greening economic activity. It is advisable to implement a comprehensive mechanism that covers the state, local and organizational levels of government to develop the ecological responsibility of agrarian business. The state level is aimed at creating a favourable regulatory environment and includes the introduction of environmental control, the use of concessional lending for ecological projects, the development of standards of ecological responsibility, etc. Local level should ensure the formation of the groundwork for effective chain cooperation: local authorities - business - village inhabitant. It is necessary to develop and implement a strategy of green development, to form voluntary ecological reporting, to conduct green procurement and staff training at the general economic level.

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