

Bondar O. I.

*Doctor of Biological Sciences, Professor,
Rector of the State Ecological Academy of
Postgraduate Education and Management,
Corresponding Member of the Department of Agriculture,
Irrigation and Mechanization of
National Academy of Agrarian Sciences of Ukraine
ORCID: <https://orcid.org/0000-0002-4488-2282>*

Butrym O. V.

*Doctor of Economic Sciences, Senior Researcher,
Head of the Green Economy Department
State Ecological Academy of Postgraduate Education and Management
ORCID: <https://orcid.org/0000-0002-2448-6098>*

Galushkina T. P.

*Doctor of Economic Sciences, Professor,
Professor of the Green Economy Department
State Ecological Academy of Post-Graduate Education and Management
ORCID: <https://orcid.org/0000-0002-0694-0090>*

Bereznytska M. V.

*Researcher, Private Consultant on Climate Change Aspects
ORCID: <https://orcid.org/0000-0002-4140-3442>*

**ENSURING LOW CARBON DEVELOPMENT
AS THE ECOLOGICAL AND ECONOMIC LEVERS
OF THE UKRAINIAN GREEN GROWTH
(ON THE EXAMPLE OF LAND-USE SECTOR)**

Summary

The present economic approach with resource oriented development, when the enterprises dealing with the crop production raise their income due to the agro-resource potential disturbance, has been recognized in the world to be blind-alley and economically unprofitable. Statistical data analysis has proved that the method being usually applied for land-using in Ukraine is not well-balanced, initiates up to 10 % of total greenhouse gas (GHG) emission in the country and does not promote sustainable development. By this reason, the introduction of low carbon agricultural land-use is a hot topic not only in the ecological, economic contexts, but as guaranty of fulfilling of international obligations towards saving of climatic system and land resources. This type of land-using can ensure an integral balance of carbon stock change in the pool of mineral soils for save of the agrarian resources potential, which is one of the

system of goals for green growth. Introduction of the aforesaid requires developing the theoretical and methodological principles with the further applied aspects and serves as the basis for the domestic carbon market (DCM) formation and functioning in the land-use sector. DCM formation and introduction for the land-use sector creates new organizational and economic conditions for agricultural production. This uncovers new financial and economic benefits to the agricultural production sector. The sources of these benefits are unconventional; they include trading the carbon units. In view of this, the increase of agricultural enterprises profits due to the land resource potential disturbance with unbalanced land-using becomes economically unprofitable. Under such conditions, the land agroecological safety characteristics will increase the influence in receiving of the agricultural business profit by crop commodity production, which are economy levers for saving of ecological security in the context of green economy.

The policy of «green economy» was officially adopted by the Organization for Economic Cooperation and Development in 2009 as a strategic direction («Green Growth Strategy» OECD) (2009). The EU countries have adopted «The Roadmap to a Resource Efficient Europe». This approach has formed the general tonality of international development, which provides both a resource-saving economic basis in general and the intensification of its low carbon aspect, above all. The development and application of institutional and regulatory support is expected in the direction of stimulating not only the reduction of GHG emissions, but also increasing their absorption by the natural and anthropogenic ecosystem. This stimulated the formation of the conceptual foundations of the low carbon development economy in the context of green growth in many countries around the world.

Introduction

The Low Emission Development Strategies (LEDS) for developing the land-use sector are a step towards achieving the goals defined by the UN Framework Convention (UNFCCC) on climate change. The main objective of UNFCCC is to avoid dangerous anthropogenic interference with the planet's climate system through the reduction of greenhouse gas (GHG) emissions and socio-economic activity adaptation to climate change. In this context, the activities in agricultural land-use for commodity production play an important role, which is recognized by the European community and enshrined in acceptance of the Regulation (EU) 2018/841 of the European Parliament and of the Council dated May 30, 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework (Regulation (EU) 2018/8412018).

Ukraine has declared the European integration aspirations, on the way to which a number of legislative steps of a conceptual level have been taken: **i)** the Concept of implementation of the state policy in the field of climate change for the period till 2030 (Order of the Cabinet of Ministers of Ukraine,

2016, No. 932-p) was formed with the subsequent creation of **ii**) the Action plan for its implementation (Order of the Cabinet of Ministers of Ukraine, 2017, No. 878-p), in the main stream of which **iii**) the Strategy of low carbon development of Ukraine until 2050 (2018) and **iv**) the Strategy for state environmental policy for the period 2030 (2019) have been adopted.

Thus, the country has worked to improve environmental climate policy by structuring it with strengthening the institutional component of activities to reduce GHG emissions and stimulate the adaptation to climate change, which is key to long-term integrated EU climate policy.

The development of combating climate change is increasing now with the introduction of the LCM concept, and in this context, the plant production plays a separate role, as the pool of mineral soil on the Ukrainian agricultural lands has high potential of increasing carbon stocks. This achievement is possible through the system introduction of scientifically based Low Carbon Land Use (LCLU) measures, which in common will be able to increase the carbon stock in the mineral soil pool up to 4 million t C to 2050 (O. Butrym 2018, p. 253). The cost for implementation of the aforesaid in Ukraine is indicatively assessed at 8–9 % of national gross profit (O. Butrym, 2018, p. 255). The principle of determining the carbon unit volume as a result of LCLU implementation has been proposed. It can be as basis for formation of financial and economic tools of DCM for land-use sector with the circulation of carbon units. The establishment, formation and implementation of DCM will accelerate the achievement of balanced land-using and will contribute to ensuring an acceptable level of agroecological and food security of the State.

Based on the outcomes of the GHG Inventory data for some countries and the international statistics sources through the use of statistical analysis methods and their visualization with applying the graphical method, it has been proved that the Ukrainian agricultural land using is unbalanced; the increasing of crop production volumes exists due to disturbance of agro-resource potential with the following growth of GHG emissions from the pool of agricultural mineral soil. By involving the system analysis and synthesis methods, the necessity of reforming the organizational and economic ties between the subjects of agro-industrial activity in the land-use process has been substantiated. The central consolidating role of LCLU for sustainable development has been highlighted and the stabilizing influence of the DCM on the economic situation has been proven. Based on the analytical method, the strategic directions of the DCM development in land-use sector are proposed. Its importance for both stimulating agroecological and food security and enhancing the development of a number of related facilitating industries for overcome ecological and economic crisis in Ukraine, is shown.

Part 1. Analysis of dependence of the introduction of balanced land-use and agricultural productivity

LEDS implementation involves technological modernization not only of the industrial complex, as a separate component of the economic system, but also focuses on the upgrading of all the components of production stages and consumption. The indicators for efficiency of the DCM implementation are statistics indicators of economy and the qualitative state of the environment. The indicators for efficiency of the DCM implementation are statistics indicators of economy and the qualitative state of the environment. The GHG emissions are as evidence of the anthropogenic interference level with the environment and take the main place in named roster. The agricultural land cultivation also leads to emissions of one of the major GHG – carbon (Figure 1).

The efficiency of the policies of protectionism of land resources is shown, which leads France in a relatively stable level of emissions around of 4 k t C (Submissions, 2019 of GHG Inventories – Annex I Parties UNFCCC), and leads the improvement in Poland, where the emission has decreased up 4 times (with stable step of 5 k t C per year since 2010). This state is explained through changes in the structure of crops, in particular, relatively stable volumes of perennial crops in France with the timely reducing of sunflower seed production from 1.6 mln tons in 2013 to 1.2 mln tons t in 2018 (FAOSTAT, 2018) and relatively stable volumes of meat production at the level of 3.7-3.6 million tons and milk at the level of 26-25.6 million tons for 1990-2016. In Poland, the milk production has slightly decreased from 15.8 to 13.2 million tons for the same period. Nevertheless, in general, the livestock sector, which is the source of manure, is preserved in these countries. So, the listed statistic indicates on the saving and increasing nature-stabilization types of land-using (perennial crops) with decreasing area of higher level of anthropogenic loading (plots for sunflower and beet growing) while maintaining the livestock sector.

These data confirm the effectiveness of the Common Agricultural Policy (CAP) in the EU's countries (Overview of CAP, 2013), where the approaches to government subsidizing depend from a balanced agricultural development approach and from balanced land-using are applied with priorities: **i)** conservation of the environment as close as possible to the original state of landscapes; **ii)** ensuring the acceptable vital life sustenance of the population and development of rural territories; **iii)** conservation of profitability and competitiveness for agricultural producers – the EU's residents in ensuring the development of education, research and innovation activities. The implementation of new economical CAP tools and levers provides integrated environmental benefits subject to its local requirements have been complied with.

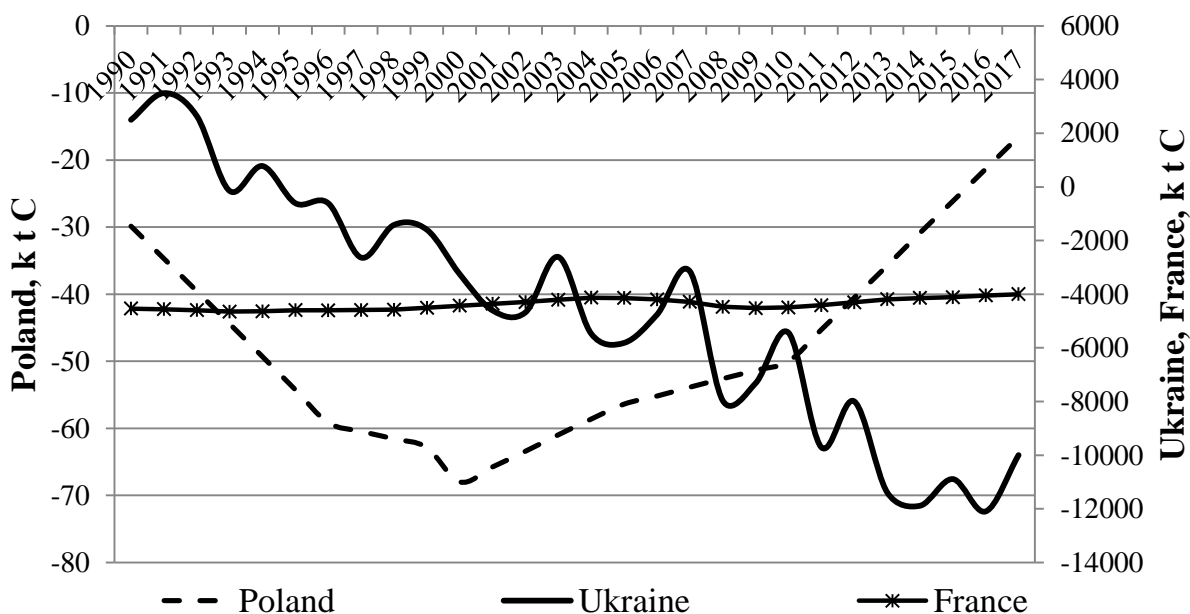


Figure 1. Dynamics of carbon stocks changes in the pool of mineral soils, 1000 t C

Source: elaborated by author by using data of national inventory reports, 2019 submission [http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php]

Instead, in Ukraine, the situation is characterized by increasing the sunflower seeds production output from 2.1 to 14.2 million tons (Agriculture of Ukraine, 2019), and with decreased livestock up to 8 times (since 25 mln in 1990s to 3 mln today, Animal production of Ukraine, 2019), and since 1990, the milk production output has decreased from 19 to 8.6 million tons with none of figures regarding of the meat production output for Ukraine on the FAOSTAT website since 2005 at all. The livestock shortening negatively affects for the manure implementation in soils. The general agricultural activity trends in Poland, France and, for comparison, in Ukraine, are shown in Figure 2 (a) – in the Plant Growing Activity Block and (b) – in the Livestock Activity Block, in million tons.

Ukraine has the highest disproportions between the agricultural lands and other land types in the comparison group. In accordance with statistics, approx. 70 % of Ukraine falls to the agricultural lands, and most of the domestic territory (almost 54 %) has been plowed, only 16 % of the territory is covered by forest (Environment of Ukraine, 2015). Moreover, a significant negative impact on the agro-chemical state of the soil environment is created by the burning of organic remains immediately in the fields. One of the reasons for such actions, despite the legislative ban, is the attempt of land users to reduce the costs of the technological stage of plowing. The priorities

of economic activity of the Ukrainian agricultural enterprises are in the economic plane, Table 1.

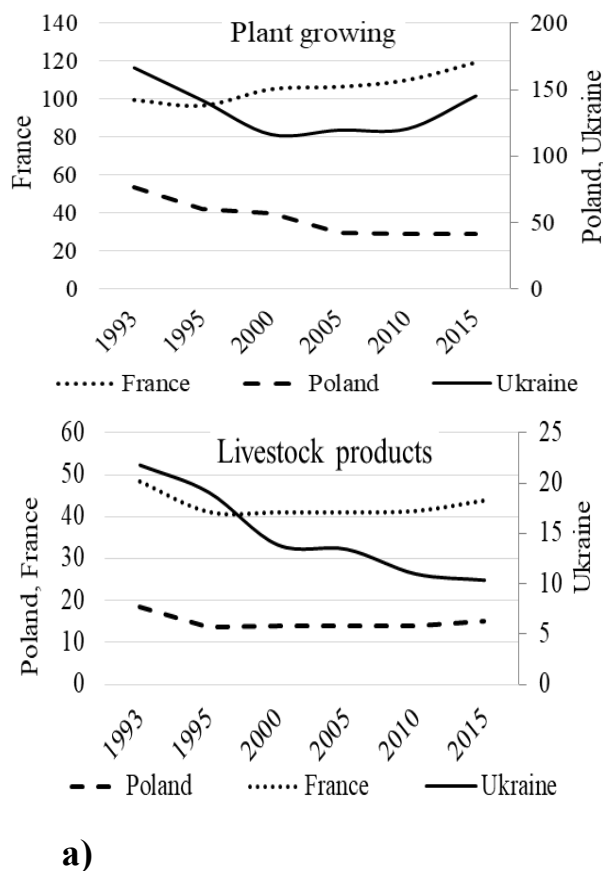


Figure 2. Dynamics of commodity products by agriculture in countries, mln tons

Source: elaborated on FAO data [http://www.fao.org/faostat/en/#data/GC]

Analysis of the Table 1 shows the dependence of the humus content dynamics in soils and the characteristics of agricultural production. First of all, a direct link with the correlation 0.86 between of the manure introduction dynamics and the humus content is observed. It should be noted that, an increase in the volumes of only the mineral component of fertilizers cannot provide an acceptable state of fertility and agroecological safety, the value of the low correlation (0.18) with humus content proves the above argument. Unbalanced use of mineral fertilizers contributes to reducing the buffer capacity of soils, the deterioration of their agrochemical and physical characteristics, such as the change in an acid-alkali reaction, and ultimately leads to loss of fertility. At the same time, the general trend to increase the agricultural crops yield (Table 1) creates higher levels of anthropogenic loading on the soil environment. An increase of volume crop production per 100 hectares is an indicative result, which, according to the State Statistics Service of Ukraine (Statistical Yearbook of Ukraine, 2016) for the period of

2000 – 2017, has almost doubled (from 370.7 thousand UAH to 715.7 thousand UAH, in 2010 prices) however, the rate of plant production growth for different land-user categories is not the same. The increase in the volumes of crop production for agricultural enterprises during this period was 2.5 times, and within this group of producers, there has been a group of farms, in which the growth has been almost 7.5 times (from 2.9 billion UAH to 21.7 billion UAH) against an increase of 1.5 times for households (from 47.0 billion UAH to 70.9 billion UAH).

The cost-efficiency indicators are a significant factor in the priority of segregation of agricultural land for seeding and volumes of commodity productions: the cost-efficiency of cereal crops, rape and sunflower production is constantly high, their area is increasing. At the same time, the trend of reduction of direct investments volume in agriculture from 680 million USD to 505.2 million USD from 2010 to 2016 (Statistical Yearbook of Ukraine, 2016), which does not contribute to the balanced land-use and stimulates the increasing of the profits due to the disturbance of agro-resource potential.

The agro-resource potential preserving with an acceptable level of cost-efficiency indicators will be maintained, it is possible if land-users / landowners bear financial and economic responsibility for the state of qualitative land resource characteristics that appear as a result of their using. Until recently, the cost of agro-resource potential is not fully taken into account in the process of production of saleable crop products, which made it possible to increase profits through disturbance of soil fertility. The solution to this problem is seen as possible through the introduction of the financial and economic mechanism of DCM for the land-use sector, which gives the possibility to increase the capitalization of land resources through the sale of carbon removal units. The introduction of this approach is based on the modification of key UNFCCC principle ‘polluter pays’ as ‘user compensates’ principle, i.e., whoever caused any damage to the land should compensate it. Namely, this means provision of financing for the implementation of land protection measures.

Table 1

Some economic characteristics of agricultural land use in Ukraine

Description	1990	2000	2010	2015	2016	2017	Correlation level with humus content, %
1	2	3	4	5	6	7	8
Agricultural crops yield (Agricultural of Ukraine, 2019), tons/ha:							
- cereals	35.1	19.4	26.9	41.1	46.1	42.5	-0.54
- corn	38.7	30.1	45.1	57.1	66.0	55.1	-0.82
- sunflower	15.8	12.2	15.0	21.6	22.4	20.2	-0.72
- rapeseeds	14.5	8.4	17.0	25.9	25.7	27.9	-0.79
- perennial herbs	38.7	20.6	35.8	38.1	41.7	40.9	-0.42
Agricultural production cost-efficiency (Agricultural of Ukraine, 2019):							
- cereals, %	275.1	64.8	13.9	42.6	37.8	25.0	0.87
- sunflower	236.5	52.2	64.7	78.4	61.9	41.3	0.75
Fertilizing (Agriculture of Ukraine, 2019):							
- Nitrogen, kg N/ha	44.2	5.4	18.7	23.7	28.9	32.9	0.18
- Organic, kg/ha	6207.8	692.9	239.5	232.8	220.8	223.5	0.86
Scope of the land protection measures taken (Environment of Ukraine, 2015):							
- Hydraulic and anti-erosion structures, km	157.8	27.1	8.5	0.2	n / a	n / a	0.89
- Land remediation, th ha	19.2	3.7	0.5	0.1	n / a	n / a	0.90
- Degraded and polluted arable lands, ha	12,785.0	14,974.0	1,015.2	164.8	n / a	n / a	0.88
Agrochemical Survey Series	V 1986-1990	VI 1991-1995	VII 1996-2000	VIII 2001-2005	IX 2006-2010	X 2011-2015	
Content of humus in the Ukrainian soils (Yatsuk, 2017), %	3.36	3.28	3.19	3.15	3.14	3.16	

Part 2. Formation of the financial and economic tools of DCM for the land-use sector as a way to restore and preserve the soil fertility

The current situation with agricultural land-using poses a threat to the level of agroecological and food security of Ukraine. The solution seems to be possible by Low Carbon Land Use (LCLU) implementing that ensures an integral carbon balance in the pool of mineral soils, and therefore, determinates the soil fertility restoration and conservation, which is a factor agroecological security. The effectiveness of the LCLU implementation depends immediately on the DCM formation for the agricultural land-use sector, which is a system of organizational and economic ties between business entities and the financial and economic tools ensuring achievement of the balanced land-use. Under the updated organizational and economic conditions, the amount of agricultural producers' profits becomes dependent on the qualitative agroecological characteristics of the soil cover and on changes in carbon stocks in a result of the agricultural land using. The increasing the cost-efficiency of commodity crops production due to disturbance of agro-resource potential, as it in most cases occurred until recently, becomes unprofitable. Through this the conditions for promotion to implement a science-based system of the LCLU measures are created, which provides its balanced way, restoration of humus stocks, which determines the level of soil cover fertility.

The basis for idea of developing an DCM for economic agricultural entities is based on a set of prior justifications in accordance with paragraph 4, Article 3 of the Kyoto Protocol (1997) and the decisions of the Conference of the Parties to the UNFCCC concerning the mobilization of flexible mechanisms according activities in the sector LULUCF. The initial step of organizing this kind of market are definitions of the «base level» and «base year», which are reference points for assessing the effectiveness of implemented measures aimed at increasing carbon stocks in the pool of mineral agricultural soil. Fundamentally, the main idea of the DCM development in the land-use sector lies down in the development of several stages.

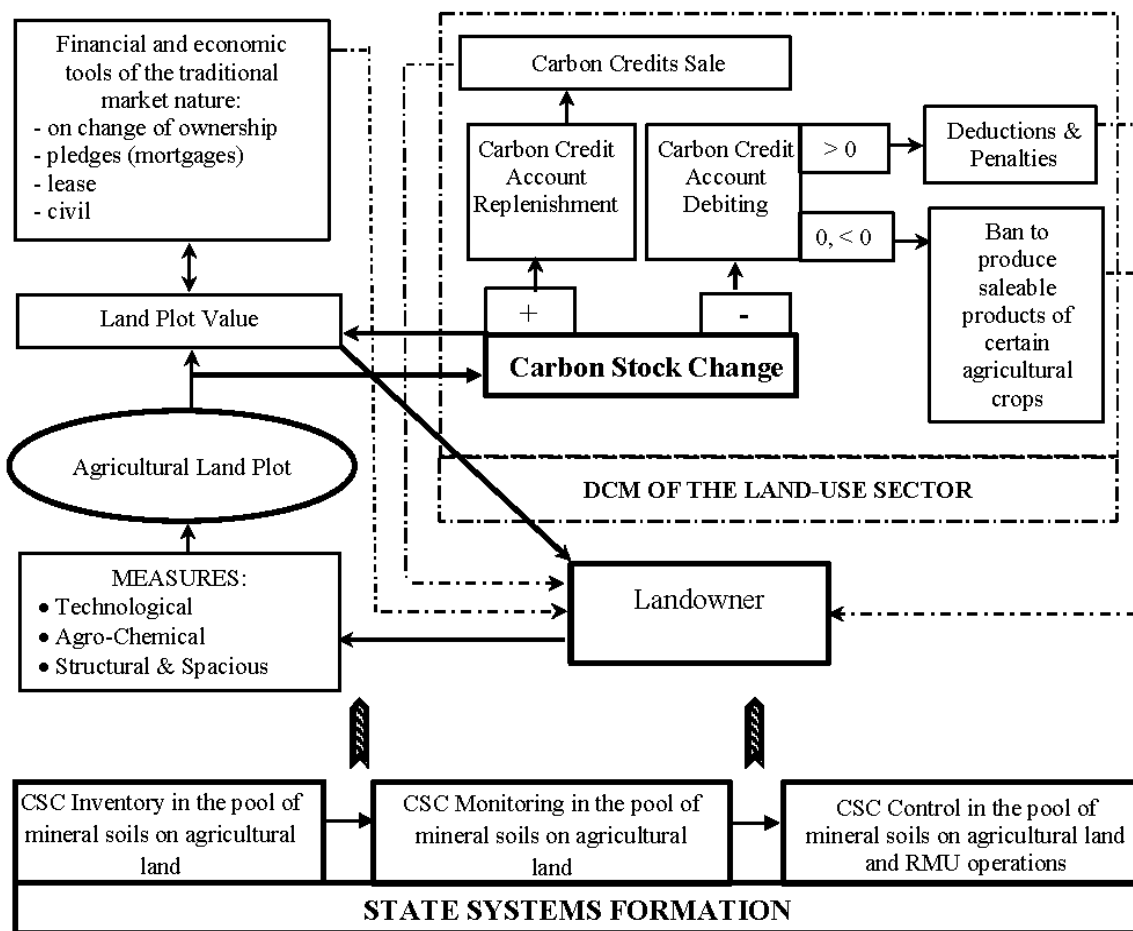
Before the implementation of activities aimed at increasing carbon stocks, an agricultural land plot is assessed for the carbon stock thereof in the soil, which is scheduled to be regarded as a testing ground of the potential receipt of removal units (i.e., it is assessing base level). This assessment should be done by independent certified laboratory. According to the assessment results, an officially approved document is issuing, which certifies the initial amount of carbon stocks. After a certain period of time to be officially established for all the DCM participants (an example, five years or more), the same will be repeatedly assessed and the results thereof are entered into a certificate with similar parameters. The difference in assessment results gives rise to a conclusion regarding the carbon stock dynamics to be reflected as a last entry recorded in the certificate. In accordance with a conclusion stated in the Certificate to be approved by the Verification Board, in case of any increase in

carbon stocks, the landowner is eligible to receive units of permits for GHG emissions. In the opposite case, he or she will be forced to acquire the carbon units additionally in amounts appropriate to a decrease or to pay a penalty that cannot be less than the cost of necessary carbon units payable at market price at the time of the official fixing of carbon stock reductions on a land plot. In the case of the conservation of carbon stocks at the base level, the chosen land-use method can be continued, without the receiving of the carbon units or to impose penalties. In the case of repeatedly confirmed reduction (on the third case) in carbon stocks below the base level, the land-user (or landowner, according the contract) will be required to compensate for this difference, or through penalties, or by using the carbon units purchased from other land-users and will be restricted for the cultivation of certain types of crops (for example: sunflower, rapeseeds, corn, sugar beets) until the carbon stocks have been increased. But establishing the list of these crops requires additional research and should be differentiated according to agro-climatic conditions of different natural zones, taking into account the characteristics of the plants influence on the different types of soils. It is clear that ensuring the increase (conservation) of carbon stocks in soils will require the system of land protection measures and, above all, the return of the nutrients that were taken by crops during the cultivation of harvests. The starting point for the formation and functioning of the financial and economic tools system for regulation of CDM in the land-use sector is the change in carbon stocks in the pool of mineral soils on agricultural lands, which is depended from both the volumes of harvests and the characteristics of land-use. DCM opens up a number of opportunities for managing the level of agroecological safety, the principal scheme of whose formation is shown in Figure 3 below. This approach is easily integrated with the system of financial and economic tools of the traditional market profile.

DCM introduction requires improving the development of the regulatory, legislative environment and the institutional framework for the carbon stocks inventory systems formation and development at the regional level. Related task is the need to harmonize their outcomes with the annual reporting data provided by a country to the UNFCCC Secretariat by the LULUCF Inventory Sector (for mineral soils in the 'Cropland' and 'Grassland' land-use categories). In order to accomplish this task, it is required to develop a legislative support framework for the clear functioning of an extensive monitoring system of the qualitative of agricultural land (primarily, to the humus stocks). Also, it is necessary to develop a comprehensive control and audit regarding both the inventory outcomes commit process related to any CSC in the agricultural soils with the subsequent release of carbon units and to qualitative and quantitative introduction of the land protection measures. The level of profits of landowners depends on the measures implementation not only as a result of increased saleable products volume and an opportunity to increase the financial proceeds from the sale of carbon units, but also as a

result of increase in the value of land (the market value of plots depends from the fertility level and humus stocks).

Therefore, the DCM introduction contributes to raising the level of agricultural land resources capitalization. The introduction of the DCM will facilitate the improvement of the overall economic situation in the country, inasmuch as incentives will appear for the development of a number of related industries, such as: animal husbandry, agricultural chemistry, agricultural machinery, thereby additional employment opportunities are created, as well as it indirectly contributes to the forestry development.



Indications on the diagram: - government regulation ties; - organizational ties; - financial and economic ties

Figure 3. Conceptual diagram of DCM formation for land-use sector

In addition, regulation of the DCM implementation process needs to create the standards system. In order to ensure and accelerate the restoration of the agro-resource potential of territories with a reduced carbon content in the soil cover, as well as to optimize financial payments and maintain the competitiveness of agricultural enterprises, the amount of payments for land-

use and collection of land tax should be depended from the scope of LCLU measures implementation and the quality of these works. It also requires taking into account the values of the land area which is in the using with the respect to a protectionist approach for small- and medium-size enterprises. Providing a comprehensive positive impact of the DCM functioning on the ecosystem of regions with the agricultural land requires forming of special assignments to the local budgets. Any agricultural enterprises are obligated to deliver a determined part of their financial proceeds from carbon removal units sold (the same, like taxes), which will contribute to filling the local budgets. Funds accumulated in this way should be only for land protection and be allocated for implementation of the established list of measures of restoring the natural resource potential in regions. The formation of such a financial pool provides additional economic opportunities for improving the overall state of ecological safety in the regions.

In cases of carbon stocks reduction in the land, but provided that the carbon units earned in the previous periods are available on the enterprise's accounts, the agricultural production entities should be subject to penalties to be transferred to the state budget or local societies. These funds should also have the intended purpose of use and be allocated to the implementation of measures for the restoration of natural resources potential on the state land. Another type of recipients of this finance – lands, where the responsibility for the results of economic activity thereon can no longer be established, but these lands require the introduction of renewable land- or environmental protection measures, e.g., quarries or mines where mining has been carried out prior to the establishment of the period of the independence of Ukraine, but the re-cultivation measures have not been timely implemented.

In our opinion, an administrative and regulatory lever, whose introduction requires state intervention, is of importance. In particular, it is required to regulate a permit system related to commodity crop production legally. Pursuant to this legally stipulated condition, an enterprise acquires the rights to carry out agricultural commodity production activities, providing that carbon units are available on its account. Such a regulation would serve as the legislative and regulatory incentive to reduce the level of anthropogenic interference with the agroecosystems, expand the areas of ecologically stabilizing lands at the regional level. At the level of agricultural enterprises, this will serve as an incentive for the balanced agricultural land-use, in particular, in respect of compliance with crop rotation and adherence to other agricultural and technological standards well-grounded scientifically. The outcomes of all control stages must be available for the general public access.

Conclusions

Based on the dynamic analysis of carbon stocks in the pool of mineral soil on agricultural land (see Figure 1) and of agricultural production in various countries (see Figure 2), the unbalanced land-use method in Ukraine has been

proven. Increasing profits earned by agricultural enterprises in Ukraine and the saleable crop production cost-efficiency increasing in most cases occur due to agro-resource potential disturbance and land protection measures scope reduction (see Table 1 above). On this basis, the necessity of reforming the organizational-economic relations between land-use subjects has been grounded, which is aimed at the LCLU introduction with the subsequent DCM formation. The named goals need the systematization of differently-sided methodological approaches and methods of decision making under conditions of high uncertainty and conflicts of interest. For the methodical platform of choosing strategic directions of the development of Ukraine as a whole, which are intended to provide low carbon development, can be consider the proposed suggestions in publication (Karaieva and Bereznytskaya 2016).

The DCM introduction in the land-use sector requires to develop a regulatory and legislative environment and to improve the institutional system in such strategic direction, as: an inventory systems formation and development for carbon stocks changes in the agricultural land pool at the regional level, monitoring their status and control and audit both of financial and economic operations with carbon units, areas of the financial resources use, obtained from these operations and the land protection measures introduction at all levels. This requires the program development for the agricultural soils protection at the regional level that should be based on the calculation of potential level of carbon stock increasing. The foregoing is in line with the requirements for a system of measures for the low carbon development of the agricultural sector that is considered at the level of the EU countries (Allen B & Maréchal A (2017).

Ensuring the effective DCM functioning requires the development of a system of standards, indicators, indicative guidelines (drivers) for the development of systematic scales for local budgets based payments on sales of carbon units and penalty standards to the state budget, as well as the definition of a hierarchical list of crop types, the cultivation of which may be subject to restrictions in cases of significant reduction of carbon stock levels in mineral soils on agricultural lands.

The introduction and provision of the effective functioning of the financial and economic tools for DCM regulating will contribute to ensuring balanced land-use and achieving an acceptable level of agroecological and food security, as well as overcoming the ecological and economic crisis in Ukraine.

References:

1. Regulation (EU) 2018/841 of the European Parliament and of the Council of 30 May 2018 on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision No 529/2013/EU <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R0841&from=EN>

2. On Approval of the Concept for the Implementation of the State Policy in the Field of Climate Change for the period up to 2030: Order of the Cabinet of Ministers of Ukraine dated December 7, 2016, No. 932-p. (in Ukrainian) Official site of the Cabinet of Ministers of Ukraine: <http://zakon.rada.gov.ua/laws/show/932-2016-%D1%80>.
3. On approval of the action plan for the implementation of the Concept of implementation of state policy in the field of climate change for the period up to 2030: Order of the Cabinet of Ministers of Ukraine dated December 6, 2017, No. 878-p. Official site of the Cabinet of Ministers of Ukraine: <https://zakon.rada.gov.ua/laws/show/878-2017-%D1%80> (in Ukrainian)
4. Ukraine (2050) – Low Emission Development Strategy <https://unfccc.int/process/the-paris-agreement/long-term-strategies>. Accessed 01 Sept 2018.
5. About the Basic principles (strategy) of the state environmental policy of Ukraine for the period till 2030: Law of Ukraine dated February 28, 2019 No. 2697-VIII. Official site of the Legislation of Ukraine: <https://zakon.rada.gov.ua/laws/show/2697-19?lang=en#Text> (in Ukrainian)
6. Butrym O. (2018) Theoretical and Methodological Bases of Domestic Carbon Market Formation in the Context of Sustainable Development of Agrosphere. DIA. Kyiv.
7. Submissions 2019 of Greenhouse Gas Inventories – Annex I Parties. Reporting and review under the Convention. Transparency and Reporting. UNFCCC. UNFCCC Process-and-meetings: <https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2019>
8. FAOSTAT. Data. <http://www.fao.org/faostat/en/#data/GC>. Accessed 27 Sept 2018.
9. Overview of CAP Reform 2014-2020. Agricultural Policy Perspectives Brief, EAFRD: European Agricultural Fund for Rural Development, 2013. # 5. 10 p.: https://ec.europa.eu/agriculture/sites/agriculture/files/policy-perspectives/policy-briefs/05_en.pdf Accessed: 10.01.2018.
10. Agriculture of Ukraine, 2018. Statistical yearbook. State Statistics Service of Ukraine. Kyiv, 2019. <http://www.ukrstat.gov.ua/>
11. Animal production of Ukraine, 2018. Statistical yearbook. State Statistics Service of Ukraine. Kyiv, 2019. <http://www.ukrstat.gov.ua/>.
12. Environment of Ukraine, 2015. Statistical yearbook. State Statistics Service of Ukraine. Kyiv. <http://www.ukrstat.gov.ua/>
13. Yatsuk, 2017. Survey of agricultural lands. General information. Edited by I.P. Yatsuka (in Ukrainian) Official site of the State Institution `Soils Protection Institute of Ukraine`: <http://www.iogu.gov.ua/pasportizaciya/ahrohimichne-obstezhennya-silskohospodarskyh-uhid/>
14. Statistical Yearbook of Ukraine for 2016. State Statistics Service of Ukraine. Kyiv. <http://www.ukrstat.gov.ua/>
15. Kyoto Protocol to the United Nations Framework Convention on Climate Change. Official site of the UNFCCC. <https://unfccc.int/resource/docs/convkp/kpeng.pdf> Accessed 27 Sept 2018
16. Karaieva N. and Bereznytska M. (2016) Methodical principles of selection management solutions in the field of low-carbon energy development. Balanced Nature Management. #3: 30-37. <http://natureus.org.ua/index.php/ua/component/phoca-download/category/5-zbalansovane-prirodokoristuvannya-2016-rik>
17. Allen B & Maréchal A (2017) Agriculture GHG emissions: determining the potential contribution to the Effort Sharing Regulation. Report prepared for Transport and Environment. Institute for European Environmental Policy, London. https://www.transportenvironment.org/sites/te/files/publications/2017_IEEP_Agriculture_mitigation_potential_in_ESR_final.pdf