ЕКОНОМІКА ТА УПРАВЛІННЯ НАЦІОНАЛЬНИМ ГОСПОДАРСТВОМ

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SOIL BALANCE FORMALIZATION PROBLEM

In this article the methodology of assessment of losses from soils deterioration is considered. Loss decompose into price (at the expense of quality), by reducing the planting acreage and yield deterioration. The increase of risks of soil deterioration is shown as a result of industrial crops cultivation. The rate of return has proved to be significantly worse when the costsbneeded to restore soil fertility are taken into account.

Key words: *modeling, farming, ecology, soils, ecological and economic monitoring.*

STATEMENT OF THE PROBLEM

For many decades, the impact of economic activity on the state of the environment attracted the attention of both researchers and the wider social circles.

Environmental problems for developing and developed countries are being solved in fundamentally different ways.

If the Golden billion countries level of economic development, measured as gross domestic product per capita (GDP per capita), is more than $20,000 with some exceptions, for developing countries (India, China, Brazil, Russia, Ukraine and etc.) this figure in the coming years is unlikely to be achieved.

Therefore, if the developed countries are highly satisfied by real GDP 1-3 % growth, then for Ukraine with $3000 GDP per capita level (direct method) to implement the European vector of development is nessesary to achieve significantly higher rates of economic growth. There is no doubt that higher rates of economic development contribute to the environment pressure (China's problems are sufficiently influencing the environment [1], the condition of which in modernUkraine in present situationis rather unfavorable.

Energy-intensive and inefficient production structure historically formed during the planned economy is the reason for this. In recent years the prodigality index (waste index) had spread, which shows how many pounds of natural materials you need to use to produce 1kg of product that is actually consumed. In developed market economies, the index is equal to 4 kg, and for countries whose production structure is developed in a planned economy conditions – 30 kg.

As for the agricultural sector, there is more convenient to use another indicator: differential ecological costs – the difference between the cost per unit of production in the performance of established environmental requirements and cost without compliance with environmental requirements. This indicator is extremely important for the Ukrainian agricultural sector, which develops under the influence of the global food market and leads to significant structural changes in the crop production. In these conditions the main problem is the possibility of significant deterioration of the large part of soil. Cultivation of alternative crops under the influence of increased demand from the EU (EU-20 directive on increasing of biofuel consumption) affects the condition and soil fertility in Ukraine. Therefore the goal of this paper is to develop methods of ecological-economic monitoring of quantitative analysis of the impact of soil structure condition on indicators of economic efficiency in agriculture.

Research in this direction is conducted both in our country and abroad. However, the most disputable issue is the role of the state in the matter of environmental management. The basic, in terms of a market economy, is Koaza theorem [2], which states that in a free market exchange and the establishment of property rights, parties (the owners) can reach an agreement on the mutual compensation of damages or rational reallocation of resources (resource allocation which leads to growth social utility function). In this case, the question regarding public (budget) costs of preservation of the environment is closed.

In Ukraine, where the agricultural land market does not exist and the rules of rational environmental management in prevailed lease relations do exist, but they are hardly implemented, this point of view, unfortunately, is lacking in prospects. Koaza theorem implementation, unfortunately, is not very promising. Therefore the environmental damage burden, in most cases, is on the state. The main role in the ecological and economic monitoring at this stage rather should belong to the state institutions. As the economic power and number of farms grows, its unions' role in maintaining the environment structural state should be increased.

Classic ecological-economic approach based on the works of Academician [3], who emphasized the relationship between the biosphere and the course of humanity as its integral part and geological environments of the Earth. Modern approaches in modeling of economic activity based on a system of equations of Leontief-Ford in which the process of consumer products production includes the disposal costs of waste production [4]. In the paper of Ch. Deissenberg and V.Gurman is given a modified Leontief-Ford model, which takes into account investment in traditional capital, investment in environmental capital, investment in innovative capital, real consumption of traditional goods, vector technology-health measures, export and imports of traditional consumer goods. As in a basic version of the model, the flow of exports and imports are considered as exogenous [5].

The continuation of these ideas is the introduction of calculation methods of gross domestic product (green GDP), taking into account the

damage that inflicted state of the environment (calculated as a sum of money needed to set the initial environmental state (Держкомстат [6]). Since about 90 % of Ukraine's GDP is produced outside the agricultural sector, these recalculations relate mainly to the major sectors Ukraine economy: metallurgical, chemical, power.We turn to the issues of the agricultural sector and soil monitoring. Condition and soil fertility were studied in the paper [7]. All soils are divided over the content of microelements and divided into 20 categories.

However, according to the formula is difficult to assess the damage due to lack of information, therefore we will use a different methodology. If we consider the environmental usage in a national scale, the question of ecological-economic monitoring closely connected with the problem of rational land potential usage, which necessarily includes the presence of the reserve fund (reduction plowed degree). In developed countries the food market is the main engine in food production ecologization. The proportion of so-called green market is growing (without use of pesticides and fertilizers). More than 50 % of U.S. consumers willing to pay a green premium to manufacturers who comply to environmental standards.

However, as Global Ecolabel Monitor organization stresses in the global institutional level it is necessiry to implement environmental standards of product quality, detailed information regarding the technologies used by manufacturers and evidences of product quality [8]. Two paths of ecological agricultural production are traced: the first is typical for developed countries, and it is in control of the final product, the second is typical for developing countries, and it is on the state control as the major components of production: soil, water, air. Unfortunately, the condition of the food market (absence of significant demand for green products) does not allow Ukraine to implement the first ecologization option.

OBJECTIVES FORMULATION

The purpose of this work is to develop a cost-based approach for soil monitoring, involved in agricultural production, in order to obtain objective assessments of financial losses from deterioration of ecological status. Such an approach would offer a model of environmental management throughout the country.

The paper addresses the following topics:

1. Analysis of the state of scrutiny issue of soil quality.

2. Investigation of the structure of the land and the state of soil in Ukraine at the present stage of development.

3. Submit ecological-economic model of rational usege of soils.

4. Provide environmental and economic assessment of profitability of growing certain crops.

BASIC MATERIAL

Let's consider the methodology for assessing losses from deterioration of ecological state in next sample. Lets suppose, that some agricultural

company produces mono production using land area S (ha), pollution of which is γ (measured in mt), yield per hectare and unit price are decreasing functions of pollution – $Y(\gamma)$ та $P(\gamma)$ ($\frac{dY}{d\gamma} < 0; \frac{dP}{d\gamma} < 0$). Let the initial (baseline) state of pollution is γ_0, increased pollution – $\Delta\gamma$ (profit is function pollution only). Then gross income for given parameters of production and the usage of only one culture is:

$$\Pr = P(\gamma) \cdot S(\gamma) \cdot Y(\gamma). \quad (1)$$

Income loss due to rising pollution on $\Delta\gamma$ (logarithmic and difference procedure) (1):

$$\frac{\Delta \Pr}{\Pr} = \frac{\Delta P}{P} + \frac{\Delta S}{S} + \frac{\Delta Y}{Y}. \quad (2)$$

All values of the basic functions and their derivatives are taken at the level of pollution γ_0:

$$\Delta P = P'(\gamma_0)\Delta\gamma; \Delta S = S'(\gamma_0)\Delta\gamma; \Delta Y = Y'(\gamma_0)\Delta\gamma \quad (3)$$

Since all derivatives (3) are negative, then all the terms in the expression (2) are also negative, so the relative loss for each of the parameters are summarized. Expression (2) allows us to estimate the loss, all the values of basic indicators changed to their mathematical expectation (average value):

$$\Delta \Pr = \left(\frac{\Delta P}{\overline{P}} + \frac{\Delta S}{\overline{S}} + \frac{\Delta Y}{\overline{Y}}\right)\overline{\Pr} \quad (4)$$

Straight losses due to rising pollution are only a fraction of losses. For the situation is not complicated, it is necessary to bring soil to its original state. Let the cost of pollution reduction on a unit square (ha) depends on the level of contamination which depends from point location (x; y): $\varphi = \varphi(\gamma(x; y))$, subjected to the next condition:

$$\frac{d\varphi}{d\gamma} < 0$$

(reducing pollution per unit cheaper at considerable pollution). If contamination is not isotropic and it is necessary to reduce its level from γ_1 to γ_0 on the area S, the cost of this operation is:

$$F(\gamma_1, \gamma_0, S) = \int_{\gamma_1}^{\gamma_0} d\gamma \iint \varphi(\gamma(x, y))dxdy. \quad (5)$$

If the entire area is made up of particles

$$S_1; S_2; \ldots, S_n \left(\sum_{i=1}^{n} S_i = S\right),$$

where pollution can be considered constant, we can introduce the average weighted rate of pollution:

$$\bar{\gamma} = \frac{1}{S}\sum \gamma_i \cdot S_i$$

.

In this case expression (5) can be represented as a sum:

$$F(\bar{\gamma}, \gamma_0, S) = \sum_{i=1}^{n} S_i \cdot \varphi(\gamma_i)(\gamma_0 - \gamma_i) \quad . \qquad (6)$$

The total amount of damages is equal to the amount of damages from loss of productivity, reduce cost of production, space and cost required to bring the soil to a favorable condition:

$$L = \Delta \Pr(\gamma; S) + F(\bar{\gamma}, S, \gamma_0) \quad . \qquad (7)$$

Let's consider the overall structural distribution of Ukrainian land to further identify the quantitative and qualitative composition of the soil. The total area of the country is 60,4 million hectares, of which about 71 % is agricultural land, forests make up only 17,6 % of the total territory of the country (table 1). This is significantly lower than European standards reforestation 25–30 % and significantly affects the overall environmental situation in the country (reforestration growth reduces the natural period of environmental rehabilitation). Extremely large is a plow degree – 53,8 %.

Table 1

Land of Ukraine (on January 1, 2011) according to the State Committee of Ukraine of land resources

The main types of land and economic activity	Area of land	
	Area of parts (mln ha)	% of the total area of Ukraine
Agricultural land	41,5	68,8
including these:		
arable	32,3	53,6
Hay and pasture	7,3	12,1
Other agricultural land	1,9	3,1
Forests and other wooded areas	10,6	17,6
Built-up lands	3,8	6,3
Areas covered by surface of water	2,4	4,0
Unsuitable lands for agricultural production	2,1	3,3
Total (territory of Ukraine)	60,4	100,0

Souce: [9, 10]

However, this value is not constant, it changes dynamically under certain circumstances, including the main tendency – areas growth for cities development. Ukraine has an institutional mechanism for removal of agricultural lands, which is based on certain amounts paid to the state budget. This process is available in Fig. 1, where the model of exponential trend quantitatively represents agricultural land alienation process.

In the time interval from 1990 to 2010, using the model of exponential trend consideres reducing rate of the area of agricultural land in Ukraine and Kyiv region (Fig. 1). In Kiev the rate of decrease in arable land is 0,6 % per year, while for the whole Ukraine this rate is only 0,04 %. Such a significant difference relates to the expansion of the metropolis (Kyiv).

Excessive tillage and especially the extensive nature of soil usage led to its degradation, violated the natural processes of soil formation. Soils lost its renewable power in considerable degree. In the world agriculture, and consequently, in Ukraine, there are four types of threats to soil: 1) erosion and deflation, 2) desertification, destruction and 3) toxification 4) direct loss of soil due to land transformayion to cities and villages, roads, airports etc.

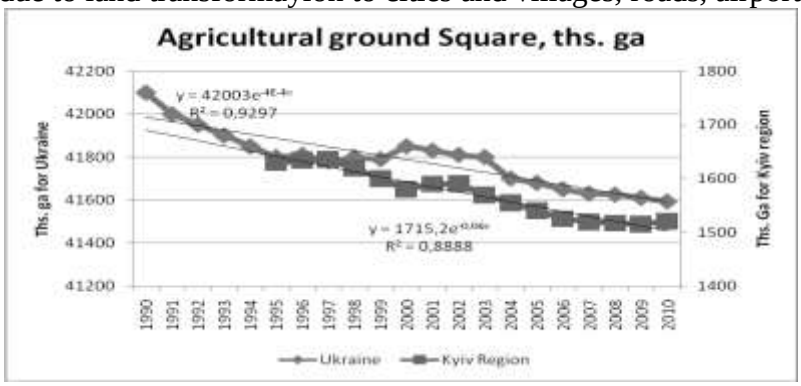

Fig. 1. Dynamics and the exponential trends parameters of agricultural land of Ukraine and Kiev region for 1990–2010 years period

Source: own calculations based on data of State Committee of Statistics

The last item (direct loss) we have already considered and it is a natural and inevitable consequence of economic development. The greatest harm for Ukrainian agriculture development is caused by soil erosion and toxification.

At first glance, it is the extent of violations that can not affect the overall agricultural land (at the end of 2009, the area of disturbed land was 156,7 thousand hectares). The reasons are the ruin, drying and salting of the soil under irrigation. According to the State Committee of Statistics, more than 40 % of agricultural land is subjected to degradation (ДАЗР 2012). It means, that almost on the half of the land negative trends have been observed, which in the future may lead to a complete withdrawal from agricultural production.

At 2011 the total land area in need of conservation, reaching 1,1 million hectares, including 644,2 hectares – degraded, 432,1 hectares – unproductive and 1,9 hectares – technologically polluted land. During the last year carried out 2,3 hectares of conservation of land, of which 0.9 hectares through reforestation and 1,4 hectares – meadow. Today only 18.1 hectares of land are under conservation. Earth, the most degraded require a greater degree of handling and greater investment. In 2011 rotsi reclaimed

only 571,1 hectares of land, of which more than 63 % is agricultural land, but it is a very small percentage of all degraded land. The total area that is under restoration is 6,6 hectares [9].

Failure to comply with the rules of farming, crushing fields stocks, plowed lands, expanding plantings energy-cultures resulted in reduction of mobile compounds of nutrients decrease of humus content in the soil all soil-climatic zones.

Let's consider a differentiated assessment of ecological value on the example of rape cultivation. Most convincing argument in favor of expanding the area under this crop is steadily growing demand for it, as raw material for the production of biofuels in the EU. Sowing of rape during rapid and sustained increase in oil prices (2006–2007) reached 1,4 million ha in Ukraine, but in recent years they have stabilized at about 0,7–1,0 million ha.

In 2011 in Ukraine it planted about 1 million ha, of which about 0,891 million ha returned stairs (the Ministry of Agrarian Policy and Food of Ukraine 2013). The range of rape prices for the interval from 400 $/mt to 600 $/mt in the period of 04.–07.2011. If we analyze the prices of the time interval from 08.2010 to 08.2011, we see oilseeds price growth (Fig. 2).

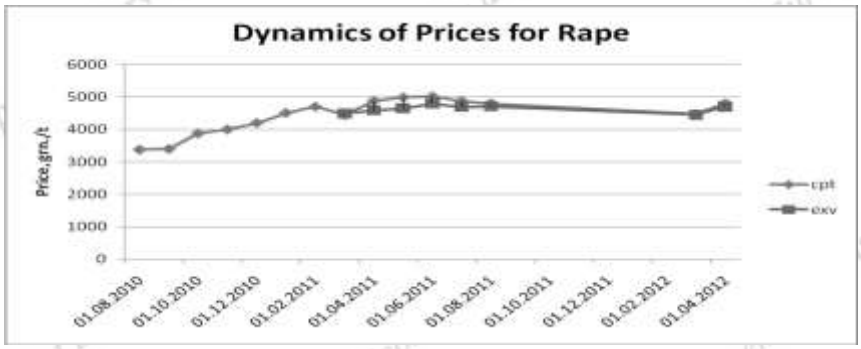

Fig. 2. Dynamics of prices for rape sowing 2010–2012

Source: ZernoUA.info

At first glance, we see that the high price level should provide big profits, but make adjustments that take into account environmental damage from growing production.

Approximately 15–25 % of nutrients rape extracts from groundwater reserves, and the rest should be put in the form of organic and mineral fertilizers, especially when a planned yield of 30–40 kg/ha.To make 1 ton of crop seed, rape brings with soil: nitrogen – 45–80 kg; phosphorus – 18–40 kg; potassium – 25–100 kg; calcium – 30–150 kg; magnesium – 5–15 kg; sulfur – 30–45 kg.

These elements are available in recultivating mass but given the dose necessary to restore the soil, and their value is not apparent profitability of cultivation. We must note that rape also requires a lot of elements that are available only in high-quality fertilizer, which should be applied separately.

Ekstrer cost of normal state soil providing equols in 2011 price approxsimstly 6500 UAX ($800) [10].

Despite of the application of fertilizers, rape can not accumulate all the elements that are provided with recharge. So it is advisable to consider the problem of soil and chemicals underground reservoirs. Also rape absorbs many minerals that are not made with fertilizers, thereby impoverishing soils.

To recovered ground after sowing rape, at least 5 years are needed. Rape should not be planted in the rotation and a variety of biological products to improve soil fertility should be used. When per 1 ha minimum required $800 for the purchase of biologics and renovator of the soil to eliminate the negative impact on crops and rapeseed cultivation. That is appropriate differential ecological value in the calculation of economic indicators. Cost rape is about $350/t and selling price during 2011 fluctuated around $560/t The average yield – 2 t/ha. So from 1 hectare farmer can get $1120 at their cost – $700.

Profit is 420 $, but not less than $800, he must spend on preparations soil for its recovery (used in the calculation of new preparations abroad that promote rapid recovery properties of the soil after the crop that it exhaust). Losses due to rising pollution represent a just share some losses, but that the situation is not complicated by the need to bring the soil to its original state. This is a set of measures on rehabilitation, that should be used to calculate the differential ecological value.

From the calculations, we can say that the difference between the cost of production of 1 ha sowing the performance of established environmental requirements and costs without performing environmental requirements is approximately $ 800. Let's calculate loss on rape growing in Ukraine, which takes into account the total acreage of culture and economic cost of soil remediation after sowing:

$$Зб_{кпі} = 6421uan \times 891000 = 5{,}721 \text{ billion.}$$

We see that even high profitability (30 %) does not cover losses caused by growing this crop. And given that failure to comply with the growing introduction of fertilizers and crop rotation, this figure can vary in a major way. It should be considered that the consequences of the use of fertilizers and other chemicals adversely affect the properties of the soil and underground water.

CONCLUSIONS

Ukrain had very big percent of arable land. In Kiev region the rate of decrease in arable land is 0,6 % per year, while for the whole Ukraine this rate is only 0,04 %. Such a significant difference relates to the expansion of the metropolis (Kyiv).

Despite this the share of arable land is extremely large, virtually no backup availability of land fund which has a positive effect on the

recovering of soil condition. The value of forest cover is not sufficient to ground the reset process.

In the paper it was propned the evaluation metodolgy of arable land total damage. Total damage is equal the sum damages amount from loss of productivity, production price reduction and cost required to bring the soil to a favorable conditions.

It was shown the dengerus tendencys in some agriculturel cultuers production without non evaluation soil quality decresing.

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ЕКОНОМІЧНИЙ АНАЛІЗ СТАНУ ҐРУНТІВ

У статті розглянута методологія оцінки втрат від погіршення стану ґрунтів. Втрати розкладаються на цінові (за рахунок погіршення якості продукції), за рахунок зменшення площ посіву і погіршення урожайності. Показано зростання ризиків погіршення якості ґрунтів внаслідок вирощування технічних культур. Доведено, що показники рентабельності суттєво погіршуються при врахуванні коштів, необхідних для відновлення родючості ґрунтів.

Ключові слова: *моделювання, аграрне виробництво, екологія, ґрунти, еколого-економічний моніторинг.*

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