Kucher A. Economic assessment of losses caused by contamination of soil resources within effective their use [Електронний ресурс] / Anatoliy Kucher, Irina Kazakova, Lesya Kucher // Соціально-економічні проблеми і держава. — 2015. — Вип. 1 (12). — С. 190-199. — Режим доступу до журн.: http://sepd.tntu.edu.ua/images/stories/pdf/2015/15kaaetu.pdf.

UDC 332.365
JEL Classification: Q15, Q51

Anatoliy Kucher [1],
Irina Kazakova [2],
Lesya Kucher [3]

[1] National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky»,
4, Chaikovska, Kharkiv, 61024, Ukraine
e-mail: anatoliy_kucher@ukr.net
Ph.D., Head of the Sector of Economic Research in National Scientific Center

[2] National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O. N. Sokolovsky»,
4, Chaikovska, Kharkiv, 61024, Ukraine
e-mail: kazakova@meta.ua
Ph.D., Senior Researcher

[3] Kharkiv National Agrarian University named after V. V. Dokuchaev,
village Kommunist-1, 62483, Kharkov region, Ukraine
e-mail: kucher_lesya@ukr.net
Ph.D., Assoc. Prof., Department of economy enterprise

ECONOMIC ASSESSMENT OF LOSSES CAUSED BY CONTAMINATION OF SOIL RESOURCES WITHIN EFFECTIVE THEIR USE

Abstract. *The article analyzes the current state of soil contamination in Ukraine and valid method of determining loss from contamination. Losses from soil contamination can be direct and indirect ones. Direct losses, on the total, characterize reduction of consumer's cost of land as a tool and object of labour. Indirect losses are predefined by decline in yield of agricultural crops on contaminated soils, worsened quality of products, increase in unit-cost of contaminated produce through increased per cent of semi-fixed expenditures due to reduced crop productivity. A scientific and methodical approach to the assessment of internal ecological and economic losses of agricultural enterprises from soil contamination is grounded. Basic criteria to determinate internal ecological and economical losses from soils' contamination are losses of profit whose obtaining is the main goal of the enterprise performance in marketing conditions. Major constituents of internal ecological and economical loss incurred by an agrarian enterprise are: losses of profit due to obtaining less products than expected, because of shortage of crop yield through contamination of soils; losses of profit due to deteriorated quality of agricultural produce through contamination of soils; losses of enterprise profits due to increase of product unit-cost through declined labour productivity, predefined by reduction of crop-yield productivity at the same rates of semi-fixed expenditures. Such complex science & methodical approach to determination of loss on micro-economical level can help one completely identify losses of agricultural production, caused by* *contamination of soils and strengthening one's attention hereto, possibly, increasing responsibility of contaminants for quality of soils and products obtained hereof.*

Keywords: *agricultural lands, ecological and economic losses, soil contamination, losses of profit.*

Introduction. Actuality, expediency and meaningfulness of this study are specified by the fact that soil contamination is the inalienable present-day factor in determination of ecological status of agricultural lands. Due to soil-scientists' argumentation, contaminated soils are soils where concentration of harmful ingredients is two or more times greater than their average natural contents. Due to origin, two types of soil contamination exist (i.e., technogenic and agrogenic) which, in their turn, are chemical, radioactive and biological pollutions (Dobryak, 2009). A necessity to consider some issues in assessment of ecological and economic losses, caused by contamination of tilled soils in agrarian industry, becomes actually urgent in context of fundamental principles of economical use of polluted areas across agricultural territories.

Analysis of latest studies and publications. Analysis of latest studies and publications reveals a series of certain successful science & methodogy results in this issue. Thus, in the study by T. Ratoshniuk (2005),

– an adjustment to monetary evaluation of radio-polluted agricultural lands (where technological surplus expenses on neutralization of radio-contaminants, through efforts on liming and fertilizing the affected soils, are taken in account) is methodically substantiated;

– several methodological approaches to assessment of ecological and economic value of radioactively polluted areas (based on contamination– intensity indices and rates of radionuclides' ingress into plants from soil), are specified;

– calculations for economic stimulation for land– owners and users to reduce soil contamination with radioactive elements (based on the principle to increase stimulation size depending on the reduction of soil contamination) are proposed and validated.

In view of insufficient attention to the problem of determining environmental quality of soils, in evaluation of agricultural lands (especially at investigations for impact of contamination and taking into account its role in ecological and economic assessment of lands):

– evaluation of soil contamination (per certain aspects of ecological quality of soils in regional scale) in the study of O. Khvorost (2005), is completed and

– integrative estimations of economic losses from agricultural land pollution (assuming for reduced incomes from contaminated lands, costs of soil-recovery, duration of pollution impact and the discount rates were accomplished.

In paper by O. Sytina (2010) an account of results from cartographic modeling of soil-contamination (at elaboration of soil-ecological monitoring-block and correction of monetary assessment of arable lands on urbanized territories), is recommended. Several scientific & methodical aspects in estimation of losses from soil deterioration and pollution are reviewed by O. Kolpakova (2010). At the same time (as is justly notified by O. Tarariko, V. Grekov, V. Panassenko (Tarariko et al, 2011)), issues of soil-fertility and land-protection (from degradation and contamination) require us to implement innovative organizational and scientific & methodical concepts adaptable to EU rules and requirements.

This research was addressed to substantiation of scientific & methodical approach to assessment of ecological and economical losses by agrarian enterprises due to soil-pollution, through analysis of present-day status of affected land-areas and now-valid methods of determining the losses from soil-contamination.

Concerning the present-day status of polluted soils of Ukraine, let us note that problems of residual amounts of pesticides, heavy metal-salts and radionucludes Cs^{137} and Sr^{90} (being key indexes of ecological safety of human activities) were generalized by experts of "Institute for Protection of Soils of Ukraine" (IPSU) Public agency (Table 1).

Table 1

Intensities of agricultural land-plots' contamination in Ukraine (as reported by IPSU public agencies)

Inspected	Area, thousand ha	Including Intensity of contamination, Ci/km^2					
		Cs^{137}					
		Up to 1	1–5		5–15		>15
			Total	Including turf	Total	Including turf	
Total	3375.2	3362.3	12.9	0.3	0.0	0.0	0.0
including arable land	3106.0	3094.6	11.4	0.0	0.0	0.0	0.0
grassland and pastures	251.6	250.2	1.4	0.3	0.0	0.0	0.0
perennial planting	17.7	17.5	0.2	0.0	0.0	0.0	0.0
Inspected	Area, thousand ha	Including Intensity of contamination, Ci/km^2					
		Sr^{90}					
		Up to 0,02	0,02–0,15		0,15–3,00		>3,00
			Total	Including turf	Total	Including turf	
Total	3375.2	1470.2	1350.3	6.9	8.4	1.3	0.0
including arable land	3106.0	1414.4	1232.3	0.3	6.2	0.0	0.0
grassland and pastures	251.6	114.0	109.3	6.6	2.0	1.3	0.0
perennial planting	17.7	4.4	8.4	0.0	0.2	0.0	0.0

Source: Naumenko, 2014.

Research objects were agricultural lands of Ukraine. The total area, subjected to inspection in 2012, amounted to 5.1 mio ha, including plough-land (4.8 mio ha); grassland and pastures (208 thousand ha) and perennial planting (20.6 thousand ha) (Naumenko, 2014). During their efforts, researchers of IPSU agencies studied 52,800 soil-samples and found out that average content of mobile forms of Pb, in soils of inspected Ukrainian districts, varies from 1.35 mg/kg to 9.6 mg/kg. Lead-contents exceedance over MAC-norm in soil was identified in 56 soil-samples, whereas total contaminated areas make up 7,020,000 ha. Soil-samples were similarly analysed for content of cadmium, showing MAC-exceedance in 82 tests (0.15 %). Cd-indices, on the average area of 3,260,000 ha, vary within 0.01–192 mg/kg vs 0.7 mg/kg reference MAC in soil. Almost 15,000 test-samples were analyzed for mercury, resulting in 0.014 mg/kg max. content, thus not exceeding 2.1 mg/kg MAC-limit in soil. 33,700 test-samples were analyzed for content of zinc. No matter that this heavy metal is present in Ukrainian soils, no MAC extremes were identified. 36,400 test-samples were analyzed for content of copper. MAC excess was detected in 31 test-samples (0.08 %) on 1,040,000 ha of contaminated area. Top index of Cu (8.73 mg/kg) exceeded its nominal MAC-value (3 mg/kg) by ~3 times (Naumenko, 2014).

While estimating degrees of technogenic soils' contamination, let us note that every year, in almost 175,640,000 test-samples probed from agricultural-purpose areas of Ukraine, content of heavy metals (e.g., lead, copper, mercury, cadmium and zinc) exceed their MAC in average 169 soil-samples (i.e., ~ 0.01 %). As harmful impact of single pollutants is thereby adding to harmful behavior of others, the resulting negative synergy-effect of soils' contamination can rise increasingly [ibid].

Thus, inspection of agricultural– purpose earth for content of ecologically dangerous chemical elements (such as Pb, Cd, Hg, Cu) testifies to fact that their concentration in soil stays mainly at more or less stable level of their baseline values. MAC-excess in soil is only observed in land– plots adjacent to big industrial enterprises, and on territories of vineyards, orchards, gardens, hop-gardens etc. Contamination of soils with copper is noted. In regard to soil-pollution with heavy metals, agricultural-purpose lands can mainly be considered as ecologically safe areas, needing no extra actions to reduce contaminant's penetration into plant-produce. At the same time, territories near big industrial objects or adjacent to urban agglomerations, interstate highways, areas under past-time orchards, gardens, vineyards, hop-gardens, agrochemical storehouses etc. need especially careful inspection, sectional localization and enlistment into inventory registers, with consequent actions for their rehabilitation (Tarariko et al, 2011).

However, in terms of hazard-estimations for contaminated soils in agricultural sector, of most importance are rather accumulations of heavy metals in marketable plant-growing and stock-raising food-products than indices of their concentrations in soil.

Data of plant-grower produce' contamination-control (monitored by regional branches of IPSU) testify that exceedance in plants of Pb vs MAC makes up [0.1–0.6%]; Zn = [0.09–0.4%]; Cu= [0.08–0.3%] and Cd = [0.06–0.8%]. These data mainly refer to sunflower and its process by-products (Baliuk et al, 2010).

In Ukraine, normative monetary estimation of agricultural lands, due to valid normative & legal acts, is an official basis of calculations for amount of harm resultant from land resources contamination. This estimation is also a normative base for calculation of harm scope from contamination of lands for other purposes.

Amount of losses – reimbursement compensation (*Alc*) is calculated per formula:

$$Alc = Ase \cdot Mec \cdot Acp \cdot Csp \cdot Cch \cdot Cee$$

where

Ase are specific expenditures on recovery from consequences of land-plot contamination (generally defined as [0.5]);

Mec is normatively monetary assessment of land-plot before soil pollution;

Acp is area of contaminated land-plot, m^2;

Csp is soil pollution coefficient;

Cpmh is pollution– substance' hazard-coefficient (Table 2);

Cee is coefficient of ecological and economical value of lands (Table 3) (Metod for determining …, 1997).

Monetary estimation of pre-contamination land-plot's cost (MEpc) is determined per formula:

$$MEpc = Apr \cdot MEsp$$

where

Apr is an area of agro-prospective group of soils, m^2;

MEap is monetary estimation* of a single 1m^2 of agro-prospective soils, UAH/m^2.

**NOTE: value of MEap is calculated by formula:*

$$\mathrm{MEap} = \frac{\mathrm{MEae} \cdot \mathrm{Slq}}{\mathrm{Seq}}$$

where

MEae is a monetary estimate of 1m^2 productive areas of an agricultural enterprise, UAH/m^2;

Slq is score of land quality attributed to agro-prospective group of soils of a land– plot;

Seq is score of land quality of (1 ha) productive areas of agricultural enterprise [ibid].

Table 2

Substances' danger/ hazard coefficient, S_{sf}

Degree of hazard	Substance		C_{pmh}
Extremely dangerous	Benzopyrene, Cadmium, Arsenic, Crude oil, Oil products, Mercury	Lead, Selenium, Styrol, Phenol, Fluorine, Zinc	4.0
Very dangerous	Benzol, Boron, Cobalt, Xylols, Copper, Molybdenum	Nickel, Hydrogen sulphide, Stibium, Toluene, Chrome	3.0
Mid-dangerous	Anionic substances, Surfactants, Acetal-dehyde, Barium, Sulphates	Vanadium, Tungsten, Manganese, Nitrates, Strontium, Formaldehyde	2.5
Low-dangerous	Civil-construction wastes, complex fertilizers, Sulphur, paper	Ammonium, Chlorides	1.5

Source: [ibid].

Table 3

Scope of ecological and economical value of usable lands (C_{ee})

Sanitary– guard zones around objects with underground and/or open sources of water-supply, water intakes and water-purifying facilities, buildings, water-ducts etc, and water-front defense structures on sea-shore, river-banks and around water-reservoirs	5.5
health– recreation areas	5.0
guard zones of natural-reserve and natural-protection– purpose	4.5
guard zones around specifically valuable natural objects, cultural heritage objects, hydro-meteorological stations etc.	4.0
recreational areas	4.0
historical & cultural heritage areas	4.0
specifically valuable areas	3.5
agricultural land-plots	1.0
public & civil construction blocks	1.0
forestry fund	1.0
industrial, transport, communication, power-engineering, military objects etc.	1.0

Source: [ibid].

Coefficient of soil-contamination (*Csc*) is calculated per formula*:

$$Csc = \frac{Vcm}{Tsum \cdot Apl \cdot Icc}$$

NOTE: if [Csc] is 1.0, this value is neglectible

Where

Vcm is volume of a contamination substance, m^3;

Tsum is thickness of arable layer, which is a denominate quantity-factor at determination of expenses on liquidation of contamination, depending on depth of soil percolation, and makes up 0.2 m (arable layer);

Apl is an area of contaminated land-plot, m^2;

Icc is index of correction to expenditures on liquidation of contamination consequences, depending on depth of pollution substance percolation (Table 4).

Table 4

Index of correction (Icc) on expenditures to liquidate residues of contamination, depending on depth of soil– percolation with pollution substance

In-soil percolation depth, m	I_{cc}	In-soil percolation depth, m	I_{cc}
0–0.2	0.100	0–1.2	0.049
0–0.4	0.082	0–1.4	0.044
0–0.6	0.070	0–1.6	0.040
0–0.8	0.060	0–1.8	0.037
0–1.0	0.054	0–2.0	0.033

Source: [ibid].

In default of data about volume of pollution substance (*Vps*), its amount is calculated per formula:

$$Vps = \frac{Mcs}{D\text{csc}}$$

where
Mcs is mass of contamination substance, t;
Dscs is specific density of contamination substance, t/m^3 (Table 5).

Table 5

Specific density (D_{csc}) of characteristic pollution substances

Contamination substance	Specific density, t/m^3	Contamination substance	Specific density, t/m^3	Contamination substance	Specific density, t/m^3
Azobenzol	1.2	Cobalt	8.7	Propyl spirit	0.8
Allyl spirit	0.85	Silicon	2.4	Mercury	14.193
Aluminum	2.7	Magnesium	1.7	Salicylic acid	1.44
Aniline	1.02	Manganese	7.4	Lead	11.3
Acetone	0.79	Oils	0.86-0.89	Selenium	4.8
Barium	3.5	Copper metaborate	3.859	Urea (carbamide)	1.33
Benzamìd	1.341	Arsenic	5.727	Silver	10.5
Chloride benzyl	1.103	Copper	8.9	Styrene	0.906
Cyanide benzyl	1.015	M-xylenol	1.022	Strontium	2.6
Benzyl spirit	1.045	M-xylene	0.864	Stibium	6.6
Gasoline	0.73	Molybdenum	10.2	Thallium	11.85
Benzene	0.88	Formic acid	1.22	Titan	4.5
Boron	2.3	Crude oil	0.73-1.04	Toluene	0.87
Bromine	3.1	Nickel	8.9	Uranium	18.7
Butyl spirit	0.81	Aluminum nitrate	3.5-3.9	Phenol	1.07
Vanadium	5.96	Iron nitrate	1.684	Phenolftaleine	1.3
Tungsten	19.3	Copper nitrate	2.04	Phormaldehyde	0.815
Carbon	2.3	Iron nitride	6.57	Phosgene	1.392
Glycerol	1.26	Aluminium oxide	3.01	White phosphorus	1.85
Ethyl alcohol	0.79	Mercury oxide	11.14	Arsenic fluoride	2.66
Iron	7.9	o-Xylene	0.881	Uranium	8.95

				fluoride	
Iodide izobutil	1.6	Tin	7.3	Chlorine fluoride	3.89
Bromide izobutil	1.27	Palladium	1.9	Arsenic chloride	2.163
Chloride izobutil	0.88	Diesel fuel	0.83	Chromium	7.19
Iodine	4.93	p-Xylene	0.861	Cesium	1.9
Arsenic iodide	4.39	Platinum	21.45	Zinc	7.1
Cadmium	8.65	Propyl acid	0.99	Zirconium	6.4

Source: [ibid].

Implementation of any nature-protection-purpose activities (environmental protection measures) is economically expedient, if relevant charges do not exceed a half of monetary assessment of lands. In case of obvious inexpediency, the land-soil conservation is implemented. Relevant losses are considered as calculation-criteria for payments for soil-pollution. In practice, major attention is often paid to estimation of ecological and economical losses that are always only a part (though very significant one) of total losses.

Empirical results and discussion. Methodology of determining size of the losses caused by contamination and pollution of soil resources through violation of nature-protection legislation is to establish procedures of calculations for size of compensation of losses incurred by subjects of land-management and physical persons in the course of their activities via contamination of earth with chemicals, alongside soil-pollution with industrial, homemaking and other wastes, and is mandatory for obedience all over the territory of Ukraine regardless of forms of land-ownership.

Yet the valid methodological approach allows us only to define direct damages from soils' contamination that characterize reduction of consumer-cost of land, such as means and subject of labour.

This also demands us to substantiate a methodology of determining indirect losses incurred by certain agrarian enterprises via soils' contamination.

We consider this kind of losses as internal ecological and economical losses, i.e. a self-damage caused by an enterprise to its own soils (Kucher, 2014).

A methodical approach (proposed to evaluation of internal ecological and economical losses from soils' pollution) is based on an assumption that a basic criterion of this loss is the loss of potential profit whose obtaining was the main goal of the enterprise' performance in marketing conditions.

In our opinion, an ecological and economical losses to an enterprise, caused by its soils' pollution, includes the following components:

1. Losses of profit caused by receiving less products than planned, because of shortfall in crop-yield due to contamination of soils (*Lp1*), determined by the formula:

$$Lp1 = \sum Ai \cdot \Delta Yci \cdot \Pr i$$

where

Ai is area of [i]-agrarian culture plantation, ha;

ΔYci is value of decline in yields of [i]-crop-culture (i.e., difference of productivity rates on clean and contaminated land-plots), 10^2 kg/ha;

Pri is price of sales– realization of 10^2kg [i] -type standard products, UAH.

2. Loss of income caused by deterioration in quality of agricultural products through contamination of soils (*Lp2*), calculated per formula:

$$Lp2 = \sum Ai \cdot Yc \cdot [Rpi - Rci]$$

Yic is value of yield of [i]-crop-culture on contaminated land, 10^2 kg/ha;

Rpi is the price of 10^2 kg of [i]-type standard products (planted on pure-soil land-plot), UAH;

Rci is the price of sales– realization of 10^2 kg of [i]-type contaminated products (from polluted land-plot), UAH;

3. Losses of enterprise's profits (*Lp3*) due to increase of cost price of production due to crop yield reduction caused by soil contamination (at the same semi-fixed costs (*Csf*), calculated per formula:

$$Lp3 = \sum Ai \cdot Yic \cdot \left[\left(\frac{Vsfe}{Rpi} + Vsve \right) - \left(\frac{Vsfe}{Rci} + Vsve \right) \right]$$

where

Rci is value of yield-productivity of [i]-ï crop-culture on contaminated land, 10^2kg/ha;

Rpi is a value of [i]-crop-culture productivity on clean land, 10^2kg/ ha;

Vsfe is value of semi-fixed expenditures on growing a unit of [i]-culture product, UAH/10^2kg;

Vsve is value of semi-variable expenditures on growing a unit of [i]-culture product, UAH/10^2kg.

Hence, total value of internal ecological and economical loss by an enterprise due to contamination of soils (*LTcin*) is determined by summarization of above-considered and other potential economic losses (*Ln*) per formula:

$$LTcin = (Lp1) + (Lp2) + (Lp3) + \ldots + (Ln)$$

Thus, the above-considered scientifically-methodological approach to determination of internal ecological and economical loss from contamination of soils provides a comparison of indexes of the use of the landed resources of enterprise in a contaminated and conditionally clean environment, that, in turn, is base on idea that the productivity of agricultural crop-cultures, as well as quality of products on contaminated soils is lower than on unpolluted soils.

Factor of feed-back between heavy metal-contents in soil and crop-yield-productivity is accounted for, e.g., by Romanian researchers Raută, Cârstea (1986) in their classification for degrees of soil-contamination (Melnychuk et al, 2004).

Table 6

Decrease in productivity and (or) deterioration of quality depending on degree of soil contamination

Degree of soil contamination	Decrease in yield and (or) deterioration of quality,%
Virtually unspoiled	<5
Slightly polluted	6–10
Moderately polluted	11–25
Heavily contaminated	26–50
Severely contaminated	51–75
Excessively contaminated	>75

It should be noted that due to many studies, decrease of crop-yield by ~15–20 % is considered as its ultimate threshold-level, since this is accompanied by such a hygienically critical bio-circumstance as heavy metals' concentration above MAC norms in a part of food-plants.

Let us illustrate an application of above-considered scientific & methodical approach to determination of internal ecological and economical loss from contamination of soils on such a conditional example that, in its essence, is typical to present-day realities, where:

– productivity of winter wheat on a clean land– plot is 50 kg-10^2/ha,

– productivity of winter wheat on a mid-polluted plot is 20 % less,

– costs of production of winter wheat on a clean land-plot are 6000 USD/ha;

– share of semi-fixed expenses makes up 70 %;

– price of standard produce sale makes up 250 UAH/10^2 kg; while same of polluted-soil produce is 220 UAH/10^2 kg.

Results of these calculations (Table 7) have shown that internal ecological and economical loss from contamination of enterprise's soils, at growing winter wheat makes up 4140 UAH/ha, whereby the most part (60.4 %) of the loss-structure constitute losses of profit, due to obtaining less products than expected as a result of yield– shortage; whereas other losses make up ~ 20 % each.

Table 7

Calculation of internal ecological and economical losses due to soils' contamination, from example of winter wheat growing– practice

Index	Pure soil plot	Polluted soil plot	Loss of profit, UAH/ ha
Crop-yield, 10^2 kg/ha	50	40	x
Semi-fixed expenditures, UAH/ha	4,200	4,200	x
Semi-variable expenditures, UAH/10^2 kg	36	36	x
Expenditures, UAH/ ha	6,000	5,640	x
Price of produce' sale, UAH/10^2 kg	250	230	x
Cost of yield at price of standard (pure soil) produce' sale, UAH/ha	12,500	10,000	x
Losses of profit due to obtaining less products than expected as result of yield– shortage from soil– pollution (L_{p1}), UAH/ha			2,500
Cost of yield from polluted soils at variable prices of produce– sale, UAH/ha	10,000	9,200	x
Losses of profit due to produce quality deterioration, due to soils' pollution (L_{p2}), UAH/ha			800
Operating profit at equal rate of semi-fixed expenses, UAH/ha	5,840	5,000	x
Losses of enterprise's profits (L_{p3}) due to increase of cost price of production due to crop yield reduction caused by soil contamination (at the same semi-fixed costs (C_{sf}), UAH/ha			840
Internal ecological and economical loss due to enterprise's soil– pollution while growing the winter– wheat, UAH/ha			4,140

Source: author's calculations

Conclusions. Thus, using analysis of the present-day status of soils' contamination and valid methodology of determining damage from soil pollution, a statement can be made that losses from soil contamination can be direct and indirect ones. Direct damages, on the total, characterize reduction of consumer's cost of land as a tool and object of labour. Indirect losses are predefined by decline in yield of agricultural crop-cultures grown on contaminated soils, worsened quality of products, increase in unit-cost of contaminated-produce through increased per cent of semi-fixed expenditures due to reduced crop– productivity. Thus, basic criteria to determinate internal ecological and economical damage from soils' contamination are losses of profit.

Major constituents of internal ecological and economical loss incurred by an agrarian enterprise are: losses of profit due to obtaining less products than expected, because of shortage of crop-yield through contamination of soils; losses of profit due to deteriorated quality of agricultural produce through contamination of soils; losses of enterprise's profits due to increase of product's unit-cost through declined labour productivity, predefined by reduction of crop-yield productivity at the same rates of semi-fixed expenditures.

Such the complex science & methodical approach to determination of loss on micro-economical level can help one completely identify losses of agricultural production, caused by contamination of soils and strengthening one's attention hereto, possibly, alongside upgrade of to pollution– mongers' liabilities for quality of soils and products obtained hereof.

REFERENCES

1. Baliuk, S. et al. (2010). National Report on the state of soil fertility Ukraine [*Natsional'na dopovid' pro stan rodyuchosti gruntiv Ukrayiny*]. Kyiv, 112 p.
2. Dobryak, D. (2009). Classification of agricultural land as a scientific premise of ecologically use [*Klasyfikatsiya sil's'kohospodars'kykh zemel' yak naukova peredumova yikh ekolohohobezpechnoho vykorystannya*], Kyiv, 464 p.
3. On approval Method for determining the amount of damage caused by pollution and contamination of land resources through violations of environmental laws [Pro zatverdzhennya Metodyky vyznachennya rozmiriv shkody, zumovlenoyi zabrudnennyam i zasmichennyam zemel'nykh resursiv cherez porushennya pryrodookhoronnoho zakonodavstva]. *Order of the Ministry of Environmental Protection and Nuclear Safety of Ukraine* № 171 dated October 27, 1997, available at: http://zakon2.rada.gov.ua/laws/show/z0285-98.
4. Khvorost, O. (2005). Organizational and economic foundations of environmental consideration in assessing soil quality agricultural land [*Orhanizatsiyno-ekonomichni osnovy vrakhuvannya ekolohichnoyi yakosti gruntiv v otsintsi sil's'kohospodars'kykh zemel'*]. Sumy, 18 p.
5. Kolpakova, O. (2010). Scientific and methodological approaches to the assessment of the damage caused by disturbed and contaminated land [Nauchno-metodicheskie podkhody k otsenke ushcherba ot narushennykh i zagryaznennykh zemel'], available at: www.kgau.ru/img/konferenc/2010/a9.doc.
6. Kucher, L. and Kucher, A (2014). Environmental Economics [*Ekonomika pryrodokorystuvannya*]. Kharkiv, 264 p.
7. Melnychuk, D. et al. (2004). Soil quality and modern fertilization strategies. Kyiv, 488 p.
8. Naumenko, A. (2014). The content of pollutants in soils for agricultural purposes [Vmist zabrudnyuvachiv u gruntakh sil's'kohospodars'koho pryznachennya]. *Agrochemical Service of Ukraine: the role and place of agriculture in the state*, Kyiv, pp. 277-280.
9. Ratoshnyuk, T. (2005). Organizational and economic trends greening of contaminated lands [Orhanizatsiyno-ekonomichni napryamy ekolohizatsiyi radioaktyvno zabrudnenykh zemel']. Kyiv, 19 p.
10. Sytina, O. (2010). The migration of heavy metals in the soil-plant man-made landscapes (for example, Lugansk) [Mihratsiya vazhkykh metaliv u systemi grunt-roslyna tekhnohennykh landshaftiv (na prykladi m. Luhans'ka)]. Kharkiv, 20 p.
11. Tarariko, O. (2011). Protection and restoration of degraded soils under the project of European Union soil [Okhorona ta vidnovlennya dehradovanykh gruntiv vidpovidno proektu gruntovoyi dyrektyvy Yevrosoyuzu]. *Visnyk ahrarnoyi nauky*, (5), pp. 9–13.

Рецензія: д.е.н., проф. Ульянченко О. В.

Reviewed: Dr., Prof. Ulyanchenko O. V.

Received: April, 2015

1st Revision: April, 2015

Accepted: May, 2015