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Management of Soil Fertility Based on Improvement Methodological Approach to Evaluation of Arable Land: Case of Ukraine

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Abstract:

The article deals with the issues of the management of soil fertility based on the application of two methodological approaches to arable land normative monetary evaluation (NME). These researches have been conducted on the results of economic activity of the Poltava region agrarian enterprises of Ukraine. The differences between the two methodological approaches to the calculation of the NME of arable land in the Poltava region are shown. These approaches, namely, on cereals and on five agricultural crops, presuppose the calculation of the NME of arable land on the basis of capitalized rent income. The approaches are similar to the Ricardian model of land pricing, which is being widely used with its various modifications in different countries of the world. Our own methodology for analyzing the approaches to the NME of arable land, based on the developed stochastic harmonic models (SHM), is represented in the article.

The application of the two methodological approaches to the calculation of the NME of arable land in the Poltava region of Ukraine, which presupposes its consideration on the data concerning cereals and five agricultural crops, revealed essential differences between them in the course of the conducted economic-mathematical analysis. It has been found that the methodological approach on cereals has a lower level of the explanatory attribute variation (of humus content in soils) compared to five agricultural crops. That finally leads to the essential difference in the optimum values of the arable land NME at increasing humus content in soils. Thus, the optimum value of the arable land NME within the second methodological approach is twice as much as within the first one. The measures to improve the arable land NME, based on the data of the Poltava region and can be successfully used all over

Ukraine, as well as in many countries of the world. The advantages of applying the methodological approach based on five agricultural crops were studied and grounded in the current research. This approach proves the dependence of arable land NME on the humus content and enables higher objectivity for effective and rational management of soil fertility.

Keywords: management of soil fertility; innovation methodological approach; economic land pricing; normative monetary evaluation of arable land; humus; soil quality; stochastic harmonic models (SHM).

JEL Classification: Q15; Q24; C12; C51.

Introduction

Increasing the efficiency of land resources use is one of the foreground tasks of the agrarian policy of Ukraine. In this context, land resources or factor of production, as they are called in the Western economic science, play a remarkable role in the economic development of the agrarian sector, the agricultural and food markets in particular. Moreover, land is a complex and the main factor of production, since it combines the resource and subject of labor and is often considered not only from the economic point of view, but certain issues concerning its rational use, formation of the balanced system of natural resources use and sustainable development increasingly come to the sphere of public interest. Thus, resolving the issues connected with environmental problems of land use is an inherent demand nowadays. One of the ways to meet it, according to Palenichak (2013) should be the formation of an effective economic mechanism for stimulating rational agricultural land use, including application of financial sanctions. Furthermore, it is important, as stated by Gutorov (2014), that the market mechanism of the economic management is not able either to provide rational, ecologically safe use of nature resources or to prevent harmful influence on nature, until the latter is directly associated with the profitability of the producer's activity. In this case the problem is worsened due to the fact, that there are significant contradictions between the economic and environmental components, where, as emphasized by Artyushok (2014), it is associated first of all with the constant change of the system of ecological and economic needs and the inconsistency of economic and environmental interests and priorities at the macroeconomic level.

The diversity issues of soil fertility management on the base transition matrices and crop rotation showed by Nuppenau (2018). However, a special place is taken by choosing the approach when evaluating the reproduction of soil fertility. In this context, it is necessary to apply more wide a tool as possible, such as integrated soil fertility management, which is considered by Batijo *et al.* (2018). Innovative soil management practices and sustainable soil management is among the most topical academic and practical issues (Helming *et al.* 2018; Towhid 2018; Baritz 2018; Vargas*et al.* 2018).

Taking into account the fact, that as a result of economic turnover land brings income, which is nothing else but the rent by its socioeconomic origin, the land serves as an economic basis and a spatial object at the same time. Consequently, it is characterized by economic and physical parameters, namely, by such a complex term as "quality". However, it is extremely difficult to ensure rational land management without developing and implementing effective methodological and regulatory tools for land economic appraisal. Performing the economic appraisal of land is important also considering the fact that socio-economic relations concerning objective distribution of the rent are to be regulated, i.e., economic land appraisal simultaneously reflects the object of appraisal both as a natural resource, and as the main means of production in agriculture, and it grounds the reason for performing the normative monetary evaluation of agricultural land as well.

The economic appraisal of land is one of the main kinds of land evaluation, and lays the legal framework in this scope, provided by The law of Ukraine "On Land Evaluation" (2003). But firstly, its essential role, in absence of a full value land market, is related to the fact that it serves as the basis for performing normative monetary evaluation of land, the latter being the basis for accounting the rent for state and communal property, which is set forth by the corresponding laws: the law of Ukraine "On Land Lease" (1998) and the Land Code of Ukraine (2001).

In general, the World Resources Institute plays an important role in managing soil fertility in highly-developed economies of different countries in the world. However, in post-Soviet countries this trend has acquired specific forms. Firstly, these reasons are connected with the absence of market conditions for land pricing. Secondly, it's important to have an economic indicator for evaluating the state of soil fertility management.

1. Literature Review

Main Issue

In general, the normative monetary evaluation of the agricultural lands is closely linked to the issue of the rent as well as to the calculation of the capitalized rent income for every agro-industrial group of soils. Therefore, an important stage in the study of rent formation is its marginal increment or the productivity of land assets in the economic turnover.

For Point of View the Classical and Marginalist School of Economy - Historical Excurse

Smith (1962), a representative of the English classical economy school, stated, that land rent forms one third of the price of the majority of goods. Though the founder of the school Petti (1940) considered that land rent forms one fourth of the product as sometimes the rent used to be replaced with one fourth of the goods produced on the land. So, we can see that land rent may be different, as it is dependent on the approach to evaluation and has a tendency to vary with time. In other words, it is a figure without a constant value, which is changeable depending on socio-economic conditions of a certain country. Moreover, for monetary evaluation of land area or a tract multiplicity of annual rent payment or the volume of its capitalization are of particular importance.

This parameter is also characterized by variability and may discern significantly in different countries. Referring to this problem Petti (1940) stated, that the sum of annual rent should equal to the average lifetime of three representatives of different generations (grandfather, his son and grandson), underlining, that in England it made twenty-one years. In such way the scientist equated the value of the land to 21 years of annual rent capitalization. At the same time he noted, that the value can approximate to thirty annual rents as a result of more secure rights for land, higher population density and possibly a clearer idea about the value and lifetimes of three people.

A significant contribution to the land rent theory was made by another representative of the same economy school, Richardo (1955), which served as a basis of practical attempts of defining the volume of annual land rent. According to him, “rent is that portion of the produce of earth which is paid to the landlord for the use of the original and indestructible powers of the soil”. However, a representative of Lausanne School of Marginalism, Walras (2000) subjected to thorough analysis the scientific ideas, following from the richardian land rent theory, with their check having been based on quantitative methods of land rent calculation.

Issues to Econometric Models and their Accepted Conditions

Nowadays the principles of marginal product are widely used in econometric models. The assessment of the influence of land as a production factor and the extent of its elasticity are researched in scientific works by Petrick and Kloss (Kloss 2013), different types of such functions being considered. It is revealed, that with its different production functions in many countries of EU, land as a factor mostly has a positive effect, which in its absolute value of elasticity coefficient is more influential than the fixed capital.

Meanwhile, the issue of the evaluation of different production functions remains important, as it was stated by Griliches and Mairesse (1998). Since it occurs due to the problems of correspondence of the production functions to the generally accepted conditions resulting from their stochastic origin (the Gauss–Markov theorem), especially, associated with the availability of collinearity, which was brought into focus by Bond and Söderbom (2007), and also described in detail by Ackerberg (2005).

Cobb-Douglas Production Function at Management Land Resources and Soil Fertility

It should be noted, that the change of the specification of production functions provides more opportunities for the investigation of the main means of agrarian production – the land. At the same time, the influence of the latter on the formation of production volumes allows to take into account the quality of land as one of the important criteria of its economic assessment. Thus, Lichtenberg (1989) not only considers the Cobb–Douglas production function specification from the viewpoint of division into two factors, one of which is the land, and the other provides for a part of aggregated cost of capital, but also introduces the parameter of the land quality, ranging from 0 to 1, into this function. Here, the minimum quality of land takes the value “0”, and the maximum quality – “1”. Moreover, Feichtinger and Salhofer (2013) apply the transformation of the Cobb–Douglas production function to investigate the influence of the common agricultural policy as well as of the heterogeneous quality of land on the value of the rent and its distribution in the EU countries.

Using Model of Constant Absolute Risk Aversion (CARA)

Thus, the opportunities for using the production function are ample enough, but at the same time, it remains beyond the bounds of the formation of prices for agricultural land from their direct annual rent. In this case, the econometric approach is being applied, where the Ricardian model of pricing serves as the theoretical basis. Taking into account the government payments to farmers and a number of other factors, Just and Miranowski (1993) proposed a completely new model of land pricing. Their complex equation is called Constant Absolute Risk Aversion (CARA), according to which the real price of land (p) is being determined starting from the period “t”.

Using Present Value Model (PVM)

Despite different approaches to modeling land prices the Present Value Model (PVM) is the most widely spread nowadays. This model originates from the Ricardian theory of land rent capitalization. At the same time, its various modifications or the proposals as to the calculation of land prices can be found in scientific literature. So, Weersink *et al.* (1999, 431) and some other scienticts proposed two indices of payments for land: one from the products (P_t) and the other – government payments (G_t), which total up to the rents (R_t). According to the latter model Ay and Latruffe (2013) proposed to introduce changes, singling out two main channels of payments for land. The first channel influences the present evaluation of land, obtained according to PVM or $f(R_{t+i})$. The second channel of payments, in its turn, directly influences the price of land or "g" and it is the function, not depending on payments for land (rents). The component as to the information support of this model also remains essential, which is described in detail in the study by Ay and Latruffe (2017).

Using spatial autoregressive model (SARAR)

In another research, Latruffe, Minvai and Salanié (2013) applied a generally accepted approach to land pricing, connected with capitalization of rents, including payments in form of state dotation. The main components of this model of land pricing originate from an earlier model proposed by Weersink *et al.* (1999), however, the spatial autoregressive model (SARAR) serves as the basis for calculations. At the same time, the authors widely modify the econometric model of land pricing, depending on many important factors, namely, on changing the environment in the region of Brittany, France.

Improve (Modification) Present Value Model (PVM) and using Basic Value of Arable Land (BVAL)

The question of rent capitalization within standard approaches presupposing the PVM model application is subjected to a number of researches worldwide. The usual model of rent capitalization as the only source of payment is studied by Kirwan (2009).

Besides, another possible variant of the land rent capitalization according to PVM, when the government payments for agriculture support are not considered separately, and the rent is viewed only as an annual amount of payment for the use of a land plot. Thus, Bradáčová (2007) proposes to calculate the land annual rent (LAR) as the difference between the value of the standard output, obtained from the land plot and the sum of the amount of the standard value of the incurred costs of the standard output and the standard profit at the level of 10 %. In this case, the estimated price of arable land includes the important component in the PVM – the basic value of arable land (BVAL).

Normative Monetary Evaluation of Agricultural Land (NME): Case of Ukraine

In Ukraine, the methodology of the normative monetary evaluation of agricultural land based on the rental income, calculated on cereal crops, was valid before 2017. However, this methodological approach had certain disadvantages and needed some improvement, what was stated by many scientists, by Fedorov (2009) in particular. Therefore, one of the variations for improving the NME of land was proposed (Martin 2013), the scientist accepted the methodological approach, which presupposed calculating the standard value of the capitalized rent income as its basis. At present, this methodological approach is applied in calculating the normative monetary value of land according to the adopted Decree of the Cabinet of Ministers of Ukraine "On Approval of the Methodology of Normative Monetary Evaluation of Agricultural Land" (Decree of the Cabinet of Ministers of Ukraine No. 831 dated November 16, 2016).

In addition to the above-mentioned methodological approaches to the economic evaluation of agricultural lands, other methods of evaluation of the real estate objects are being used more and more widely in world practice. It's especially important in determining the value of an object for taxation, and therefore land as an object of taxation is not an exception. In general, such methodological approach is based on a mass valuation of the object under consideration. As stated by Ibatullin and Stepenko (2014), the mass evaluation is a systematic estimation (in monetary figures) of groups of the real estate objects on a certain date, using standard procedures and statistical analysis.

It should be mentioned that mass land evaluation in terms of agriculture is an effective tool for performing fiscal policy as well as for land purchase and sale operations. But together with it innovation methodological approaches of effective and rational soil fertility regulation should be introduced in order to take into account such important indicator as NME.

2. Methodology

Methodological Approach

The scientific researches show, that the differences between the NME of arable land, calculated by two approaches (on cereals and on five agricultural crops) are significant, which is also illustrated by positioning on the trigonometric circle (Ulko 2018). As one the reasons for it, the quality of land should be taken into account, to be more exact, the bonitet of arable land, which differentiates the NME, obtained by different methods, as agricultural crops react somewhat differently to it. Therefore, it is important in this case to consider one of the characteristic parameters of the influence of land quality on their NME in more detail.

The interdependence between the content of humus in soils and the value of the normative monetary evaluation of arable land, calculated on cereals in the Poltava region of Ukraine according to the sinusoidal stochastic specification of the model, is given in general equation (1):

$$NME(cereals)=\frac{1}{5}\cdot à\cdot\sin(\frac{b^3}{4}\cdot X)+c-d\cdot\sin(b\cdot X)+e \quad (1)$$

where a,b,c,d – coefficients (regressors) of the stochastic model; X – the content of humus in soils in the Poltava region of Ukraine, %; e – remainder (an error of approximation) caused between the empirical (actual) and the theoretical values of the dependent (endogenous) variable.

The expanded harmonic sequence of the sinusoidal function has the following record (2), according to which its derivative (3) was obtained:

$$\hat{Y}(\overline{NME(cereals)})=\underbrace{15456,6\cdot\sin(-3,377\cdot X)}_{1^{st}-harmonic}+24901,2+\underbrace{8664,1\cdot\sin(-2,3815\cdot X)}_{2^{nd}-harmonic} \quad (2)$$

$$\frac{d(\overline{NME(c)})}{dX}=f'(\overline{NME(c)})=\left(\frac{1}{5}\cdot 30913,2\cdot\sin(\frac{-2,3815^3}{4}\cdot X)+24901,2-(-8664,1)\sin(-2,3815\cdot X)\right)'=$$

$$=-20876,9\cdot\cos(3,377\cdot X)-20633,6\cdot\cos(2,3815\cdot X). \quad (3)$$

Improving the qualitative characteristics of the model through changes in its specification is important in view of the fact, that it would both satisfy all requirements in accordance with the Gauss–Markov theorem, and was endowed with predictive capabilities with minimizing the error (offset) of the dependent variable. So, the worked out specification of the model of the arable land NME on cereals, containing harmonics, reflects nonlinear nature of the influence of the humus content on the normative monetary evaluation of arable land. It is clearly seen in Figure 1, that the theoretical line of the NME of arable land on cereals has a wavelike manifestation, containing two completely different downs and ups. Certainly, the nature of this fluctuation also has a specific economic content, resulting from the methodological approach itself. That is, all else being equal ("Ceteris paribus" – lat.), the NME of arable land on cereals in the Poltava region of Ukraine reaches a high level also at the low content of humus in soils as opposed to the ones with high content. Thus, we may assert with some certainty, that this methodological approach minimizes the influence of the quality of land (humus content) on its monetary evaluation.

The interdependence between the humus content in soils and the value of the normative monetary evaluation of arable land, calculated on five agricultural crops (winter wheat, spring barley, maize for grain, sunflower and sugar beet) in the Poltava region of Ukraine according to the combined stochastic specification of the model, is given in general equation (4):

$$NME(5)=15325,6+5967,9\cdot X+\frac{1}{2}\cdot à\cdot\sin(\frac{b}{3}\cdot X)-d\cdot\sin(b\cdot X)+e \quad (4)$$

The expanded harmonic sequence of the above-mentioned function has the following record 5, according to which its derivative 6 was obtained:

$$\hat{Y}(\overline{NME(5)})=15325,6+5967,9\cdot X+\underbrace{1129,7\cdot\sin(-4,246\cdot X)}_{1^{st}-harmonic}-\underbrace{886,7\cdot\sin(-12,739\cdot X)}_{2^{nd}-harmonic} \quad (5)$$

$$\frac{d(\overline{NME(5)})}{dX}=f'(\overline{NME(5)})=\left(15325,6+5967,9\cdot X+\frac{1}{2}\cdot 2259,3\cdot\sin(\frac{-12,739}{3}\cdot X)-886,7\cdot\sin(-12,739\cdot X)\right)'=$$

$$=5967,9-4796,7\cdot\cos(4,246\cdot X)+11295,7\cdot\cos(12,739\cdot X). \quad (6)$$

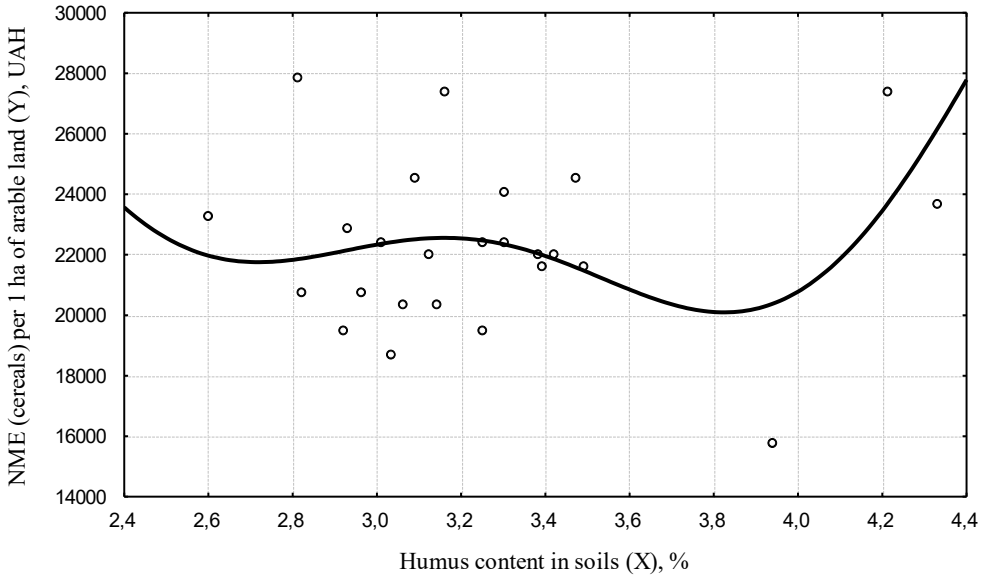
Data and Analysis

The study is based on a survey of economic activities of agricultural enterprises of administrative districts of the Poltava region of Ukraine. The territory of the region has dynamically changing relief and soils characteristics. Financial-economic results of the agricultural enterprises in this region approximate to the data on the soils quality. Analytical data on the humus content in the Poltava region are represented by the results of agrochemical analysis carried out during the Ukrainian IX tour.

3. Empirical Results and Discussion

The humus content, the influence of which is shown in Figures 1 and 2, stands for such parameter.

Figure 1. The dependence of the normative monetary evaluation of arable land on cereals on the humus content in soils in the Poltava region (Ukraine), UAH/ha



Source: Prepared by the author based on own calculations on the statistical data in the Poltava region of Ukraine (Main department of statistics of the Poltava region, 2011 and 2014).

As seen from Figure 1, the line of theoretical value of the NME of arable land on cereals in the Poltava region of Ukraine does not have a clear upward trend depending on increasing the value of the humus content in soils. Meanwhile, this line rises sharply enough only in the range of high values of the humus content. Hence, the heterogeneous nature of the influence of the humus content on the NME of arable land on cereals requires the development of the model that would deviate from the linear or simplified designing a theoretical series of the monetary evaluation of land according to its qualitative components. In Figure 1, the theoretical line of the NME of arable land on cereals is a reflection of the sinusoidal function with two harmonics (the analytical record is given in equation 2), which finally enabled increasing the approximation value on the actual data.

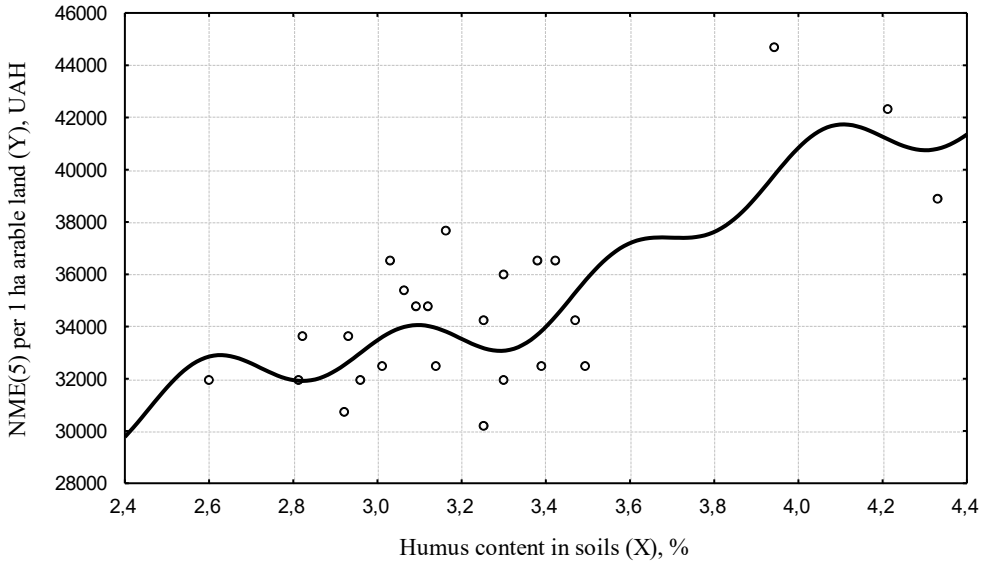
However, a completely different situation is to be observed within the methodological approach, when the NME of arable land is calculated on five agricultural crops (Figure 2). In this case, the content of humus in soils affects the formation of the NME of arable land on five agricultural crops substantially, and therefore, it depends on one of many parameters of the quality of agricultural lands.

The theoretical line, shown in Figure 2, is also a reflection of a sinusoidal function with two harmonics (the analytical record is given on equation (5), but in distinction from the previous model (equation 2) with a certain change of the specification, it simultaneously contains a linear component. So, the general characteristics of this stochastic harmonic model have improved considerably (Table 1).

The stochastic harmonic models of the NME of arable land within the two methodological approaches are adequate, as the calculated values of the F-distribution (the Fisher–Snedecor distribution) are higher than their tabular values at the significance of α=0.05 and at the corresponding degrees of freedom. However, the obtained coefficients of the models did not fully satisfy the requirement for their reliability according to the Student's t-Test. This is especially true for the NME of arable land on cereals, where the two coefficients, namely, "*a"* and "*d"*, which are harmonic coefficients on the calculated value of *t*-statistics, are somewhat lower than their tabular values at

the significance of α=0.05. At the same time, all the coefficients for the two stochastic harmonic models have a probability of distribution higher than 0.9, despite the general requirements for the significance of α=0.05.

Figure 2. The dependence of the normative monetary evaluation of arable land on five agricultural crops on the humus content in soils in the Poltava region (Ukraine), UAH/ha



Source: Prepared by the author based on own calculations on the statistical data in the Poltava region of Ukraine (Main department of statistics of the Poltava region 2011 and 2014).

Taking into account this remark concerning the reliability of the obtained coefficients of stochastic harmonic models of the NME of arable land on the two methodological approaches, they can be used to improve the set of variables (factors) in connection with the permissible values of the obtained average approximation errors. The latter makes 8.7 % for the NME of arable land on cereals, and the one on five agricultural crops – 5.1 %.

Table 1. The main characteristics of the stochastic harmonic models of the NME of arable land on the groups of agricultural crops in the Poltava region of Ukraine

Explanatory variables (exogenous factors)	Parameters of the model and their reliability on:				Correlation coefficient	Coefficient of determination, %	Adequacy criterion (F-factor)	Average approximation error, %
	a	b	c	d				
I. Normative monetary evaluation of arable land on cereals (NME(c)), UAH/ha								
Humus content in soils, %	30,913.2* (1.35)	-2.38* (-127.63)	24,901.2* (12.20)	-8,664.1* (-1.42)	0.385	14.8	3.65**	8.7
II. Normative monetary evaluation of arable land on five agricultural crops (NME(5)), UAH/ha								
Humus content in soils, %	2,259.3* (1.79)	-12.739* (-66.49)	x	886.7* (1.38)	0.775	60.1	31.58**	5.1

Source: Prepared by the author based on own calculations on the statistical data in the Poltava region of Ukraine (Main department of statistics of the Poltava region 2011 and 2014).

Notes: The figures in parentheses (.) are calculated values of reliability according to the Student's t-Test. The critical (tabular) value of t-statistics at the significance of α = 0.05 and degrees of freedom of $df=24$ is 1.711. Asterisks * the coefficients of regression are given, and ** the calculated values at the F-distribution. The critical (tabular) value of the Fisher–Snedecor distribution at the significance of α = 0.05 and degrees of freedom of $df_1=2$; $df_2=22$ is 3.44, and at $df_1 / df_2=3/21$ – 3.07.

It should be noted, that the methodological approaches to the NME of arable land depending on the content of humus have different degrees of connection. The weakest (0.385) correlation was found on cereal crops, and the connection on five agricultural crops was strong (0.775). According to the coefficients of determination, the second methodological approach is significant for the formation of the NME of arable land depending on the content of humus, within which the variation of the NME of arable land by 60.1 % is to be explained by the content of

humus, while the variation within the first methodological approach is only 14.8 %, and all the rest are the factors, not taken into account.

Thus, the application of various methodological approaches, which in this case take into account different number of the objects of the rent income (agricultural crops), has quite different consequences as to the formation of the NME of arable land, and as to dependence on the humus content in it. The methodological approach only on cereals shows that the content of humus in soils does not play an important role and, in general, the quality of land has no significant influence on the formation of its monetary evaluation. However, the situation with land quality in the case of five agricultural crops drastically changes as improving and facilitates a more objective monetary evaluation of land. One of the reasons, leading to such a state, is some distortion of cropping pattern, and therefore, the method associated with the change of the number of agricultural crops is economically feasible.

Based on the obtained derived functions within the two methodical approaches to the calculation of the NME of arable land, namely, on cereals equation (3) and on five agricultural crops equation (6), the optimum values, shown in Table 2, were calculated for them.

As we see from the Table 2, the figures of the optimum values have an essential difference between the two methodical approaches to the NME of arable land. At the same time, the NME of arable land on five agricultural crops clearly exceeds the value, obtained on cereal crops. Along with it, the optimum value of the NME of arable land on five agricultural crops can be achieved at higher values of the humus content, than it results from the methodological approach on cereals.

Table 2. Figures of optimum values of factors in the local and global regions of the appropriate stochastic harmonic models of the NME on the groups of agricultural crops in the Poltava region of Ukraine

Explanatory variables (exogenous factors)	In the range of minimum values of exogenous factors (min)		In the range of numerical values {min; max} optimum (global optimum)		In the range of maximum values of exogenous factors (max)	
	X_1	Y_1	X_o	Y_o	X_2	Y_2
I. Normative monetary evaluation of arable land on cereals (NME (cereals)), UAH/ha						
Humus content in soils, %	2.72	21 687	3.18	22 533	3.83	20 190
II. Normative monetary evaluation of arable land on five agricultural crops (NME(5)), UAH/ha						
Humus content in soils, %	2.63	32 905	2.82	31 917	4.30	40 747

Source: Prepared by the author based on own calculations on the statistical data in the Poltava region of Ukraine (Main department of statistics of the Poltava region 2011 and 2014).

Moreover, one of the differences on cereals lies in the fact that the optimum value of the NME of arable land at the maximum values of the humus content is less than the one at its low values. Thus, it is of an inefficient nature of the economic use of arable land, which is evidenced by the low level of its monetary value. Consequently, the optimum value of the NME of arable land in the Poltava region of Ukraine makes 22 533 UAH/ha, with the content of humus in soils of 3.18 %. It should be noted, that the analysis of the NME of arable land is carried out according to the data in the most stable period, that is, before the beginning of a sharp devaluation of the national currency (hryvnia). Proceeding from this, in order to provide their optimum values for the present moment (01.01.2018), one should multiply it by the cumulative value of the annual indexation coefficients of 2014 – by 1.249 and of 2015 – by 1.2.

The optimum value of the NME of arable land on five agricultural crops is to be achieved at the content of humus in soils of 2.82 %, and the value itself is 31 917 UAH/ha. Moreover, the difference between the second methodological approach from the first one is of great importance, as increasing the humus content in soils leads to the increase of the monetary evaluation of arable land. Thus, at the maximum values of the humus content in the Poltava region of Ukraine, which is 4.3 %, the optimum value of the NME of arable land makes 40 747 UAH/ha. The results of the calculations prove the essential difference between the methodological approaches, especially, in the use of the soils with high content of humus. In such case, the optimum value of the NME of arable land on five agricultural crops is twice as much as the one on cereals.

Thus, the use of the first methodological approach to the calculation of the normative monetary evaluation of arable land gives “poor results” and false conclusions in soil fertility management. Unlike the first one, the second methodological approach improves the quality characteristics of the management system and allows to avoid the curvature of values (indicators), and the normative monetary evaluation itself gains more statistic reliability.

Conclusion

The study deals with innovation management of soil fertility based on the application of two methodological approaches to normative monetary evaluation of arable land, clear difference of results between the approaches having been defined. The research was conducted on the results of economic activity of agrarian enterprises in the Poltava region of Ukraine.

The paper reveals essential difference between the two methodological approaches to the NME of arable land. Handling the index of the humus content in soils as one of many parameters of land quality assessment in the Poltava region of Ukraine proves the advantages of the second methodological approach, within which the objects of the rent income formation are five agricultural crops, such as: winter wheat, spring barley, maize for grain, sunflower and sugar beet. The application of the second methodological approach makes the NME of arable land dependent on the content of humus (variation of the NME of arable land by 60.1 % is caused by the variation of the content of humus), as the variation of the NME of arable land on cereals is explained by the investigated factor only by 14.8 %. Improvement undertaken has shown that the value of the NME of arable land on five agricultural crops exceeds the value, obtained on cereals, and such increase doubles under conditions of the high humus content in soils.

So, improving the methodology of normative monetary evaluation of arable land (NME) is an economic indicator of soil quality changes. Therefore, it is necessary to apply such methodological approaches that would best link the results of economic activity to the quality of land. The results of the research confirmed that the humus content in soils is an essential qualitative characteristics, which positively influences at introducing changes in the valid methodology of the normative monetary evaluation of arable land. At the same time, the application of the second methodological approach to the management of soil fertility is of primary importance, since it has a protective orientation of soils from loss of their quality (fertility).

Further scientific investigations should be direxted to the study (consideration) of other parameters of land quality and their influence on the formation of the NME of (arable) land. In this context, it is necessary to continue determining (calculating) the optimum values of quality indices and of the NME of (arable) land by expanding the application area of the stochastic harmonic models (SHM).

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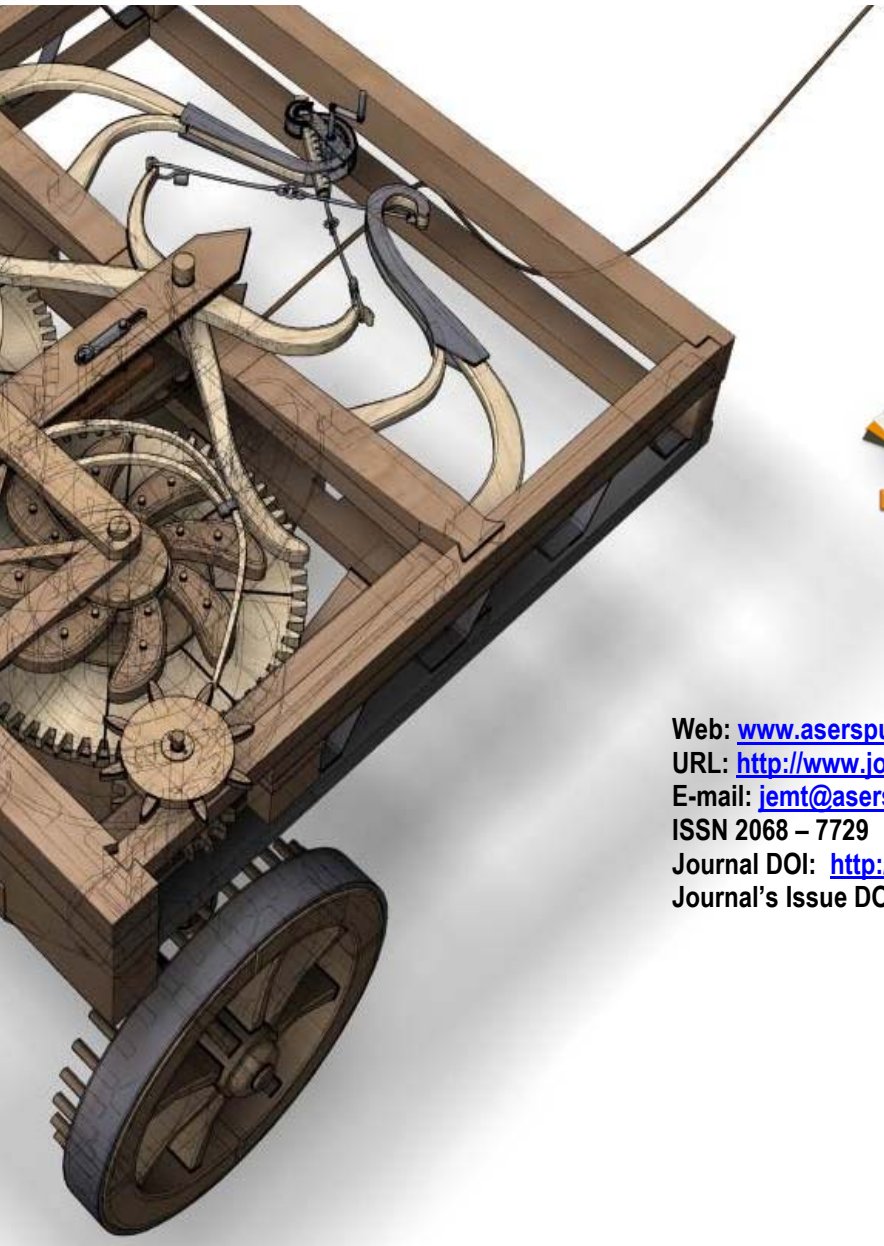

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