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Iryna Koshkalda, Anastasiy Suska, Tetiana Anopriienko and Alona Riasnianska

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Iryna Koshkalda[1,*[0000-0003-4855-8890]], Anastasiy Suska[2 [0000-0002-7465-1776]], Tetiana Anopriienko[3 [0000-0001-7143-0591]], Alona Riasnianska[4 [0000-0002-7362-2990]]

1 V.V. Dokuchayev Kharkiv National Agrarian University, Kharkiv, Ukraine
iryna.koshkalda@springer.com
2. Petro Vasylenko Kharkiv National Technical University of Agriculture, Kharkiv, Ukraine
n.suscka@gmail.com
3 O.M. Beketov Kharkiv National University of Urban Economy, Kharkiv, Ukraine
tetiana.anopriienko@springer.com
4 Petro Vasylenko Kharkiv National Technical University of Agriculture, Kharkiv, Ukraine
alona.riasnianska@springer.com

Abstract. The rapid development of economic systems leads to the modeling and as a result of the involvement of modern information technologies. The land tax system is no exception, as land is a special real property and is included in the list of items of taxation in each country. In international practices, there are three basic concepts of the taxation system, based on the land as a subject property: the land as a separate item of taxation; the land is taxed with the real estate located on it; the land is subject to multiple taxes. The most widespread system is the land tax along with the real estate located on it.

Ukraine has introduced a model of a combined system of land taxation. Land taxpayers are the owners of the land, land shares (land units) and they are land users. The tax base is the regulatory monetary valuation of land plots and their area. Local self-government bodies set rates of the land tax and tax preferences. Establishing discriminatory rates of the land tax, the category of land, functional use, composition of farmlands, the qualitative status of the land, etc. are taken into account. Particularly relevant is the issue of modeling of the taxation of agricultural land – farmlands, which occupy the largest share of the land fund of the country, and the priority of their use for the intended purpose.

Models of the general system of land taxation in Ukraine and farmland taxation have been developed. Concerning it, the classification of farmland taxation has been proposed and the variants of establishing diversified rates of the land tax have been considered. They consider the qualitative state of specific land plots and the level of implementation of measures to improve their quality using the Thomas Saati Hierarchy Analysis Method. The introduction of a diversified taxation model will encourage taxpayers to allocate their funds for activities aimed at improving, rationalizing and protecting agricultural land.

Keywords: System of taxation, Land tax, Farmland taxation.

1 Introduction

In international practices there are three basic concepts of the taxation system, based on the land as a subject property: the land as a separate item of taxation; the land is taxed with the real estate located on it; the land is subject to multiple taxes. Each country chooses its model of the real estate taxation system, farmland included, which depends on the economic development, political orientation, historical and cultural

values of the country, as well as the structure of its land fund. At the same time, one of the tasks that are solved during the modeling is to ensure the conditions for efficient and rational use of the land, introduce a system of measures for improving its quality indicators.

2 Background

2.1 Types of Taxation Systems in the World

The most common system is the taxation of land along with the real estate located on it. In particular, this system is widely used in the USA, Canada, Portugal, Spain, and other countries. This system has two types: 1) the tax rate is the same for the whole land plot along with the real estate; 2) different tax rates for the land and the real estate located on it. For example, F. Dye Richard and W. England Richard, in their work entitled "Assessing the Theory and Practice of Land Value Taxation", give an example of the successful application of the Pennsylvania tax system: "The City of Scranton, Pennsylvania, has a two-rate tax with an estimated value of land taxed at 10.3 percent and improvements at 2.2 percent. Given that land value and improvements value represent 24 and 76 percent of the total tax base respectively, the equivalent of a single property tax rate on both land and improvements would be 3.7 percent" [1].

However, the world's land taxation systems differ not only in terms of the land as an object of the separate value or the value together with buildings but also in terms of other indicators. Thus, researchers R. Bjord and E. Slack in their scholarly work "International Handbook of Land and Property Taxation" emphasize that land taxation systems in different countries of the world differ not only in terms of the subject to taxation: "... there are differences in the determination of the tax base, the setting of tax rates, and the ability to levy and collect the tax. In some countries, one property tax covers all types of property. In others, there are different taxes for different components of real property. Countries may, for example, have separate taxes on land and buildings; separate taxes on the residential and non-residential property; or separate taxes in urban and rural areas" [2, p.4].

Thus, we can also distinguish two types of taxation systems, based on the tax base: based on the value of the taxable object; based on the taxable area.

A very important function of land taxation is to fill local and state budgets. In particular, in the United States, bodies of local self-government adjust the land tax rate each year so that the proceeds from the land tax payment can cover the budgeted costs of financing specific social events [3].

It is worth noting the system where the rental value of the land is the tax base. This system is applicable in the UK, Spain, France, Portugal, Greece, India, Thailand and Tunisia. Due to the complex process of determining the estimated rental value, countries such as the United Kingdom, Portugal, and Indonesia abandoned such a system and switched to the market value of the land as a tax base [4].

The taxation system in which the cadastral value of the land acts as a tax base is fundamentally different. The peculiarity of this system is that the state cadastral authority collects the necessary information and evaluates the real estate,

while in countries where the market value is used as a tax base, special institutions (registration, valuation, insurance companies) perform these activities. Countries with such a system are France, Germany, and Sweden.

In countries with low levels of land cadaster, the land-based cadaster is applied in the countries of Central and Eastern Europe, Latin America, and Africa. As a rule, in these countries, the land and real estate are taxed separately [4].

Among the 28 EU countries, only nine countries have a land tax as a separate tax, while in others there are combined tax options. Thus, in post-socialist countries, land taxation depends on the form (type) of the land use and takes into account the real estate assets on it. At the same time, real estate taxes, including the land tax, play an important fiscal function when filling local budgets. Local authorities set tax rates independently based on the market value or cadastral value of the assets. Many researchers consider it is advisable to use a rented land taxation system.

World experience shows that the differentiation of land payments introduced by the state very often gives positive results in the form of more efficient and rational use of the land, the introduction of a system of measures to improve its quality.

In some countries, the legislation sets out the mechanisms, employing which the state exercises the incentive functions of rational land use. For example, in the case of irrational land use, the tax rate increases, and when introducing effective land-use methods, preferential conditions are granted, up to a zero tax rate, or for low-productive lands, rates are reduced to 50%. Although in some countries in Eastern Europe, the tax rate depends on the value of the area, not on the object.

2.2 Land Taxation in Ukraine

Ukraine has a combined system. Thus, the Tax Code of Ukraine [5] establishes that the tax base is the normative monetary value of land plots, taking into account the indexation coefficient and the area of land plots where the normative monetary evaluation have not been carried out. The rates of land tax for agricultural land where the normative monetary evaluation have been carried out do not depend on the location of the plot and they are:

– for the agricultural land – not less than 0.3% and not more than 1% of their regulatory monetary value;

– for the public land – not more than 1% of their regulatory monetary value;

– for land plots that are in constant use of economic entities (except for the state and municipal property) – not more than 12% of their regulatory monetary value;

– for all other types of land – not more than 3% of their regulatory monetary value.

One of the most effective levers for improving the quality of land, preserving its natural fertility and potential is to use economic mechanisms, including the taxation system.

2.3 Land taxation in European countries

In European countries, the price scale is quite high: from 4 thousand euros per hectare in Finland to 10-12 thousand euros per hectare in France and Germany, and 25

thousand euros in the Netherlands [6]. Their assessment includes such factors as the level of agricultural intensity, the structure and type of soil, and so on. In the United States, agricultural land prices range from $ 2-3 thousand per hectare in arid regions up to 30-40 thousand dollars per hectare in California.

2.4 Estimation Methods with the Storie Index Determination: US Experience

The most known land evaluation technique in the United States is the Storie Method [7–9], which provides for the classification of arable land with the definition of a Storie Index that affects the land value.

$$\text{Storie Index} = A \bullet B \bullet C \bullet X, \quad (1)$$

where A is the different characteristics of the soil profile;
B – mechanical soil composition;
C – ground slope;
X – other characteristics (drainage, erosion, fertility rate, micro-relief).

Thus, arable land is found to be divided into five classes, wherein the higher the class the higher is the Storie Index. For the first class, the Storie Index is in the range of 80-100%, for the 2-nd class – 60-79%, for the 3-rd class – 40-59%, for the 4-th class – 20-39%, for the 5-th – less than 20%. According to this classification, the value of US agricultural land ranges within $ 300-1,200 per year.

3 Research Approach

3.1 Adaptation of the Storie Method to Determine the Land Tax in Ukraine

Using the Storie method, the formal model of determining land tax in Ukraine will be as follows:

$$LT = \langle F, R, CFT, Q, B, t \rangle, \quad (2)$$

LT – land tax;
F – the legal framework of the land taxation system;
R – the legal regime of the land plot (property, permanent use, the subject of taxation);
CFT – land category, functional use, and type of land;
Q – the quality of the land;
B – benefits of the land taxation system;
t – period (time) of land taxation.

The Tax Code of Ukraine [5] stipulates that the land tax rate for the farmland (irrespective of its location) should be not less than 0.3% of its normative monetary evaluation and not more than 1% of its normative monetary evaluation, taking into account the indexation coefficient.

Therefore, the model of the land tax system for farmland in Ukraine is as follows:

$$LT_{al} = <F, R, FT, Q, B, t>, \quad (3)$$

LT_{al} – land tax on farmland;

F – the legal framework of the system of land taxation of farmland;

R – the legal regime of the land plot (property, permanent use, subject of taxation);

FT – functional use and type of farmland;

Q – the quality of the land;

B – benefits of the land taxation system;

t – period (year, time) of land taxation.

In the Ukrainian land taxation system, including the farmland taxation, there are constant changes and improvements in the regulatory framework (F), so the time factor plays an important part of the current model of land taxation (t).

The Tax Code of Ukraine [5] stipulates that land taxpayers are the owners of the land, land shares and they are the land users. Differentiated land tax rates are set out in Articles 273-277 of the Tax Code of Ukraine [5], which consider the land category, functional use, type of land (FT) and regulatory monetary evaluation of the respective plots of land and shares. The Land Code of Ukraine [10] provides for five types of agricultural land – arable land, lay land, perennial crop fields, hayfields, and pastures. These types of land can be provided for agricultural commodity production as well as for individual gardening, horticulture and the like.

Local bodies of self-government, in their territories, independently set land tax rates and benefits (B) for tax payment. When establishing differentiated land tax rates, the quality of the land (Q) is also taken into account.

3.2 Introduction of Differentiated Taxation System in Ukraine

In Ukraine, to increase the concernment of landowners and permanent land users in the land use based on measures aimed at improvement, rational use and protection of the land, it is advisable to introduce a classification of farmland during taxation, namely a diversified system of taxation of farmland based on five classes:

1-st class – non-eroded and slightly eroded land and eroded land on slopes over 3º, with no measures taken by the subject of taxation to improve its quality;

2-nd class – slightly and moderately eroded land on slopes up to 3º with no measures taken by the subject of taxation to improve its quality;

3-rd class – slightly eroded land on slopes up to 7º, the subject of taxation is introducing measures to improve the quality;

4-th class – moderately and heavily eroded land on slopes up to 7º, the subject of taxation is introducing measures to improve the quality;

5-th class – eroded lands on slopes over 7º, the subject of taxation is introducing measures to improve the quality.

4 Results and Conclusions

To establish diversification in the system of taxation of agricultural land (based on five classes), we consider two options for determining the tax rate based on the quality of land and measures taken directly by the subject of taxation to improve its quality, setting a minimum rate for the 5-th class (0.3% of the regulatory monetary evaluation) and the maximum rate for the 1-st class (1.0% of the regulatory monetary evaluation).

While grouping, these classes imply a certain qualitative composition of the soil surface and slope of the land, the worse the quality indicators, the more the necessity to attract resources, especially financial ones, to preserve and improve the quality, the more complex the measures for achieving the optimum result may be.

The first option. We assume to set equal intervals for increasing the tax rate from 0.3% to 1.0%.

(1.0% - 0.3%) / 4 = 0.175%.

Round to the tenths, we get an interval of 0.2%.

Then the land tax rates will be:

5-th class: 0.3% of regulatory monetary evaluation.

4-th class: 0.3% + 0.2% = 0.5% of regulatory monetary evaluation.

3-rd class: 0.5% + 0.2% = 0.7% of the regulatory monetary evaluation.

2-nd class: 0.7% + 0.2% = 0.9% of regulatory monetary evaluation.

1-st class: 0.9% + 0.2% = 1.1% of regulatory monetary evaluation. Since the maximum amount of the land tax is set at 1.0% of the normative monetary evaluation, and given that landowners and land users do not take measures to improve the land, the land tax rate for the 1-st class is set at 1.0% of normative monetary evaluation of these types of land.

The second option. Setting land tax rates for different classes, we propose to apply the Thomas Saati Hierarchy Analysis Method, which has been widely used in evaluation activities while selecting alternatives and finalizing the results of the evaluation [11].

Therefore, to determine the land tax rates for farmland of different quality and where the measures to improve its quality can be introduced by landowners and land users (subjects of taxation), we suggest to use paired comparisons and the following scale to evaluate the results of the comparison of alternatives:

1 – equivalence (equal importance);

3 – moderate (slight) advantage;

5 – great (significant) advantage;

7 – a very (obvious) advantage;

9 – the highest (extreme, absolute) advantage;

2, 4, 6, 8 are intermediate values.

We make paired comparisons of alternatives, the results of which are presented in Table 1.

Table 1. Paired comparisons of alternatives

Class	5	4	3	2	1
5	1	2/1	3/1	6/1	9/1
4	1/2	1	4/1	5/1	6/1
3	1/3	1/4	1	2/1	3/1

2	1/6	1/5	1/2	1	2/1
1	1/9	1/6	1/3	1/2	1

We change a simple fraction into a decimal and calculate the term sums of the results of paired comparisons of alternatives, the normalized value (which sum should be equal to 1.0), and define the weighting coefficients (Table 2). According to the Saati method, the normalized values are accepted as evaluations of alternatives. The calculation of the weighting coefficients is approximated to 10%.

Table 2. Calculation of the weighting coefficients using the Hierarchy Analysis Method based on the results of paired comparisons of alternatives

Class	Sum by line	Normalized value	Calculated weight, %	Defined weight, %
5	21,00	0,4195	41,95	40
4	16,50	0,3296	32,96	30
3	6,58	0,1315	13,15	20
2	3,87	0,0772	7,72	10
1	2,11	0,0422	5	0
Total	50,06	1,0000	100	100

Then the land tax rates (rounded to tenths) will be:
1-st class: 1.0% - 0.7% · 0% = 1.0% of normative monetary evaluation.
2-nd class: 1.0% - 0.7% · 10% = 0.9% of normative monetary evaluation.
3-rd class: 0.9% - 0.7% · 20% = 0.8% of normative monetary evaluation.
4-th class: 0.8% - 0.7% · 30% = 0.6% of normative monetary evaluation.
5-th class: 0.6% - 0.7% · 40% = 0.3% of normative monetary evaluation.
Thus, as in the first case, the difference between the minimum and maximum rates of land tax is 0.7%, with the maximum rate being defined for the 1-st class 1.0% of the normative monetary evaluation (Table 3).

Table 3. Classification of farmland taxation at different rates

Class	Characteristics of farmland	Land tax rate,% of normative monetary evaluation.	
		Option 1	Option 2
1-st	Non-eroded and slightly eroded land and eroded land on slopes over 3º, with no measures taken by the subject of taxation to improve its quality	1	1
2-й	Slightly and moderately eroded land on slopes up to 3º with no measures taken by the subject of taxation to improve its quality	0,9	0,9
3-й	Slightly eroded land on slopes up to 7º, the subject of taxation is introducing measures to	0,7	0,8

	improve the quality		
4-й	Moderately and heavily eroded land on slopes up to 7º, the subject of taxation is introducing measures to improve the quality	0,5	0,6
5-й	Eroded lands on slopes over 7º, the subject of taxation is introducing measures to improve the quality	0,3	0,3

Economic indicators of the profitability of the land of different quality influence their demand from potential landowners and land users. Eroded land on slopes over 7º requires significant investment to undertake measures to improve the quality of such plots. A reduced rate of land tax will allow economic entities to use more of their saved money for land protection measures and to increase the land fertility. Non-eroded and poorly eroded land on slopes up to 3º requires measures mainly to maintain its condition and prevent its deterioration. Such measures require small investments and are mostly ensured with the crop rotation, hay and pasture systems maintained by the economic entity.

The results obtained for the two variants of the calculations shown in Table 3 indicate the similarity of the results. It is worth noting that the data obtained by the Hierarchy Analysis Method are more accurate to reflect the level of investment for the implementation of measures to improve the quality of eroded land and to create sustainable environmentally friendly agro-landscapes and more.

Consequently, the introduction of a diversified taxation model will encourage taxpayers (landowners and land users) to allocate their funds for the activities aimed at improving, rationalizing and protecting the farmland.

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