The Peer Land Exchange in Land Readjustment Models

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Abstract – The research is aimed at substantiation of land readjustment optimization models based on the equivalence of land plots to be exchanged. European experience of land readjustment has been considered. The formation of the notion of equivalency in the readjustment optimization models has been scrutinized. Factors influencing the land plots equivalency have been singled out. Land reallocation modelling with the formation of demands to the equivalence of the reallocated land plots by qualitative and spatial and technological characteristics has been suggested.

Keywords – land exchange, mathematical model, land readjustment, land consolidation, optimization.

I. Introduction

At the current stage, land readjustment substantiation and improvement is an important issue for most countries. Land readjustment is considered as the basic part of the existing land tenure improvement (concerning agricultural land [1], [2], [3] as well as urban territories [4], [5]).

Land readjustment is aimed at the correction of land plot characteristics in accordance to social, environmental and economic demands. The most common aims are the removal of fragmentation, land allocation for nature conservation, infrastructural objects, squatting, etc. [3], [6], [7].

Local peculiarities predefine the need for the adaptation of general approaches to readjustment aims and conditions.

II. The peer exchange at land readjustment

As the result of readjustment the improvement of land plot characteristics like mutual placement, dimensions, configuration, land massive (plot) structure are expected.

In accordance to UN Food and Agriculture Organization (FAO) recommendations [6], the general principle of land readjustment aiming at its improvement is the avoiding of land owner's losses.

Let us scrutinize the case there is no need for compensation. Since land plots are contrasted at readjustment, in accordance to FAO recommendations [6], the relative value can be used in this case. This approach is most essential provided the land market is weak or underdeveloped.

Land exchange is the mandatory readjustment step reflected in land readjustment algorithms [5]. It is suggested to put peer land exchange into the basis of readjustment by the principles outlined in the researches [8], [9].

III. Land readjustment modeling

The exploration of the best possible options of land tenure mutual placement and their characteristics is effectively realized by optimization models building [5], [10], [11].

In accordance to the existing approaches to readjustment modeling the exchange of land plots of equal area with the considering of the soil quality [11] or of equal value (within the preset acceptable value fluctuation range) is envisaged [10].

Researches of FAO [6] point out "Equal value" is thus not only a question of soil values but includes all factors that have a substantial impact on the use of land.

It is desirable to scrutinize the exchange as the peer one in case land plots to be exchanged are of equal value according to a set of main natural and acquired properties from the point of view of its general functional role [8], [12].

At agricultural land readjustment modeling it is suggested to take into consideration the characteristics of agricultural land plots as the production factor [12]. Useful properties of the land plot like soil quality in accordance to demands on cultivation of crops and existence of improvements should be taken into consideration. Technological processing conditions predefine the production capability in case of the equal fertility. The placement of the land plot predefines the profit from land usage in case of equal production capability. The existence of easements or servitudes can cause agricultural production losses.

IV. Land readjustment model based on the peer exchange

It is assumed that at land readjustment the exchange of land plots equal by a set of qualitative and spatial and technological characteristics is envisaged. As the result of the readjustment, land tenure spatial and technological characteristics should be improved.

The modeling is conducted in accordance to the readjustment aims. In case of the strip farming priority the following model is suggested.

Target function meets the condition:distance between new lots and holder yards should be minimal [10], Eq. 1:

$$F = \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{1}{d_{ij}} x_{ij} \rightarrow \max , \qquad (1)$$

where d_{ij} is the distance from the land plot of the owner j within land massive i to the household centre;
x_{ij} is unknown area of j-th participant in i-th land massive;
n is the quantity of land massives involved to the project; m is the quantity of land owners involved to the project.

It is suggested to form the demands considering the following list:

1. The exchanged land plots should be the peer ones at the readjustment, Eq. 2:

$$\sum_{i=1}^{n} K_{ij} B_{ij} x_{ij} = \sum_{k=1}^{l} K_{jk} B_{jk} S_{jk} , \quad j = 1,2,..m, \qquad (2)$$

where K_{ij} is the coefficient characterizing the combined impact of qualitative, spatial and technological characteristics of the land plot after readjustment [9]; B_{ij} is the average ball-bonitet of the land plot soil; K_{jk} is the coefficient characterizing the combined impact of qualitative and spatial and technological characteristics of the land plot before readjustment [9]; B_{jk} is the average ball-bonitet of the land plot soil of the land plot k belonging to the owner j before the readjustment;S_{jk} is the area of the land plot k belonging to the owner j before the readjustment; l is

the quantity of land plots belonging to the owner *j* before the readjustment.

Ball-bonitet of the corresponding land plot soil (specifies the soil quality by the core natural and acquired properties from the point of view of growing basic crops by 100-point scale) [11].

Value K is calculated as the product of separate factors depending on the presence of the corresponding factors by Eq. 3:

$$K_i = K_{qi} \times K_{li} \times K_{imi} \times K_{fi} \times K_{ri} \times K_{gi} \times K_{mi} \times K_{oi}, \quad (3)$$

where K_q is the factor characterizing the lowering of the soil quality as the result of contamination, erosion, etc.; K_l is the factor characterizing the type of agricultural land; K_{im} is the factor characterizing the land improvements; K_f is the factor characterizes configuration; K_r is the factor characterizing relief; K_g is the factor of the hydrographic characteristics of land plot; K_m is the correction factor for land plot placement; K_o is the factor characterizing the existence of easements or servitudes [9].

2. The total of all land plots within a land massive before and after the reallocation is equal (Eq. 4):

$$\sum_{j=1}^{m} x_{ij} = S_{0i}, \quad i = 1,2,...n, \quad (4)$$

where S_{0i} is the area of *i* project land massive.

3. The total land area within the project before and after readjustment should be equal, Eq. 5:

$$\sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij} = \sum_{i=1}^{n} S_{0i}. \quad (5)$$

4. The shape of the newly created land plots should be the most convenient and should not worsen after readjustment. The total newly created land plot configuration index should be not less than the total land plot configuration index before readjustment, Eq. 6:

$$\sum_{i=1}^{n} K_{ij} x_{ij} = \sum_{k=1}^{l} K_{jk} S_{jk}, \quad j = 1,2,...m, \quad (6)$$

where K_{ij} is the coefficient characterizing the land plot configuration after readjustment; K_{jk} is the coefficient characterizing the land plot configuration before readjustment.

It is reasonable to calculate this coefficient as the alignment index [9].

5. Variable x_{ij} are nonnegative values only, Eq. 7:

$$x_{ij} \geq 0. \quad (7)$$

Conclusion

According to the European experience, land readjustment at the existing land tenure and ownership improvement has been considered. Peer land exchange as the basis for land readjustment has been considered. The equivalency of land plots to be exchanged is defined as the precondition for the land owners' losses avoiding. The exchanged land plots equivalency criteria have been suggested.

Land reallocation modelling with the formation of demands to the equivalence of the reallocated land plots by qualitative and spatial and technological characteristics has been suggested.

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