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RESEARCH ARTICLE

Monitoring of land and crop types in the foothills of Kashkadarya province, Uzbekistan

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Abstract. The gap in the food production's modest increase in Uzbekistan shows that the country's overall food security problem is becoming insecure every year. Increasing the effectiveness of agricultural land usage, which serves as the main foundation for the development of these agricultural products, is key to solving this problem. Given the foregoing, the goal of this study is to develop a system for the appropriate organization of monitoring of land and crops in rainfed areas of Kashkadarya province, Uzbekistan. The location of fields, the internal structure of the region, and the creation of a set of measures aimed at minimizing water erosion should all receive special consideration while working on land management initiatives. Such an experimental project was created using the "Turnabulak" massif as an illustration, which is located in the arid Yakkabag district of Kashkadarya province. This research suggests that it is crucial to create such agricultural projects experimentally and, in these projects, the proper selection of plots of arable land for crops and trees based on all the characteristics of the rainfed land.

Keywords Crop rotation • Landscape • Rainfed cropland • Uzbekistan • GIS • Contours

Introduction

In order to meet the growing demand of the population for food, it is important to radically increase the use of irrigated land, as well as rainfed land [1]. Improving the efficiency of arable land based on historical experience and innovative approaches to the use of such areas and attracting large investments in such areas are global key challenges [2]. At the same time, the establishment of orchards and vineyards, walnut orchards, and pistachio-almond orchards based on intensive technologies is a priority of agriculture [3]. For such arable lands it is necessary to select and zoning varieties of grain, legumes and oilseeds resistant to drought and to introduce scientifically based crop rotation in arable farming [4]. Moreover, it is important to pay special attention to the optimization of land and crop types in the regions of natural location of these areas [5].

Drylands are non-irrigated arable lands in plains, hills, foothills and high mountain areas [6]. Their distribution is inextricably linked with the altitude of the territories [7]. Therefore, in the organization of the use of dry lands in the future of agriculture, in optimizing the ratio of land and crop types, it is important to take into account such features as soil types scattered along the height of the region closely related to it. According to the statistical data [8], the total area of arable land in the world is 1,600 million hectares, of which 80% is irrigated land.

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Nowadays, whereas the demand for land resources of the economy of Uzbekistan is growing, it is important to rationally organize the use of drylands [9]. In particular, to create scientific recommendations for optimizing the ratio of land and crop types on the basis of adequate regulation of the use of existing methods of land use in agriculture is challenging across the country [10].

In addition to the rapid growth of the world's population, especially in Uzbekistan, the gap in the limited growth for food production suggests that the issue of food security is becoming more acute from year to year nationwide [11]. The solution to this problem is primarily related to increasing the efficiency of agricultural land use, which is the primary basis for the cultivation of these products [12]. Taking into account the above, the main purpose of this study is to create a methodology for the proper organization of monitoring of land and crops in dry areas on the example of Kashkadarya province, Uzbekistan.

Materials and methods

The main negative factors in the use of drylands, which are widespread in the plains, hills, foothills and mountainous areas of the study area, are the complex relief structure, improper plowing, and cultivating [13]. The complex measures on crop rotation schemes and crop species ratios in rainfed areas is considered to be untimely and insufficient application [14]. The study of the current state of agricultural land use shows that 258700 hectares of arable land in the study site are arable land. The peculiarity of the climate of rainfed land is that the precipitation is mainly in the form of heavy rains, which clog the soil and greatly impede the growth of crops on the ground [15].

Precipitation occurs mainly in the autumn-winter and early spring periods, and the low growth potential of a number of crops at very low vegetation temperatures is a key feature of rainfed farming. In particular, in Yakkabag administrative district of Kashkadarya province (Uzbekistan) selected for this study, along with irrigated agriculture, there is also dryland farming. In total, 67.3% of the land area in this district is arable land, and 40.8% of this figure is irrigated land [16].

The data on the distribution of the total drylands of the study area by landscape classes were summarized and analyzed in Table 1 below.

Table 1. Dryland distribution of Kashkadarya province by landscape types in 2020, ha

#	Landscape types	Total area, '000 ha	Of which:		
			Rainfed cropland, '000 ha	Rainforests, '000 ha	Other lands, '000 ha
1	Mountain	1053.77	12.98	0.19	1040.6
2	Foothill	564.98	85.37	1.01	478.6
3	Hill	483.74	129.35	0.59	353.8
4	Plain	239.62	31.0	0.42	208.2
	Total by the province	**2342.1**	**258.7**	**2.2**	**2081.2**

In general, in the 60s and 80s of the last century, large-scale land development and irrigation were carried out in the province [17]. As a result of numerous transformations, there were significant changes in the area and use of arable land.

Results and discussion

The tillage project for drylands differs from irrigated areas. The difference in altitude regions under natural conditions, in turn, explains the sharp differences in agro-technical work, crop composition determination, and production direction in these regions. In addition, the methods of working on land management projects, its components, and elements are also affected by the relief and especially the level of risk of erosion in the foothills and mountainous areas. This requires special attention to the location of fields and the internal organization of the area, the development of a set of measures to prevent water erosion. Therefore, in the drylands, we can see several vertical zones in the area of a single land user: plain, hills, foothills, mountains and mountains (Figure 1).

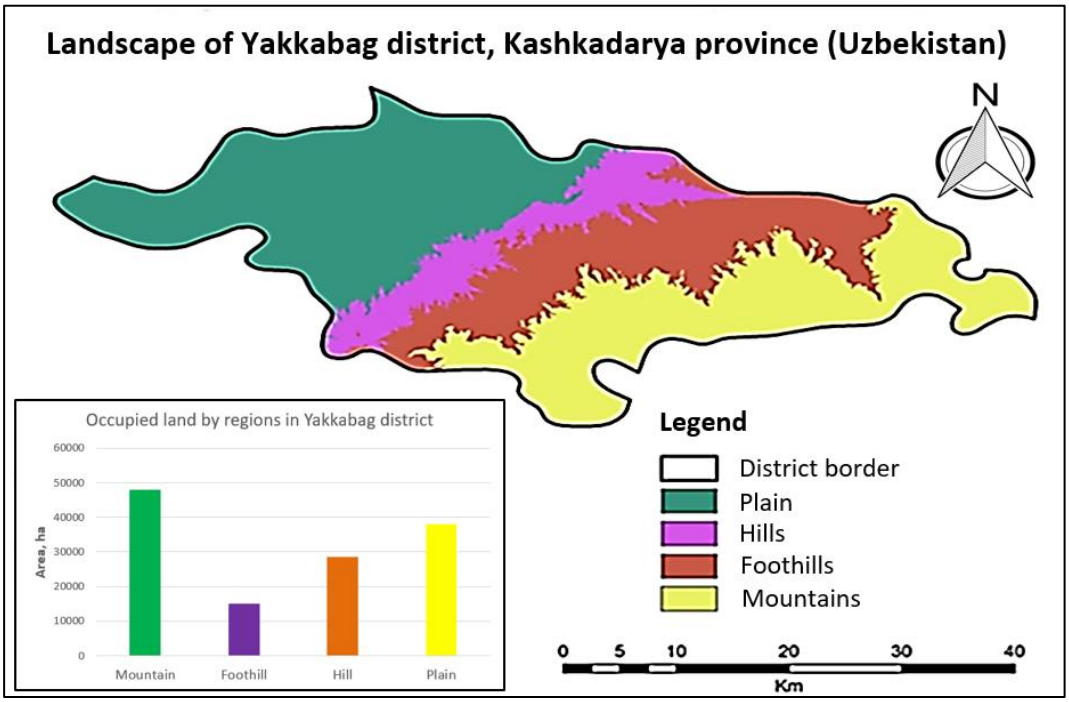

Figure 1. Drylands in Yakkabag administrative district, Uzbekistan by different landscapes.

In addition, when working on land management projects, special attention should be paid to the placement of fields and the internal organization of the area, the development of a set of measures aimed at preventing water erosion. Such an experimental project was developed on the example of the “Turnabulak” massif located in the dry region of Yakkabag district of the study area. The total area of all lands within the boundaries of the “Turnabulak” massif in the Kyr-Adyr region (Kashkadarya province, Uzbekistan) was 6012.2 hectares. Including the area of agricultural land is 5183.0 hectares or 86.2% of the total area. One of the main issues of the project for the rainfed agricultural enterprise is the organization of land types and crop rotation scheme. This issue is addressed at the level of each production department and the entire farm. In the land management project, project areas were identified on the basis of the transformation of agricultural land types, taking into account the quality of lands and natural and economic factors in the massifs (Table 2).

Table 2. Project composition of agricultural lands on "Turnabulak" massif of Yakkabag district, Uzbekistan.

#	Land use type	Area in the year of land formation, ha	Area under the project, ha	Extension, ha	Shrinkage, ha
1	Cultivated lands	1371.0	1481.96	122.05	11.09
2	Rainforests Of which: Orchards Vineyards Mulberry yards	331.0 165.5 149.0 16.6	342.09 174.5 151.09 -	11.09 9.0 2.09 -	- - - -
3	Pastures and grasslands	3481.0	3347.86		122.05
	Total agricultural land types	5183.0	5183.0	-	-
4	Gardens	277.0	277.0	-	-
5	Poplar area	1.0	1.0	-	-
6	Other lands not used in agriculture	551.2	551.2	-	-
	Total lands attached to the farm	**6012.2**	**6012.2**	133.14	133.14

The next important step is to determine the number and variety of these crop rotations. The territory of the “Turnabulak” massif is located in the foothills of the district and differs from other regions by its natural features. Based on these characteristics, the composition and field exchange for drylands are selected hinged on the existing natural and economic conditions (Figure 2).

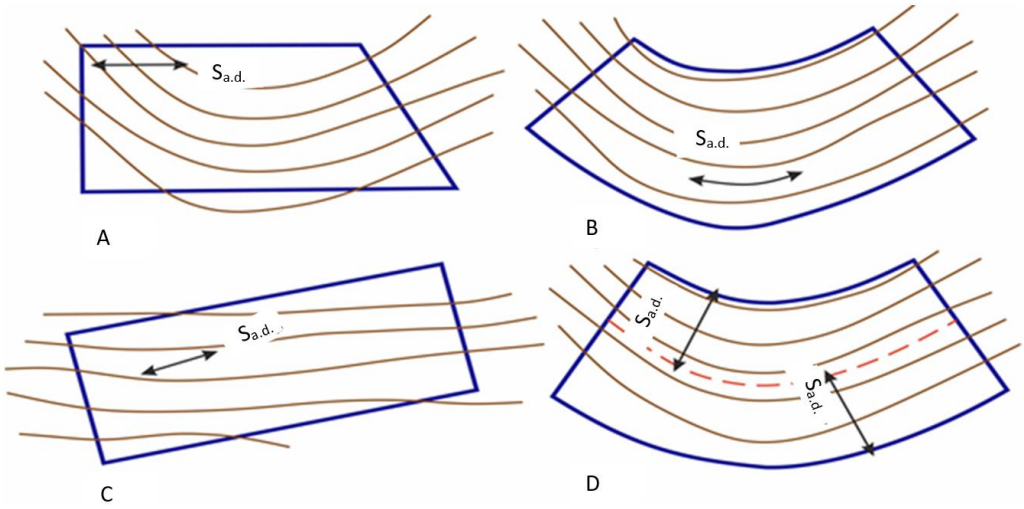

Figure 2. Designing field boundaries.

Where, a - straight line; b - contoured; c - at an angle to the horizontal; d - unacceptable length of the drainage line; and, $S_{a.d.}$ - allowable distance between the horizontals in straight-line machining.

The working slope is determined by the following expression (Equation 1):

$$i_u = \frac{h}{D} \tag{1}$$

Where, h - difference in height between the relief points, m; and, D - distance between points, m.

Working slope (i_u) value is usually expressed in percentages or degrees (Equation 2):

$$i_u = \frac{i_p\%}{1{,}75}\ ; \qquad i_p\% = 1{,}75 \cdot i_u \tag{2}$$

This expression is used in calculations on straight slopes that are not complicated. A parallel line palette is used according to the method proposed by Cheshikhin [18] to determine the average working slopes in sharp relief.

The main rule in the design is to place the long side of the field across the slope. According a number of other scientists [19, 20], the productivity of agricultural machinery increases when the slope is treated crosswise. This is because no additional power is expended to overcome the traction resistance of the trailer machines. For example, if we assume that the efficiency and fuel consumption of the equipment at the slope of 30 is equal to 1, at the high slope of 70 it varies between 0.84 and 1.10, respectively.

In contour machining, the working areas are designed in the form of line, separated by as many parallel curved boundaries as possible, as close as possible to the horizontal (Figure 3).

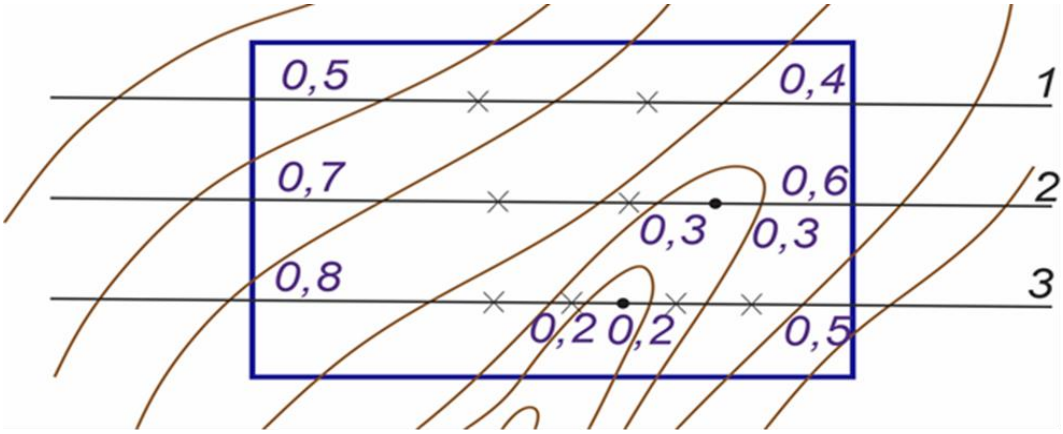

Figure 3. Determining the average working slope: 1, 2, 3 - pallet lines; 0.4; 0.6 - incomplete intervals; and, x - full intervals on the palette lines.

The description of crop rotation designed on the basis of the above requirements is given in Table 3 (fragment).

Table 3. Description (fragment) of the area of one crop rotation in the "Turnabulak" massif.

# of crop rotation field	Crop rotation area, ha	Average area of the field on the crop rotation, ha	Difference from the average area	
			ha	%
Scheme of the first crop rotation array – 1:2:1:1				
1	90.9	87.96	2.94	3.3
2	99.2		11.24	12.8
3	88.2		0.24	0.3
4	72.6		-15.36	17.4
5	87.1		-0.86	0.9
Total	**439.8**			

The placement of protective tree strips is also important in dryland land management projects. In areas protected by strips of hedgerows, the yield of agricultural crops increases. It is estimated that the increase in productivity in the protected area will reach 25-30% for food and industrial crops, and 35-40% for the green mass of vegetables and fodder crops.

Conclusions

By this research, it is recognized that the role of land management projects in the system of effective organization of the use of drylands is special. In this case, it is important to develop such agricultural projects experimentally and in these projects, based on all the characteristics of the rainfed land area, the correct selection of plots of arable land for crops and trees. We assume that it is expedient to place the area taking into account the relief, slope exposure, biological properties of crops, technological features of cultivation.

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