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Soil Quality Assessment Principles for Vegetable Crops

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ABSTRACT.
The requirements of different crops for soil fertility also vary. Therefore, the development of soil quality assessment principles for a particular crop type is one of the important issues. Most of the work on soil quality assessment in Uzbekistan has been developed for cotton. It is known that at present, along with cotton, great attention is paid to the cultivation of vegetables, melons and legumes.
The article describes the principles of developing a soil-based assessment scale for vegetable crops and the calculation of grading coefficients. It also highlights the improvement of soil fertility and the increase in quality scores through the planting of legumes and fodder crops.
KEYWORDS: soil fertility, quality assessment, humus, nitrogen, phosphorus, potassium, soil salinity, gley, gypsum, potatoes, cabbage, tomatoes, onions, peas, vetch, esparto, alfalfa, clover.

INTRODUCTION: It has long been known that the analysis of soil properties, the study of whether soils are more or less fertile. Materials for the study of soil quality can also be found in the scientific work of prehistoric scientists. Recommendations and guidelines for increasing soil fertility were given in these studies.
The Commission for Soil Quality Assessment began its work in the 1950s at the V.V.Dokuchaev Soil Science Research Institute. This work was continued in other soil science research organizations. The basic principles developed by V.V.Dokuchaev and N.M.Sibirtsev were used in the formation of soil quality assessment [1].
H.D.Foth [2] recommends taking into account factors that are lacking for plants when assessing soil fertility. This requires special experiments. Crop types are also important in determining soil fertility. This is because the nutrient requirements of different crops also vary.
According to S.K.Abd-Elmabad [3] and others, the factors limiting soil fertility include high mineralization, high sodium content in the absorption capacity, poor soil erosion.
It is recognized in the scientific work of foreign researchers that different principles of assessment for different soil-climatic conditions have been applied. It was also noted that the evaluation criteria and principles also vary by crop type. In particular, the works of

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L.A.Ilagan, R.P.Tablizo, R.B.Barba, N.A.Marquez [4], S.Kharal, B.R.Khanal, D.Panday [5] express the above-mentioned ideas.

T.M.Parakhnevich, A.I.Kiriklar [6] conducted a comparative assessment of soil quality. He noted that the quality of different regions of central black soils will also vary. Based on the data obtained, it is possible to develop recommendations for the formation of the structure of agricultural crops and increase soil fertility.

Many scientists have contributed to the creation, implementation and development of the principles of valuation of irrigated soils in Uzbekistan. In particular, S.P.Suchkov [7], A.Z.Genusov [8], G.M.Konobeeva [9], V.N.Li [10], D.S.Sattarov [11], R.Q.Kuziev [12], Sh.M.Bobomurodov [13], N.Yu.Abdurahmonov [14] and others.

U.Sobitov, N.Khalilova [15] from ancient times carried out work on the assessment of fertility in irrigated meadow-gray, gray-meadow, meadow and swamp-meadow soils. Divided into classes by productivity, the area occupied by each class is indicated.

Sh.M.Turdimetov [16] compared the properties and evolution of the old irrigated and newly irrigated soils of Mirzachul oasis. He also studied changes in the quality assessment of these soils.

Planting legumes and fodder crops is also important in increasing soil fertility. Research in this area has also been carried out by scientists of this type.

D.A. Khristenko [17] noted that after the planting of perennial grasses such as alfalfa, esparto, the amount of organic matter in the soil increased by 4.0%. In addition, the structural level of the soil has also been improved.

V.P.Zvolinsky, EN Grigorenkova, M.Yu. Puchkov [18] studied in practice the accumulation of organic mass in the soil from 6.0 to 9.5 t / ha as a result of planting annual legumes. The aggregate condition of the soil has improved. This was especially evident in the 0–20 cm layer of soil.

L.D.Frolova, M.N.Novikov [19] found that perennial grasses improved soil physical properties, increased the amount of water-resistant aggregates by 20%, improved nitrogen accumulation, had a positive effect on mobile forms of phosphorus, but had a negative effect on potassium balance.

Sh.M.Turdimetov and others [20] conducted experiments to increase soil fertility by planting different crops. To study the increase in nutrients in the soil, the situation before and after the harvest of legumes and fodder crops was compared.

It is clear from the above data that the criteria for assessing soil quality vary and depend on soil-climatic conditions. Factors affecting soil quality assessment stem from the characteristics of the regions. The demand of crops for soil fertility varies. Therefore, there is a need to develop evaluation principles based on the characteristics of the crop.

Research methods

Laboratory, field and final works were carried out to carry out research work. Information on soil quality assessment was reviewed. Materials on the natural and climatic conditions of the farm were collected. Locations for soil cuttings have been identified. In placing the soil sections, attention was paid to the areas most common in terms of soil separation.

Although vegetable varieties are diverse, they can be divided into certain groups, especially in terms of the structure and biological properties of the root system. The soil was divided into 4 groups according to the star system.

The first group includes potatoes and other legumes, which require relatively light and soft soil for normal growth.

The second group includes vegetables - carrots, radishes, beets. I am not interested in the soil conditions of these crops. This group can also include ecmapion.

The third group includes sauerkraut, cucumbers, pumpkins, and most polysaccharides.

The fourth group includes tomatoes, eggplant, peppers and others.

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We selected one plant from each group for the cultivation of vegetables. The experiments were performed on potatoes, cabbage, tomatoes and onions.
The yield of selected vegetable crops was determined. The degree of correlation between soil properties and vegetable crops was determined. Once the correlation coefficient was sufficient, the validation coefficients were developed.
The property with the highest yield on soil properties was considered to be 100 points or a coefficient of 1.0, while the remaining yields were calculated as a percentage and the coefficients were calculated relative to the highest. Soil differences were evaluated on a scale based on a scale based on the mechanical composition and genetic dependence of the soil. Correction coefficients were introduced based on indicators such as humus reserves in the soil, nutrient content, soil salinity level, glialization status, and gypsum content level. The quality score of the soil differences was calculated by adjusting the score correction coefficients on the main scale. Based on the quality score of the land plots, the average quality score of the farm was calculated.

Results and discussions

In the conditions of transition to intensive irrigated agriculture, all processes in the soil are activated, many properties of the soil are changeable in the short term, not permanent. Therefore, the criteria for evaluating soils are less variable, requiring evaluation according to the type and subtype of genetic groups, moisture series, and mechanical composition.
It has been shown that the relationship between vegetable crops and soil mechanical composition has a curve. In potatoes and onions, the top of the curve was towards the light sand, and for cabbage and tomatoes, the middle sand. The correlation coefficient between the mechanical composition of the soil and the yield of potatoes was 0,92, 0,96 in cabbage, 0,84 in tomatoes and 0,89 in onions.
Based on this, a basic scale was developed for irrigated grassland soils where vegetable crops are grown (Table 1).

Table 1
Grading scale for irrigated grassland soils for vegetable crops

		Potatoes	Cabbage	Tomatoes	Onion
		Ball	Ball	Ball	Ball
1	Lightly sandy	100	75	85	100
2	Medium sandy	90	100	100	95
3	Heavy sand	75	85	90	85

Valuation coefficients on humus reserves. Humus accumulates all the basic elements necessary for plant nutrition and is stored for a long time. As a result of gradual mineralization, these elements take on a mineral form and are used by plants. The decomposition of humus and organic residues releases large amounts of carbon dioxide, which is important in the carbon nutrition of the plant.
A.A. Okolelova, O.S. Bezuglova [21] consider that one of the main indicators in the calculation of soil quality points is the humus status. The ratio of humic and fulvic acids is considered important in assessing the humus status of the soil. The extensive use of mathematical statistical methods in the assessment of humus status has been recommended.
We conducted special experiments to determine the importance of humus for irrigated grassland and meadow soils, where vegetable crops are grown, and to use it as a benchmarking criterion. To calculate the humus reserves in the soil, the percentage of humus in the 0–50 cm layer was multiplied by its volume weight.

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To determine the relationship between the amount of humus in the soil and the yield of vegetable crops, all metering sites were divided into 5 groups according to humus reserves.
The correlation coefficient between the amount of humus in the soil and the yield of potatoes was 0,97, 0,95 for cabbage, 0,97 for tomatoes, and 0,98 for onions.
Based on these data, the valuation coefficients for half a meter of humus reserves were calculated (Table 2).

Table 2
Valuation coefficients on humus reserves in the soil (0-50 cm layer)

№	Soil gradation on humus reserve t / ha	Potatoes		Cabbage		Tomatoes		Onion	
		yield	bonitirovation	yield	bonitirovation	yield	bonitirovation.	yield	bonitirovation.
1	30-45	80	0,65	215	0,65	211	0,60	103	0,50
2	45-65	97	0,75	242	0,70	236	0,70	129	0,65
3	65-85	106	0,85	268	0,80	254	0,75	147	0,75
4	85-105	111	0,90	298	0,90	290	0,85	162	0,80
5	105-125	127	1,00	336	1,00	342	1,00	198	1,00

Rating coefficients on nutrient supply. When conducting soil grading, most authors use the amount and composition of nutrients in the soil as one of the main criteria in soil assessment work.
To calculate the correlation coefficients for the amount of nutrients, its percentage was converted to a reserve quantity for a half-meter layer and divided into groups. The calculation of the half-meter reserve was done by multiplying the percentage in these layers by the volume weight. Because the amount of nitrogen in the soil is highly variable, it was not used as a soil grading criterion for vegetable crops.
The relationship between mg / kg (0–50 cm layer) of phosphorus reserves in the soil and the yield of vegetable crops was determined. Studies show that there is an integral link between phosphorus reserves and vegetable crop yields. The correlation coefficient was 0,91 between potato yield and phosphorus reserves, 0.90 between cabbage yield and phosphorus reserves, 0,95 between tomato yield and phosphorus reserves, and 0,92 between onion yield and phosphorus reserves (Table 3). A relatively high correlation coefficient (0,95) was obtained for the tomato crop. This indicates that tomatoes require more phosphorus than other vegetable crops.

Table 3
Valuation coefficients on the amount of nutrients in the soil (0-50 cm layer)

№	Gradation in terms of supply kg / ha	Potatoes		Cabbage		Tomatoes		Onion	
		Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient
On phosphorus									
1	<50	83	0,65	208	0,65	182	0,50	140	0,65
2	51-100	91	0,70	249	0,75	221	0,65	166	0,75
3	101-150	101	0,80	275	0,85	257	0,75	183	0,85
4	151-200	112	0,85	296	0,90	296	0,85	192	0,90
5	>200	129	1,00	325	1,00	348	1,00	217	1,00

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On potassium									
1	<700	69	0,50	213	0,65	205	0,65	132	0,65
2	701-1400	87	0,65	241	0,70	225	0,70	157	0,75
3	1401-2100	98	0,75	263	0,80	264	0,85	173	0,85
4	2101-2800	110	0,85	289	0,85	280	0,90	188	0,90
5	>2800	132	1,00	335	1,00	316	1,00	207	1,00

There is also an organic link between mobile potassium reserves and vegetable crops. Its amount was 0,98 for potatoes, 0,92 for cabbage, 0,92 for tomatoes and 0,93 for onions.
This was the basis for the development of grading coefficients for the amount of nutrients in the soil (phosphorus and potassium) (Table 3).
Valuation coefficients on soil salinity. According to Yu.B. Salina, N.V. Tyutyuma, A.V. Tyutyuma [22], crop yields in weakly saline soils averaged 25%, in moderately saline areas up to 50%, in strongly saline areas up to 75% and very strong in saline soils the yield decreases to 100%. As a result of agro-ameliorative measures against salinization and widespread use of siderate crops, it was observed that the biological yield of tomatoes increased by 35% and the yield of watermelon by 15%.
Determining the relationship between the yield of vegetable crops and the level of salinity in a correlative way showed that there is a certain relationship between them. This figure was 0,71 for potatoes, 0,69 for cabbage, 0,58 for tomatoes, and 0,57 for onions.

Table 4.
Valuation coefficients on soil salinity

Salinity level	Potatoes		Cabbage		Tomatoes		Onion	
	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient
Not salted	123	1,00	329	1,00	297	1,00	221	1,00
Weakly salted	104	0,85	274	0,85	242	0,80	163	0,75
Moderately salted	77	0,65	203	0,60	162	0,55	115	0,50

As the amount of harmful salts increases, the yield of vegetable crops decreases. Based on this, the rating coefficients for the level of soil salinity for vegetable crops were calculated (Table 4).
Of the four vegetable crops, the most susceptible to salinity was the onion, a relatively salt-resistant potato crop. Cabbage and tomatoes took the middle ground.
It should be noted that in low-salinity soils the yield of potatoes is 15-20%, cabbage - 15-25%, tomatoes - 20-25%, onions - 25-30%, and in moderately saline soils - 35-40, 40-50, 40, respectively. –60, 50–60% decrease.
Grading coefficient on the depth of the glazed and glazed layer. Hydromorphic, especially in soils with a heavy mechanical composition, often encounters a gley layer. One of the factors that negatively affects soil properties and crop yields is the depth at which the gley layers in the soil are located.

The fertility of hydromorphic soils depends on the depth at which the gley layer is located: the closer it is to the top, the lower the soil fertility. The correlation coefficient between the depth at which the clay layer was located and the potato yield was 0.95, 0.88 in cabbage, 0.93 in tomatoes, and 0.91 in onions.

Table 5.
Valuation coefficients on the depth of placement of the clay layer

Depth of clay layer, cm	Potato		Cabbage		Tomato		Onion	
	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient	Productive	bonitirovka coefficient
>110	154	1,00	322	1,00	317	1,00	196	1,00
81-110	146	0,95	309	0,95	298	0,95	186	0,95
61-80	122	0,80	271	0,85	244	0,75	170	0,85
<60	101	0,65	231	0,70	202	0,70	141	0,75

The following are the grading coefficients for the depth of placement of the gley layer (Table 5). When the depth of the clay layer is more than 60 cm on the surface, a sharp decrease in the yield of potatoes and tomatoes was observed. The gley layer had little effect on the yield of cabbage and onions. The effect of the depth of placement of the gley layer on the yield of vegetable crops is related to the structure of their root system.

Valuation coefficients according to the depth of the gypsum layer in the soil and the degree of gypsuming. OG Lapotovskaya, N.D. Kiseleva [23] conducted special experiments to study the location, origin and effect of the gypsum layer on the soil and its effect on soil properties. It has been found that with an increase in the amount of gypsum in the soil, the physical properties of the soil deteriorate sharply.

When the relationship between the degree of gypsuming of the soil and the yield of vegetable crops was studied, the correlation coefficient was 0,75 for potatoes, 0,76 for cabbage, 0,68 for tomatoes, and 0,71 for onions.

Based on the obtained data, the grading coefficients for the depth of the gypsum layer and the degree of gypsuming were developed (Table 6).

Table 6.
Valuation coefficients on the depth of placement of the gypsum layer and the degree of gypsuming

Degree of gypsum	Depth, cm	Potato		Cabbage		Tomato		Onion	
		Produc-tive	bonitirovka coefficient	Productive	bonitirovka coefficient	Produc-tive	bonitirovka coefficient	Productive	bonitirovka coefficient
Plastering		134	1,00	315	1,00	320	1,00	208	1,00
Weak gypsum-gan 11-20% gypsum	30-60	118	0,90	296	0,95	275	0,85	189	0,90
	<30	95	0,70	268	0,85	256	0,80	166	0,80

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The average gypsum 21-40% gypsum	50-100	108	0,80	255	0,80	240	0,75	141	0,70
	30-60	91	0,70	230	0,75	186	0,60	125	0,60
	<30	74	0,55	189	0,60	173	0,55	114	0,55

According to the data in Table 6, the proximity of the gypsum layer reduced the yield of more potatoes and tomatoes, which is due to the fact that their roots penetrate deeper into the soil. The depth at which the gypsum was placed in the crop, where the root system did not penetrate as deeply as the onion, was less affected. This information is especially evident in weakly plastered soils.

Increase of soil fertility (quality score) by sowing legumes and fodder crops

It is known that the increase in soil fertility is influenced by various factors. A small increase in the amount of humus in our low-humus soils also leads to a certain increase in soil fertility. Also, due to the increase in mobile nutrients, the level of nutrient supply increases to a certain extent after replanting crops. In addition, a certain reduction in soil salinity was observed through the planting of forage crops such as water weeds. All of the above led to a certain increase in the yield of legumes and fodder crops, as well as cotton and wheat. This indicates an increase in soil quality score.

Table 7
Percentage of increase in nutrients after planting legumes and fodder crops

№	Crops	Humus and nutrients			
		Humus,%	N–NO_3%	mobile phosphorus, mg/kg	mobile potassium, mg/kg
1	Peas	1,63	28,3	35,2	10,3
2	Vika	3,1	3,1	33,1	3,4
3	Espartset	7,0	14,9	30,1	18,8
4	Clover	35,3	35,4	4,0	3,0
5	Alfalfa	1,91	19,5	37,8	–2,8

The correlation between cotton yield and humus content by sowing legumes and fodder crops was found to be 0,74–0,89. It was also 0,70–0,85 for nitrate nitrogen, 0,63–0,69 for mobile phosphorus, and 0,61–0,64 for exchangeable potassium.

As a result of sowing the above 5 crops, the average yield of cotton increased by 2.06 s / ha. If we express this in points, we can observe an increase of 5.1 points. A high rate of increase in productivity as a result of increased agrochemical properties of the soil was observed after alfalfa cultivation (3.0 t\s/ha).

Table 8
Influence of legumes and fodder crops on cotton yield

	Crops	Yield		Difference	
		Before planting	After harvest		
1	Peas	28,6	31,4	2,8	9,92
2	Vika	30,8	31,6	0,8	2,72

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3	Espartset	27,4	29,8	2,4	8,87
4	Clover	31,1	34,1	3,0	9,76
5	Alfalfa	30,8	31,9	1,1	3,78

Legumes and fodder crops planted to increase soil fertility have to some extent improved soil properties. As a result, the soil quality score increased. After these crops, the yield of planted cotton increased. It should be noted that the amount of increase in nutrients, as a result of calculating the rate of increase in yield of cotton, increased the average soil quality score by 5.1 compared to the previous state.

Conclusions

It was found that in Mirzachul conditions there is an integral correlation between soil properties and yields of major vegetable crops. The calculated correlation coefficients between the agronomically important properties of the soil and the yield of vegetable crops were as follows: by mechanical composition - 0.81–0.92; on humus reserves - 0,96–0,98; on the degree of salinity - 0.57–0.71; on the depth of the gley layer –0.88–0.95; Phosphorus content at a depth of 0–50 cm – 0.90–0.95; on the amount of potassium - 0.92–0.98; on soil gypsum – 0,68–0,76.

Based on the calculated correlations, it was possible to develop a rating scale and rating ratios for the mechanical composition of irrigated soils.

Given the role of legumes and fodder crops in increasing soil fertility, it is recommended to include them in a short rotation system.

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