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MAHALLA SYSTEM FOR ESTIMATING AGRICULTURAL AND LIVESTOCK PRODUCTION

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Abstract
A number of difficulties arise in modeling household decision-making in developing countries. First, the real structure and organization of a household are not adequately represented in the example of a nuclear household with a common place of residence and joint decisions on the consumption of public goods. Many scholars and practitioners around the world pay great attention to the current state of mahalla production and trends in it. However, the issue of choosing a strategy for the development of household areas has not been sufficiently studied. This creates problems for a comprehensive assessment of the state and potential of regional mahalla development. The cluster analysis method was used to group areas by the level of development of potential.
The level of development of regional clustering analysis was examined using the K-means method. Clustering can be used to analyze and reassess the development of production in districts.

Keywords: Households, regions, cluster analysis, K-means method.

Introduction

In the Republic of Uzbekistan, in 2010, tasks were set related to the reform of the makhalla institution. They included such important aspects as improving the organizational foundations of the activities of this institution, expanding its functions, and ensuring close cooperation with state authorities and management bodies. At the same time, households play an important role in the production of makhallas on their territory and improving the material condition of the population. Households are also one of the main driving forces in the

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development of the country's economy and ensuring the well-being of the population, creating the basis for their economic growth.

Due to the resource potential of households in each region of our country, the relative development efficiency of this sector is currently of great importance. Rational and maximally effective use of resources involved in the production process of households is a necessary condition for achieving the balanced interests of society in the social, economic and environmental spheres. It also serves as a basis for ensuring national priorities for agricultural development, in particular, ensuring food security, creating a successful export policy and ensuring state agrarian policy aimed at relative efficiency. In particular, we have divided the regions into clusters based on the level of development of the agricultural and livestock potential of households, their investment attractiveness.

Currently, agriculture plays an important role in household production in many countries. In this regard, all countries have a program for the development of the mahalla. In addition, it should be remembered that the development of households solves sensitive social, economic and environmental problems[6]. Regions determine the relative efficiency of households, the further development of food production. It is necessary to address the issue of the structural balance of the resource potential of households, in particular, the relationship between its individual components in terms of their costs. This is due, among other things, to the structural ratios between the land fund, the availability of equipment for land cultivation, livestock breeding and feed production, etc. The imbalance in these ratios leads to a decrease in the efficiency of household production.

If we consider the primary task of the household as the production of agricultural products, these products are food for people (fruits, vegetables, rice, meat, dairy products, eggs, etc.). Let's consider the production of livestock and agricultural products to increase the standard of living and well-being of the population. Uzbekistan's high resource potential, based on favorable climatic conditions, creates the opportunity to increase productivity and profitability. It should be noted that each region of our territory has its own sphere of social reproduction.

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Website: usajournals.org

In Uzbekistan, the household economy of the regions achieves efficiency through the use of a set of interrelated factors of a financial, economic, production, technical, organizational and social nature.

Literature review

Optimization of the living environment is a problem that must be solved together to obtain maximum benefits for the residents of the mahalla[1]. The issue of developing the resource potential of households is becoming increasingly important for countries around the world[2]. The dynamic factors that create new opportunities include climate change, environmental problems, the introduction of innovations, and attracting investments. In this regard, it is necessary to take into account the specific characteristics of the sector when revealing the importance of innovative and investment activities. The development of the potential of households is directly related to the rational use of available natural resources. The economic assessment of household land resources can be used to assess the capabilities of households. Researchers pay attention to new prospects for the development of the mahalla, the development of food production in the regions. Agricultural enterprises emerge as the dominant economic sector, closely followed by the service sector[4].

The country's regions, taking into account the potential profitability of household farms, investments and exports, do not take into account all factors of the internal and external environment. It should be noted that the importance of quantitative factors (resource potential of the region, product profitability, investment security of the region, export of agricultural products, etc.) should be taken into account[3]. Such prerequisites have led to the need to develop tools for the relative assessment of households based on the results of statistical analysis and to create an appropriate scientific and methodological model.

Cluster analysis refers to a group of individuals or objects that converge around a certain point and are therefore closely related to their positions[6]. Clustering is a means of grouping multidimensional objects, which differs from conventional clustering in that each cluster contains similar objects that differ significantly from objects in other clusters[5]. Grouping regions by the level of profitability of agricultural production and investment in households allows you

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to collect data and assess the state of production and development opportunities of each region. The K-means method is convenient to use compared to other methods.

Methods and techniques

Grouping the regions of our country by cluster analysis using the K-means method to assess the relative efficiency of household production and selecting indicators for clustering regions by the level of profitability of agriculture.

Cluster analysis is often used to group regions by a set of socio-economic indicators. The clustering method is used to assess the role of regions in determining regional disparities, grouping by similar indicators, and others. The K-means method is an iterative algorithm based on minimizing the total squared deviation of cluster points from the centers of these clusters. The essence of the clustering algorithm under consideration is as follows: the initial set is divided into a predetermined number of clusters k. The object of clustering is the regions of the Republic of Uzbekistan:

$$X=\{X1,X2,\ldots,Xn\},$$

where X1, X2, …, Xн - indicators characterizing the regions of Uzbekistan.

Let's consider the evaluation algorithm.

1. Preparation of a cluster analysis algorithm, determination of the characteristics and methods of cluster analysis.
2. Selection of K-means clusters for regions according to the level of development of household production, agriculture and livestock.
3. For 12 regions of Uzbekistan and the Republic of Karakalpakstan. For each of the two sectors, the main indicators were selected, and clustering was carried out according to them.
4. Based on the set of indicators, three clusters were formed for household production, agriculture and livestock.
5. Analysis and visualization of the results, i.e. presentation of the results in the form of graphs and tables and determination of the position of each region relative to others.

The most important aspect of clustering is that the indicators that best characterize the similarity of variables for clustering in the most effective

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characteristics of objects are selected. Important indicators in the household economy were selected and obtained based on data from the State Statistics Committee of the Republic of Uzbekistan. The level of development of the production potential of households was assessed in the context of its two main branches, namely agriculture and livestock.

The list of indicators selected for cluster analysis of regions includes:

-irrigated crop areas of all categories of farms (thousand hectares);

-agricultural products grown in dehkan and household farms (billion soums);

-labor productivity in household enterprises (sums);

- livestock products grown in dehkan and household farms (billion soums).

Table 1 presents statistical data on cluster analysis of regions by the level of development of agricultural crop potential.

Table 1. Development of household production in the regions of the Republic of Uzbekistan (2023y).

Areas	Signs	Irrigated cropland in farms of all categories, thousand ha	Agricultural products grown on farmers' and homestead farms, billion soums	Livestock products grown in peasant and homestead farms, billion soums
Republic of Karakalpakstan	H1	278090	15349,3	6861,6
Andijan region	H2	199826	41278,6	13213,5
Bukhara region	H3	240558	37350,0	16019,2
Jizzakh region	H4	231421	26401,2	13430,5
Kashkadarya region	H5	343223	38565,3	18974,3
Navoi region	H6	84422	18183,5	9884,6
Namangan region	H7	181940	29942,5	10279,5
Samarkand region	H8	257915	49140,1	18956,1
Surkhandarya region	H9	223168	32756,1	12792,3
Syrdarya region	H10	213239	13372,2	4651,8
Tashkent region	H11	275509	37979,9	16727,4
Fergana region	H12	242834	38169,5	12970,4
Khorezm region	H13	206503	26160,4	12467,8

Resource: National Statistics Committee Of The Republic Of Uzbekistan

Multidimensional observations or object classification are based on determining the distance between the objects under study. According to the Euclidean

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distance, this distance between objects j and k is a geometric distance in multidimensional space and is calculated by the following formula:

$$D_{jk} = \sqrt{\sum_{i=1}^{m} (x_{lj} - x_{jk})^2}$$

x_{j1} standardized indicators of the region

x_{jk} — indicators of the corresponding cluster center

Djk — is the main distance measure in the K-means clustering algorithm, which indicates the distance between point j and the center of cluster k. This distance is taken in the interval [0.69, 4.47]. Usually, the center of the k-cluster is the Euclidean algorithm (distance measure) used in K-means clustering (z-score) based on standardized data. First, we calculate the normal values of all columns according to the following formula.

$$x_{ij} = \frac{x - \mu}{\sigma}$$

Then the Euclidean distance is calculated using the following formula [12]. This result indicates how close this point is to the cluster. This process is repeated until convergence. D0, D1, D2 are the Euclidean distances of each point (region) to the cluster centers (centroids).

Table 2. Calculation results

D0	D1	D2	Region	Assigned_Cluster
2,50	1,49	3,78	Republic of Karakalpakstan	2,00
0,85	2,88	2,01	Andijan region	1,00
0,92	3,13	1,13	Bukhara region	1,00
0,70	1,97	2,17	Jizzakh region	1,00
2,66	4,48	0,96	Kashkadarya region	3,00
2,83	1,99	4,72	Navoi region	2,00
0,97	1,59	2,95	Namangan region	1,00
2,22	4,47	0,93	Samarkand region	3,00
0,11	2,22	1,99	Surkhandarya region	1,00
2,79	0,74	4,51	Syrdarya region	2,00
1,42	3,49	0,60	Tashkent region	3,00
0,65	2,74	1,58	Fergana region	1,00
0,72	1,67	2,54	Khorezm region	1,00

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The results obtained can be seen in the graph (Figure 1).

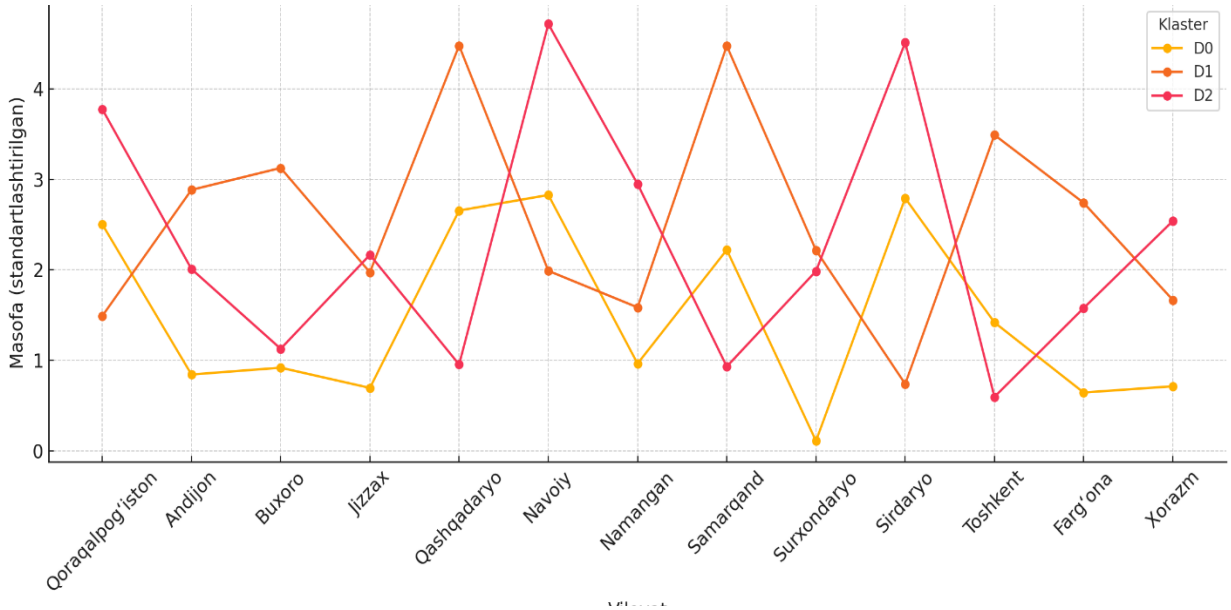

Figure 1. Clustering by products grown on peasant and household farms in the Republic

The following 3 clusters were formed based on K-means clustering for 13 regions.

Table 3. Clusters of products grown on peasant and household farms in the Republic

Cluster	Crop area (thousand ha)	Volume of agricultural products produced by peasant and household farms (billion soums)	Volume of livestock products produced by peasant and household farms(billion soums)
1	218.0	33151.2	13024.7
2	191.9	15635.0	7132.7
3	292.2	41895.1	18219.3

Cluster 1 is divided into medium-producing regions, cluster 2 is low-producing regions, and cluster 3 is developed regions.
Table 4 presents statistical data on the grouping of regions by the level of agricultural products grown in farms of all categories in 2023.

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Table 4.Cultivation of agricultural products grown in farms of all categories in 2023

Region	Profitability level of agricultural products, thousand tons					
	Grain crops	Legumes	Sunflower	Vegetables	Potatoes	Fruits and berries
	X1	X2	X3	X4	X5	X6
Republic of Karakalpakstan	317,4	35	2,9	333,3	3574,1	67,1
Andijan region	710,7	28,5	5,4	1772,6	96,4	685,9
Bukhara region	645,5	25,3	4,4	914,6	431,6	305,8
Jizzakh region	712,1	54,4	1,4	472,9	257,3	100
Kashkadarya region	840	12,5	1,5	559,3	105,3	175,6
Navoi region	257,8	8,9	1	335	195,6	106,5
Namangan region	686,2	86,1	4,9	989,3	88,2	374,1
Samarkand region	879,9	96,4	1,1	1576,7	341,3	368,2
Surkhandarya region	754,2	36,7	0,3	1169,2	725,1	182,3
Syrdarya region	559,1	27,1	0,5	302,6	357,9	46,4
Tashkent region	651	25,3	1,3	1154,7	68,5	126
Fergana region	943,9	70,1	1,2	1319,1	386,1	411,4
Khorezm region	495,5	5,1	2,7	653,4	372,6	170,9

Based on Table 4, the regions of the Republic were grouped by agricultural products grown. We included regions with high productivity, including grain crops (730 thousand tons), vegetables (1,313 thousand tons), and fruits (433 thousand tons) in Cluster 1. Producers with an average level were included in Cluster 2 (vegetables (665 thousand tons), potatoes (285 thousand tons), and fruits (123 thousand tons)), and low productivity was included in Cluster 3. This can be seen in Figure 2.

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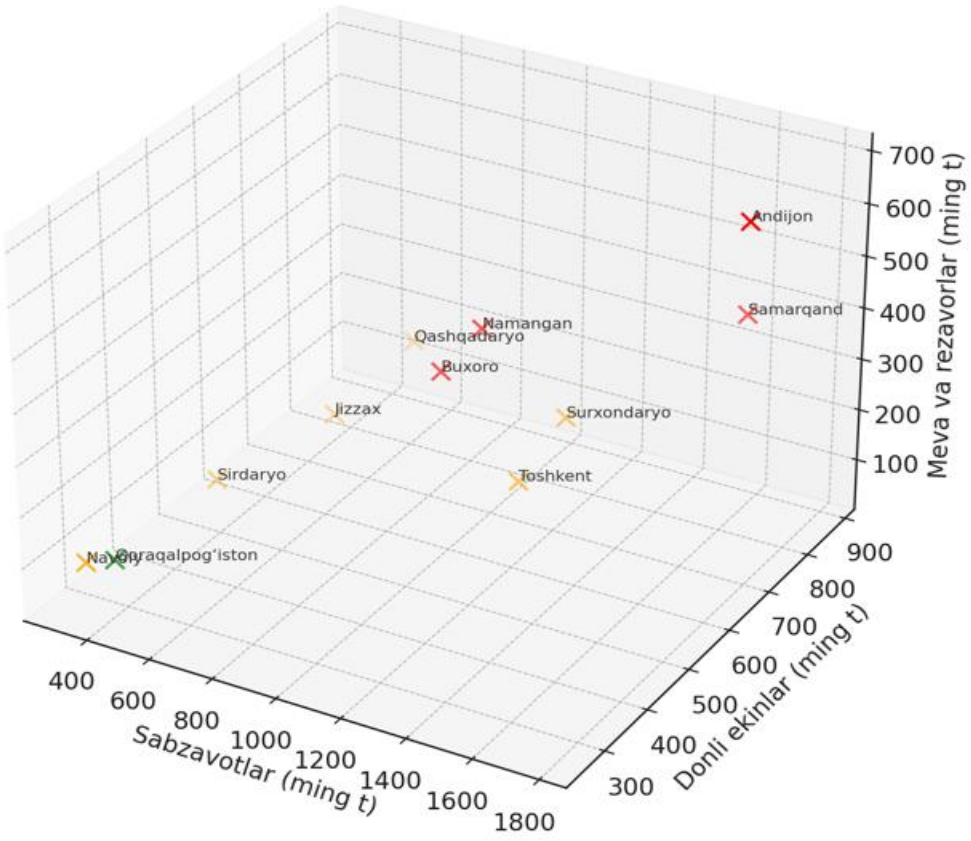

Figure 2. Clustering of regions by agricultural products

In Figure 2, the regions are shown in separate colors, with clusters identified according to the K-means algorithm. Each axis shows the yield of each type of product (thousand tons). This can be seen in Cluster 1 (red) High productivity, vegetables, cereals, fruits, vegetables and fruits at an average level in Cluster 2 (yellow). Low productivity, but very high potatoes (Karakalpakstan is in a separate cluster) in 3.

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Table 6. The level of profitability of livestock products grown in farms of all categories by region (2023 y.).

Regions	Level of profitability of livestock products						
	Cattle bred for slaughter (live weight), thousand tons	Sheep and goats raised for slaughter (in live weight), thousand tons	Poultry grown for slaughter (in live weight), thousand tons	Other types of livestock raised for slaughter (horses, camels, rabbits, etc., live weight), thousand tons	Total eggs, mln. piece	Total expressed milk, thousand tons	Received honey, tons
	X1	X2	X3	X4	X5	X6	X7
Republic of Karakalpakstan	99,6	18,5	5,1	0,7	397,9	447,7	877,2
Andijan	136,2	25,3	31,4	0,025	750,6	1090,1	1312
Bukhara	219,6	49,1	30,9	0,4	550,2	1088,9	2484,6
Jizzakh	178,6	49,7	9,6	0,3	419,9	693,8	1300,1
Kashkadarya	240	83,1	4,8	0,7	578,5	1311,4	1465,6
Navoi	124,5	47,6	9	6	406,7	539,3	1184,8
Namangan	126,8	13,6	38,4	0,1	656,3	770,8	1289,3
Samarkand	217,9	42,7	56,3	0,2	1292,7	1402,1	1288,1
Surkhandarya	161,8	49,4	2,9	0,1	589,1	950,9	976,2
Syrdarya	62,3	6	5,8	0,2	199,9	395,3	395,2
Tashkent	206,6	26,7	66,6	4,6	1547,2	1022,9	594,7
Fergana	141,9	17,8	24,4	0,3	616,8	1138,4	1459,1
Khorezm	160,9	5,3	18,7	0,041	469,6	1110,9	1208,2

The analysis shows that it is possible to propose a scientific and methodological approach to the formation and selection of a strategy for assessing the relative efficiency of household production in regions. Cluster 1 is suitable for implementing the Innovation and Investment Strategy for moderately developed regions, Cluster 2 is suitable for implementing the Support or Modernization Strategy for low-level regions, and Cluster 3 is suitable for implementing the Export and Leadership Strategy for highly developed regions. The Dendrogram below helps us divide territories into regional groups, allocate resources, or plan strategically (Fig. 1).

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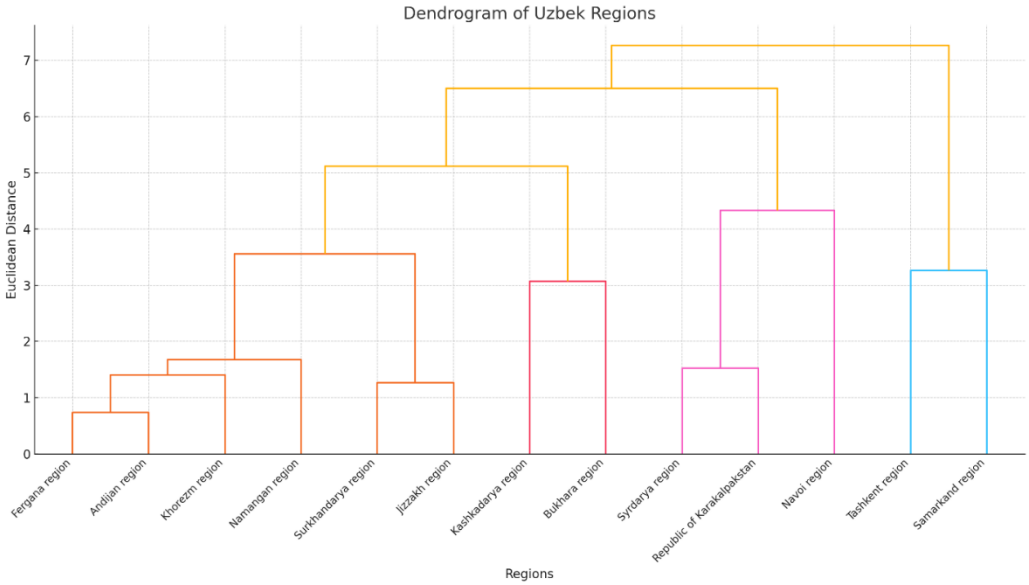

Figure 3. Dendrogram of the regions of Uzbekistan by the level of development of livestock potential, 2023 y.

In the dendrogram, regions that are close together from the top (for example, Fergana and Andijan) are connected first, indicating that they are statistically similar. Nearby regions have similar livestock indicators.The distance on the y-axis indicates that the farther the clusters are from each other, the greater the difference between them. The line through the intersection indicates that 3 groups were separated as a result of K-means. A high linkage distance indicates a large difference between regions.

Table 7. Clusters of regions by livestock products produced on farms of all categories

Klaster 1	Klasster 2
Andijan	Karakalpakstan
Bukhara	Navoi
Jizzakh	Syr Darya
Kashkadarya	
Namangan	
Fergana	
Khorezm	
Klasster 3	
Samarkand	
Tashkent	

Modern American Journal of Business, Economics, and Entrepreneurship
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Volume 01, Issue 03, June, 2025
Website: usajournals.org

Three clusters were identified by the level of development of livestock potential. The first cluster consists of eight regions with a positive trend in increasing average productivity and potential. This cluster mainly includes densely populated, economically active regions that are close to each other in terms of industry, trade, or production. The next, second cluster consists of 3 regions. This cluster is characterized by stagnation and low development of livestock. In turn, the third cluster includes Samarkand and Tashkent regions. It is characterized by high productivity of agricultural enterprises. Samarkand region is a leader not only in this cluster, but also in all of Uzbekistan in terms of livestock breeding, the number of livestock, and labor productivity in agricultural enterprises. As for Tashkent region, it leads in terms of production per capita in all regions. Thus, cluster analysis made it possible to distinguish groups of regions of Uzbekistan according to the level of development of agriculture and livestock.

Conclusion

Using the cluster analysis method, the country's regions are combined into different clusters depending on the values of the above parameters. For each group of selected regions, a separate strategy for the development of agriculture should be selected. The results of the study made it possible to confirm the hypothesis and solve the problem of choosing strategies for improving the resource potential of the region, depending on the level of the above parameters, depending on which group it belongs to.

The Mahalla production with the highest resource potential in Uzbekistan was analyzed. Using cluster analysis, 3 regional clusters were identified based on the level of development of the resource potential of agriculture and statistical data for 2023. The results of the study show that the best average level of development of agriculture is observed in the regions included in the first clusters. The third cluster has the highest average indicators of such indicators as labor productivity, gross yield of grain and leguminous crops in agricultural enterprises.

Based on a comparison of the clusters of Uzbek regions in terms of the level of development of the resource potential of livestock farming and the level of

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Volume 01, Issue 03, June, 2025
Website: usajournals.org

profitability of livestock products, the following strategies are proposed for improving the resource potential of the regions of Uzbekistan in livestock farming: support strategy, development strategy, competition strategy, export strategy.

Our study of household production, of course, has some limitations. It includes only two sectors of household production, namely, livestock farming and livestock farming, but there are other sectors of production.

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