INFRASTRUKTURA I EKOLOGIA TERENÓW WIEJSKICH
INFRASTRUCTURE AND ECOLOGY OF RURAL AREAS

No I/1/2022, POLISH ACADEMY OF SCIENCES, Cracow Branch, pp. 75-83
Commission of Technical Rural Infrastructure

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USE OF ANALYTICAL HIERARCHY PROCESS IN DAIRY CATTLE BARN SITE SELECTION

ABSTRACT

The first thing to do when planning dairy cattle barns is to determine a suitable management location. Site selection is a very important decision, as it will be difficult and costly to compensate for the mistakes made after the establishment of the enterprise. Analytical Hierarchy Process (AHP), which is used in the solution of complex problems, creates a hierarchical structure in the decision-making process in the form of purpose, criteria, sub-criteria and alternatives. AHP is defined as the method of choosing the best among many alternatives. In this study, 5 main criteria (topography, land use, marketing conditions, environmental factors and infrastructure adequacy) and 20 sub-criteria were determined in order to determine suitable areas for dairy cattle barns. In order to determine the weighted values of the criteria, a total of 30 surveys were conducted with academicians who are experts in their fields, agricultural engineers working in the livestock sector and officials working on animal production in institutions.According to the results of the survey, it has been revealed that the most important criterion among the main criteria is environmental factors. Considering the paired comparison results of the sub-criteria; it was concluded that among the topography criteria, the importance levels of the slope criteria are higher than the others. Besides, land use capability among the land use criteria; milk processing potential among marketing conditions criteria; distance to settlements among environmental factors criteria; among the criteria of environmental factors, distance to settlement areas and distance to drinking water basin protection areas; among the infrastructure adequacy criteria, proximity to electricity services are higher than the others.

Keywords: *Livestock enterprise, Dairy cattle barns, Analytical hierarchy process*

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INTRODUCTION

A barn means a structure where the animals in it live in conditions of high welfare, and all tasks such as feed distribution and manure cleaning can be done easily. For this reason, barn planning is very important in terms of yield and animal health.

The care shown in purchasing animals is often not shown at the barn planning stage. However, the success of the enterprise depends on the appropriate planning in terms of the type of aquaculture and location, taking into account the future developments. It will be very difficult and costly to fix the barns built without considering these criteria after the operation starts. This is one of the most common problems in livestock enterprises (Arıcı et al., 2005).

While selection of the enterprise site, criteria such as roads, topographic conditions, water resources and water supply, electricity supply, soil and drainage conditions, direction of the land, climatic conditions, suitability for waste water and fertilizer management, legal regulations, and its effect on neighboring enterprises should be taken into account (Olgun, 2011).

Multi-Criteria Decision Analysis (MCDA) is a decision-making method that enables choosing among many criteria for a specific purpose (Dogramacı, 2009). The Analytical Hierarchy Process (AHP), one of the MCDA techniques, was first introduced by Myers and Alpert (1968) and was developed by Professor Thomas L. Saaty in the 1970s (Kuruüzüm and Atsan, 2001). In order to facilitate decision-making in AHP, the results are reached by considering the decisions of experts in the field (Saaty, 1980; Basaraner, 2011; Omürbek et al., 2013; Yıldırım and Onder, 2015).

Analytical Hierarchy Process has many uses in many different sectors such as Site Selection Analysis for Enterprise, Human Resources Management, Natural Disaster Analysis, Risk Analysis, Land Suitability Analysis. When the literature studies are examined, it's seen that AHP is used in solving problems in different subjects such as wind observation station location selection (Aras et al., 2004), restaurant location selection (Tzeng et al., 2002), hospital location selection (Wu et al., 2007), industrial zone location selection (Eldrandaly et al.2003), the municipal landfill area (Erkut and Moran, 1991).

After determining the purpose/problem in AHP, the first step is to create the hierarchical structure that includes the purpose, main criteria, sub-criteria and alternatives. The next step is to create a comparison matrix in order to compare all criteria among themselves and find their weight values. Finally, decision makers create a scoring system based on the matrices, according to the weight values of the criteria.

MATERIAL AND METHOD

In the study, the AHP method, in which the opinions and intuitions of the decision makers can be included in the solution of the problem, was used. The first step in establishing the hierarchical structure is to determine the most suitable site selection criteria for dairy cattle barns. The criteria were created in the light of information in the previous literature on animal barn planning.

For the topography criterion; slope and aspect; for the land use criterion, proximity to grazing, land use capability, proximity to animal drinking water ponds and irrigation ponds; for the criteria of marketing conditions, milk processing potential, meat processing potential, population potential and cooperation potential; for the criteria of environmental factors, distance to settlements, distance to drinking water basins, distance to other water basins, distance to rivers, proximity to cultural and ecological protection areas, proximity to irrigation canals and reans; for the criterion of infrastructure adequacy, proximity to electricity services, distance to veterinary services, proximity to main roads, proximity to byroads, solar energy potential was established as sub-criteria.

In order to evaluate the importance levels of the criteria relative to each other, a survey was conducted with a total of 30 people, consisting of academicians of Animal Science, Biosystem Engineering and Agricultural Structures and Irrigation Departments at different universities, officials working in institutions related to the subject of study, and agricultural engineers working in agricultural enterprises (Golden et al., 1989; Gökkaya, 2014). The survey results were digitized according to the values in the scale in Table 1.

Comparison matrices, which were created to determine the superiority of the criteria over each other, were prepared separately for each criterion and transferred to the Expert Choice program and analyzed (Expert Choice, 2011).

As a result of the Expert Choice analysis, the consistency ratio (CR) of the pairwise comparison matrices was obtained. If the consistency ratio is below 10%, it means that the values show sufficient consistency. If the consistency rate is above 10%, pairwise comparisons should be reviewed (Ozturk and Kilic, 2010).

Since the knowledge and experience of the experts on the subject will directly affect the consistency ratio of the values, experts should be chosen from people who are closely related to the subject and have knowledge (Kocamaz and Soyuer, 2002).

Table 1. AHP evaluation scale (Saaty, 1980)

Numerical value of Pij	Definition
1	Equal importance of i and j
3	Moderate importance of i over j
5	Strong importance of i over j
7	Very strong importance of i over j
9	Extreme importance of i over j
2, 4, 6, 8	Intermediate values

RESULTS

Within the scope of the study, 5 main criteria and 20 sub-criteria that are thought to be effective in animal barn planning were determined. The pairwise comparison matrices formed between the criteria are given in Table 2-7. In the matrices, the components with which the criteria are compared are accepted as one (1). The pairwise comparison matrix of the main criteria is given in Table 2 and the consistency rate was calculated as 1%.

Table 2. Pairwise comparison matrix of the main criteria

	Topography	Land Use	Marketing Conditions	Environmental Factors	Infrastructure Adequacy
Topography	1.00	0.58	0.36	0.20	0.36
Land Use	1.72	1.00	0.58	0.58	0.66
Marketing Conditions	2.74	1.72	1.00	0.66	1.00
Environmental Factors	4.98	1.72	1.50	1.00	1.50
Infrastructure Adequacy	2.74	1.50	1.50	1.00	1.00

The pairwise comparison matrix of the topography criteria is given in Table 3 and the consistency rate was calculated as 0%.

Table 3. Pairwise comparison matrix of the topography criteria

	Slope	Aspect
Slope	1	1.72
Aspect	0.58	1

The pairwise comparison matrix of the land use criteria is given in Table 4 and the consistency rate is calculated as 7%.

Table 4. Pairwise comparison matrix of the land use criteria

	Proximity to Grazing	Land Use Capability	Proximity to Animal Drinking Water Ponds	Irrigation Ponds
Proximity to Grazing	1.00	1.11	4.98	3.29
Land Use Capability	1.30	1.00	2.33	3.29
Proximity to Animal Drinking Water Ponds	0.20	0.42	1.00	2.33
Irrigation Ponds	0.30	0.30	0.42	1.00

The pairwise comparison matrix of the marketing condition criteria is given in Table 5 and the consistency rate is calculated as 8%.

Table 5. Pairwise comparison matrix of the marketing condition criteria

	Population Potential	Milk Processing Potential	Meat Processing Potential	Cooperation Potential
Population Potential	1.00	0.50	1.50	0.66
Milk Processing Potential	2.00	1.00	13.90	1.72
Meat Processing Potential	0.66	0.07	1.00	0.30
Cooperation Potential	1.50	0.66	3.29	1.00

The pairwise comparison matrix of environmental factors criteria is given in Table 6 and the consistency rate was calculated as 4%.

Table 6. Pairwise comparison matrix of environmental factors criteria

	Distance to settlements	Distance to drinking water basins	Distance to other water basins	Distance to rivers	Proximity to irrigation canals and reans	Proximity to cultural and ecological protection areas
Distance to settlements	1.00	0.50	2.00	2.33	1.72	1.50
Distance to drinking water basins	2.00	1.00	9.00	6.51	4.00	13.92
Distance to other water basins	0.50	0.30	1.00	0.66	0.43	1.14
Distance to rivers	0.43	0.15	1.50	1.00	0.87	2.74
Proximity to irrigation canals and reans	0.58	0.25	2.33	1.14	1.00	3.29
Proximity to cultural and ecological protection areas	0.66	0.07	0.87	0.36	0.30	1.00

The pairwise comparison matrix of infrastructure adequacy criteria is given in Table 7 and the consistency rate is calculated as 6%.

Table 7. Pairwise comparison matrix of infrastructure adequacy criteria

	Proximity to electricity services	Distance to veterinary services	Proximity to main roads	Proximity to byroads	Solar energy potential
Proximity to electricity services	1.00	2.33	1.14	2.74	1.50
Distance to veterinary services	0.43	1.00	1.14	2.00	2.00
Proximity to main roads	0.87	0.87	1.00	6.51	2.33
Proximity to byroads	0.36	0.50	0.15	1.00	0.66
Solar energy potential	0.66	0.50	0.43	1.50	1.00

Weight values (W) of all criteria are given in Table 8. Among the main criteria, environmental factors have the highest weight value (0.331), followed by marketing criteria (0.228), infrastructure adequacy (0.204), land use (0.151) and topography (0.087), respectively.

Table 8. Weight values of main and sub-criteria (W)

Main Criterias	W	Sub-criteria	W
Topography	0.087	Slope	0.632
		Aspect	0.368
Land use	0.151	Proximity to grazing	0.404
		Land use capability	0.363
		Proximity to animal drinking water ponds	0.142
		Proximity to irrigation ponds	0.092
Marketing conditions	0.228	Population potential	0.164
		Milk processing potential	0.526
		Meat processing potential	0.068
		Cooperation potential	0.241
Enviro mental factors	0.331	Distance to settlements	0.167
		Distance to drinking water basins	0.509
		Distance to other water basins	0.059
		Distance to rivers	0.093
		Proximity to irrigation canals and reans	0.121
		Proximity to cultural and ecological Protection areas	0.051
Infrastructure adequacy	0.204	Proximity to electricity services	0.290
		Distance to veterinary services	0.207
		Proximity to main roads	0.296
		Proximity to byroads	0.080
		Solar energy potential	0.128

CONCLUSION

In the study, the most important criteria to be considered for establishing a dairy cattle barn were determined by applying AHP.

According to the AHP method, environmental factors were the most important criteria among the main criteria.

The slope is important in terms of excavation-filling cost in the land where the enterprise will be established. The AHP result in the study also supports this.

Transportation has an important share in agricultural input and marketing. High fuel cost cause additional costs on agricultural inputs. For this reason, it is important that the enterprise is close to the main roads as an infrastructure criterion.

The fact that the business is far from the market and the product processing facility will negatively affect the production process as it will be a waste of both fuel cost and time. Therefore, its proximity to the milk processing plant is one of the criteria to be considered.

Considering the possibility that any wastewater that may leak from the barn may pollute the rivers, it is necessary to keep a distance between the rivers and agricultural enterprises.

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Received: 21 November 2021
Revised: 16 May 2022
Accepted: 19 May 2022