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Analysis Of Sheep Milk Yield In Turkey By Regions Using Nested Factored Experiment Design

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ABSTRACT: *This study aims to determine the yield difference of sheep milk production according to the geographical regions in Turkey by using the nested factor experimental design. While there was no significant difference in terms of regions and cities, there was a significant difference between the cities of the regions (P<0.001). Furthermore, the variance factors related to milk yield were estimated by means of ANOVA, ML and REML methods. Estimation of variance factors found by ANOVA and REML were equal and they were found to be higher than the values obtained by the ML method.*
KEYWORDS: *Milk yield, nested design, variance components.*

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I. INTRODUCTION

Ovine breeding is an important source of livelihood for poor farmers in underdeveloped countries. After 1980, the number of goats in the world has doubled, but there was no significant change in the number of sheep (FAOSTAT, 2013).

According to 2012 FAO data, 45% of all sheep (526 million) is located in the continent of Asia; Africa follows this continent with 325 million sheep (28%), Europe was the third with 130 million sheep (11%), Oceania comes after Europe with 106 million sheep (9%) and the US follows them with 85 million sheep (7%) (FAOSTAT, 2012).

According to the data of the year 2013; China has 15% of the world's total sheep count with 185 million sheep. Australia follows China with 6.5%. Turkey ranks the 10th by having approximately 29.3 million sheep (FAOSTAT, 2013).

Approximately 1 billion sheep and goats are slaughtered, and 14 million tons of meat are produced annually in the world. China, Australia, New Zealand, and England are the leading countries in sheep meat production. Turkey ranks the second after China for sheep milk production with 1.1 million tons of milk and produces 10% of the world milk production (FAOSTAT, 2012).

A large part of the milk produced in Turkey comes from bovines. In 2013, 6% of 18.2 million tons of milk production was obtained from sheep while 2% was obtained from goats. In the last 30 years, milk yield per milking animals increased to 77 kg from 49 kg in sheep and to 105 kg from 57 kg in goats (TIS, 2014).

Sheep milk or called as ewe milk is preferred for products such as cheese and yoghurt due to its high fat and the dry substance rate. It is used for the production of ayran (a drink made of yoghurt and water) and çökelek (cottage cheese) which are the remains of oils obtained from sheep's yoghurt and it contributes to human nutrition. The majority of sheep milk is used for cheese production which has a higher economic return. Sheep milk is preferred for making various cheese types in Turkey. Sheep milk is generally mixed with cow's milk when making cheese. Under normal circumstances, 1 kg of white cheese can be produced from 6-7 kg of cow's milk while the same amount of cheese can be produced from 4-5 kg of sheep's milk. Sheep milk is also significant in yoghurt production. Yoghurt made from sheep's milk has its own unique taste and flavor. It is advantageous because it is produced without the need for any increase in dry matter due to its high dry matter content. Yoghurt made from sheep's milk has higher viscosity and clot stability than yoghurt made from cow's milk. Due to seasonal fluctuations and inadequacies in sheep milk amount in Turkey; cow, buffalo, and goat milk can also be used (Akpınar and Uysal, 2011).

The aim of this study was to determine the significance of the differences of milk yield from the sheep raised in the selected cities and districts in 7 geographical areas of Turkey.

II. MATERIAL AND METHOD

Material

The material of this study is constituted of the data of sheep count and sheep milk amount based on cities in 2013 received from Turkish Statistical Institute's (TÜİK) website. The total amount of milk production within one year (kg) has been divided into sheep count and the average sheep's milk yield (kg) has been determined. Sheep count, and milk yield according to the sheep milk amount in five cities having higher population and being most developed in terms of socio-economic conditions and 6 most developed districts of these cities among 7 geographical regions have been determined. Adana, Antalya, Hatay, Kahramanmaraş and Mersin from the Mediterranean Region; Adıyaman, Diyarbakır, Gaziantep, Mardin and Şanlıurfa from the Southeastern Anatolia Region; Aydın, Denizli, İzmir, Manisa and Muğla from the Aegean Region; Ankara, Eskişehir, Kayseri, Konya and Sivas from the Central Anatolia Region; Balıkesir, Bursa, İstanbul, Kocaeli and Sakarya from the Marmara Region; Elazığ, Erzincan, Erzurum, Malatya and Van from the Eastern Anatolia Region; Çorum, Ordu, Rize, Samsun and Trabzon from the Black Sea Region and 6 districts of each of the cities were included in the study. Thus, 7X5X6=210 number of observations were obtained, and the sheep milk yield was analyzed by the nested classification method. The absolute frequency was 6 and each district of the cities was accepted as a frequency.

Method

There are different levels of another factor under each level of a factor in the Nested Factor Experimental Design. In other words, the first factor has certain levels of the second factor in its first level while the second level of the first factor has other levels of the second factor (Efe et al, 2000). Due to the fact that there is more than one factor in the nested factor models, the observations could be seen after the last factor in the factor hierarchy. The design is called Two-Stage Nested Design when there are two factors nested in each other. Similarly, the design is called A Three-Stage Nested Design when there are three factors nested in each other. In Nested Factor Designs, any of the factors can be specially or randomly selected. In an experiment design, factors with multiplicative level factors and nested factors can be found together (Öztürk, 2014). Nested factor test is advantageous due to the fact that there is no special limitation in terms of the number of levels and the ability to calculate the error ratio of various factors depending on the based model. Moreover, it has the benefit of being applicable if the number of groups at each level is not equal to the number of observations in the group (Yıldız and Bircan, 2012). Interactions are not calculated in the nested classification experiments (Soysal and Gürcan, 2012).

The model for this two-way random nested design is given as follows

$Y_{ijk} = m + a_i + b_{j(i)} + e_{(ij)k}$, (i=1,...,a; j=1,...,b; k=1,...,n)

(Montgomery, 2001). Where; Y_{ijk} is the observation k in level i of factor A (area) and level j of factor B (city); m is population mean; a_i is area effect; $b_{j(i)}$ is i. region with j. city effect; $e_{(ij)k}$: $N(0, s^2)$ is random error assumed to be normally distributed.

Methods of estimating variance components

The analysis of variance (ANOVA) estimation of the variance components consists of equating mean squares to their respective expected value. The output equations are solved for the variance components and the solutions are the estimators of σ_α^2, $\sigma_{\beta(\alpha)}^2$ and σ_ε^2.

$$\hat{\sigma}_\varepsilon^2 = \mathrm{MSE} = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n}\frac{(Y_{ijk} - \bar{Y}_{ij})}{\alpha\beta(n-1)}$$

$$\hat{\sigma}_{\beta(\alpha)}^2 = \frac{\mathrm{MS}\beta(\alpha) - \mathrm{MSE}}{n}$$

$$\mathrm{MS}\beta(\alpha) = \sum_{i=1}^{a}\sum_{j=1}^{b}\frac{n(\bar{Y}_{ij.} - \bar{Y}_{i.})^2}{\alpha(\beta-1)}$$

$$\sigma_\alpha^2 = \frac{\mathrm{MS}\alpha - \mathrm{MS}\beta(\alpha)}{\beta n}$$

$$MS\alpha = \sum_{i=1}^{b} \frac{\beta n(\overline{Y}_{i.} - \overline{Y}_{..})^2}{(\alpha - 1)}$$

Negative variance estimation problem is the most important issue for ANOVA (Fırat, 1997).

Maximum Likelihood (ML) estimators of the variance components are

$$\hat{\sigma}_{\varepsilon}^2 = MSE$$

$$\hat{\sigma}_{\beta(\alpha)}^2 = \frac{\left(1 - \frac{1}{\alpha}\right) MS\alpha - MS\beta(\alpha)}{\beta n}$$

$$\hat{\sigma}_{\alpha}^2 = \frac{MS\beta(\alpha) - MSE}{n}$$

for $\sigma_{\alpha}^2 \geq 0$ and $\hat{\sigma}_{\beta(\alpha)}^2 \geq 0$.

Restricted Maximum Likelihood (REML) estimators of the variance components are

$$\hat{\sigma}_{\varepsilon}^2 = MSE$$

$$\hat{\sigma}_{\alpha}^2 = \frac{MS\alpha - MS\beta(\alpha)}{n\beta}$$

$$\hat{\sigma}_{\beta(\alpha)}^2 = \frac{MS\beta(\alpha) - MSE}{n}$$

for $\sigma_{\alpha}^2 \geq 0$ and $\hat{\sigma}_{\beta(\alpha)}^2 \geq 0$ (Sahai, 2004; Searle, 1992).

III. RESULTS

In this study, variance analysis was applied to sheep milk yield data by using a two-stage randomized nested classification test plan performed in 5 cities from each geographical region of Turkey. In addition, ANOVA, ML (Maximum Likelihood) and REML (Restricted Maximum Likelihood) methods were used to estimate variance factors. Results of variance analysis were presented in Table 1 and variance factor estimations with ANOVA, ML and REML methods were shown in Table 2.

Table 1. Results of variance analysis (ANOVA) for nested design

Source	df	SS	MS	F	p
Area	6	1461.236	243.539	1.304	0.293
City	4	929.240	232.310	1.243	0.319
City (Area)	24	4483.711	186.821	74968	0.001
Error	175	0.436	0.002		
General	209	6874.62			

df: degrees freedom, SS: sum of square, MS: mean of square,

According to Table 1, the differences in milk yield according to the regions are found to be insignificant. The difference in terms of milk yield among cities is also insignificant. The difference in sheep milk yield is found to be significant among cities within the regions (P<0.001). In other words, a significant difference is seen from one city to another in terms of milk production in Turkey for City (Area) factor. While it is not an important factor in the milk yield when regions and cities are evaluated separately, the cities within the regions play a significant role. Therefore, the importance of the nested factor test plan has been revealed very clearly.

Table 2. Estimation of variance components using different methods

Component	ANOVA	ML	REML
σ_{city}^2	1.083	0.866	1.083
$\sigma_{city\ (area)}^2$	31.136	24.909	31.136
σ_{ε}^2	0.002	0.002	0.002

It appears that the ANOVA, ML and REML methods estimated σ^2_{city}, $\sigma^2_{city\ (area)}$ and σ^2_{ε} as positive when Table 2 is examined. All the variance factors estimated by ANOVA and REML resulted equal while the σ^2_{city} and $\sigma^2_{city\ (area)}$ factors estimated by the ML method was found to be lower.

IV. CONCLUSION

In the nested test plan, the difference in milk yield according to the cities within the regions was found to be significant. It was seen that there was no significant difference in milk yield when individual effects of each region and city were examined. Methods based on likelihood theory in estimating variance factors by different methods (REML and ML) and variance analysis (ANOVA) method have given consistent results. No bias problem was found, and it was understood that the methods were suitable since all the variance factors were estimated positively.

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