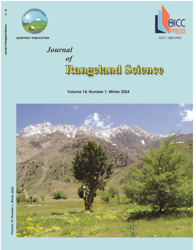

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Technical Efficiency of Traditional Livestock Husbandry and Effective Factors in Mountain Rangelands of Northern Iran

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Abstract:

Measurement of Technical Efficiency (TE) provides useful information on the competitiveness of Rangeland Unit (RU) and potential to improve productivity, with the existing resources. So, the purpose of this study was to evaluate the technical efficiency of Traditional Livestock Husbandry (TLH) and determine the main factors influencing it via management variables of Range Management Plans (RMP) and demographic variables of ranchers (age, education, herd size) in the semi-arid rangelands of Northern Iran. To do this, the study employs a Data Envelopment Analysis (DEA) via parametric stochastic frontier analysis. This technique creates efficiency indices by comparing the performance of traditional livestock husbandry. The random sampling method was used to collect data via a survey questionnaire from 82 semi-nomad ranchers in 2018 – 2019. Results show that the average value of scale efficiency (SE) was 0.78; technical efficiency (TE) at Constant Returns to Scale (TE_{CRS}) and Variable Returns to Scale (TE_{VRS}) level were calculated 0.54 and 0.69, respectively. Also, implementing RMP in some RUs could improve SE level by 0.81. Over 62.2 % of animal units show increasing returns to scale and about a quarter to a fifth of the animal units were in the area of risk-reducing returns which indicates the need to reduce the scale to improve efficiency. Therefore; a significant part of technical efficiency is related to the SE and in the current research, implementing RMP in rangeland units improved the SE up to 81 %. This ratio of RMP-in was less than RMP-out which showed the need to increase returns to scale to improve efficiency. About 10 % of animal units in implementing RMPs allocated to perfectly efficient and so-called are on the boundary function. The Tobit regression results indicated that education, experience, livestock breed and implantation of RMP significantly affected the efficiency. Policies are thus needed to improve the mentioned above factors to sustain the efficiency of RUs that diversify the rancher's economy.

Keywords: Data envelopment analysis; Range management plans; Technical efficiency; Tobit regression; Traditional livestock husbandry

1. Introduction

Rangelands are the largest terrestrial ecosystem in Iran by covering approximately 54.6 % of the total land area, i.e., 90 million ha, and nearly 65 % of natural resources (Badripour et al., 2006). These natural habitats have gotten less attention of conservation rather than other major ecosystems in Iran and unfortunately have been degrading for many decades (Abdi et al., 2018). Several studies have shown that increasing anthropogenic activities such as expansion of farmlands (Kedu, 2019), land use/land cover change (Holechek et al., 2011) and grazing intensity (Abdi et al., 2018; Gedefaw et al., 2020) are the main driving forces of degradation of rangeland ecosystems. Some researchers (Al-bukhari et al., 2018; Abdi et al., 2018; Zhao et al., 2020) showed that reclamation measures can reverse the process of rangeland degradation, cause positive changes in ecosystem, and conservation of natural vegetation or restoration of degraded lands using suitable RMP. Therefore, the Iranian government has launched a national policy for regulating the use of the rangeland resources (Kebede et al., Kebede2013). The RMP was designed with the principles of plant ecology, based on the range succession model (Mofidi et al., 2019). According to this model, a given rangeland has an ecologically tenacious status in the absence of grazing (Holechek et al., 2011). RMPs have been prepared for about 25 million ha by the rangeland technical office in Forests, Rangelands, and Watershed Organization (Zohdi et al., 2018). Despite of nearly 30 years of implementation of the RMPs, the population of livestock is still about 2.5 times more than the carrying capacity defined by the plans (Naseri et al., 2016). Although the ecological benefits of implementing the defined plans to the rangeland vegetation have been highlighted, evidence illustrates that many landholders have not gone through the sustainable management system defined by the government (Hedjazi, 2007). Unfortunately, in some of the ongoing RMP, grazing capacity (balance between forage production and livestock population), grazing season and period are not observed (Karimi and Karamidehkordi, 2016).

In economic theory, efficiency and its types include technical efficiency, allocative efficiency, and economic efficiency; this concept of how well an organization has used its resources to produce its best performance in a period of time (Gaviglio et al., 2021). The technical efficiency represents the degree of success to produce maximum output from given levels of inputs (Zhang et al., 2014). There are two parametric and nonparametric models for assessment in general, and evaluation of efficiency, in particular (Parman et al., 2019). In this study, DEA method has been used. The two most commonly-used empirical procedures for examining the production efficiency are: 1) Stochastic Production Frontier analysis (SPF) (Aigner et al., 1977), 2) Data envelopment analysis (DEA) (Sabetan Shirazi et al., 2006). Both are based on Farrell (1957) seminal paper and estimate a production frontier. Demircan et al. (2006) and (Demircan et al., 2010) found that feed and labor inputs were used inefficiently, and there was a positive and meaningful relationship between herd size and efficiency, which indicates that larger-scale livestock farms have more economic profit. Aldesit (2013) perpetuated the degree of efficiency, increased by the scale of performance development. Various studies focused on South Asian, Southeast, and Southwest Asian countries to estimate the technical efficiency and figure out its determinants and measuring the technical efficiency of animal husbandry by DEA (Fathizade Golshani et al., 2012; Aldesit, 2013; Uzmay et al., 2009; Zhang et al., 2014) but in the field of (TE) on (TLH), only few studies have been conducted in rangelands (Aldesit, 2013; Mofidi et al., 2019; Rastgar et al., 2018; Zhao et al., 2020; Zohdi et al., 2018). Many studies on the effect of RMPs on rangelands via (TLH) in Iran (Kohestani and Yeganeh, 2016) were performed by traditional methods such as questionnaires and field surveys, which have lower accuracies than commonly-used empirical procedures approaches. Therefore, exploring productivity of rangeland ecosystems and finding driving factors using (DEA) approach are necessary in Iran. Therefore, the efficient use of inputs in (RU) is thus an open question because ranchers need to adapt the use of their inputs. So, the overall purpose of this study was to analyze whether implementing RMP and demographic characteristic of ranchers by providing proper management of rangeland resources promotes the technical efficiency of long-term productivity of rangeland units or not? If so, what are the determining factors?

2. Material and methods

2.1 Study area

The study area is a mountainous region called Sajad-rud watershed, located on the southeastern of Bandpey, Babol County in Mazandaran province, in the north of Iran. The region is 11 950 km^2 and lies between 36°07′58″ to 36°12′36″ N latitudes and 51°58′21″ to 52°01′13″ E longitudes. The elevations of the highest and lowest points are 3800 m and 1800 m above sea level in the northwest of the region, respectively. The climatic condition of the area is semi-arid (cold), with a mean annual rainfall of about 350 mm (Ahmadi Gatab et al., 2017). The rangelands of the region are comprised of highly diverse landscapes. The large number of ranchers focuses on sheep and goat cattle, herded in a traditional, semi-nomadic fashion; animals feed on native forage and they have access to land mostly situated in the most productive, semiarid grassland region. The range livestock is dominated by a breed of sheep as “ZELL” (Rastgar et al., 2018).

2.2 Sampling method and data collection

Sampling and data collection took place in Sheikh Musa summer rangelands of Mazandaran province and conducted on the 6 (RUs), namely “Kangestan”, “Nirasm”, “Keikheni” with RMP and “Parijon”, “Tararje” and “Lati” without RMP in 2017 – 2018. The statistical population of the present study consists of 104 semi-nomad ranchers. The study was conducted on 6 rangeland units from 45 for field sampling that were representative of the main ranching and vegetation production systems in the Mazandaran province in Northern Iran. Prior to the interviews, a complete list of all ranchers with at least 50 herds was requested from the local department of agriculture in all the 6 selected rangeland units of

Table 1. Frequency of ranchers in different types of rangelands

Type of Rangelands	RMP-in		RMP-out		Total area	
	Frequency	%	Frequency	%	Frequency	%
Summer	24	63.16	22	50	46	56.10
Summer-Winter	5	13.16	8	18.18	13	15.85
Summer-Forest	9	23.68	14	31.82	23	28.05
Total	38	100	44	100	82	100

RMP = Range Management Plans

the province. From total 45 rangeland units in the region, only 6 rangeland units had implemented RMP during the period of at least 10 years.

We used Cochran's formula to estimate the sample size (Equation 1).

$$n = (N.t^2.p.q)/(N.d^2 + t^2.p.q) \tag{1}$$

Where:
N = the statistical population of 6 (RUs),
n = the required sample size,
p and q are the response and non-response probabilities (equal to 0.5), respectively,
t = is equal to 1.96 and
d = is the sampling accuracy ($d = 0.05 - 0.3$) (Table 1).

Since in exploratory and descriptive studies, data collection is a critical part of the research process, the interviews were mostly conducted face-to-face and in natural setting at respondents' home or office based on information related to livestock production of herder (rancher) households. The questionnaire included two parts. The first part of the questionnaire focused on the overall question (age, work experience and education level of stakeholders). The second part was concerned with variables (number of sheep and goat, sources of income from the sale of livestock, animal products, the amount of land for sheep and goat breeding, non-livestock income of ranchers). Dominant regional sheep breed "Zell" is the smallest Iranian sheep without a tail. This kind of breed is from the north of Iran, the province of Mazandaran and Golestan. Almost 6.2 % of total Iranian sheep belong to this kind of breed. Meat production is vital in fattening, but other livestock and species fattened. Changes in rangeland conditions over time and productivity were the main questions of this part. The majority of the interviews ended up with questions about livestock activities generating income and cooperative activities within the group.

2.3 Data analysis

2.3.1 Model specification

To enable model analysis using cross-sectional data, technical efficiency was estimated through parametric and not parametric methods. The Stochastic Frontier Analysis (SFA) is a parametric method, which assumes that the deviation from the efficient frontier depends on the farm's inefficiency, thus the farmer decision-making, and a stochastic parameter that is not controlled by farmers (Gaviglio et al., 2021). The problem with this method is that it assumes a parametric specification for the production technology, which in the end can affect the efficiency results. The (DEA) estimates the technical efficiency of each productive Decision-Making Unit (DMU) taking into account the resources used by the units and the results they obtain. DEA models optimize the efficiency index of each individual decision-making unit in order to estimate an efficient piecewise linear frontier. The decision-making units with higher technical efficiency scores become the benchmarks for the inefficient ones. The remaining decision-making units will have an efficiency score between 0 and 1 inversely proportional to their distance from the frontier. We employed an output-oriented approach to calculate both constant return to scale (TE_{CRS}) and variable return to scale (TE_{VRS}) technical efficiency. The methodology used in this study is a two-stage process commonly used in the literature (Gaviglio et al., 2021). The efficiency scores was estimated in the first stage, and then, the scores are used as dependent variables in the second stage. In the first stage, the data envelopment analysis or DEA (Charnes et al., 1978) was used to estimate the level of technical efficiency. For the second stage, Tobit regression was used to find the factors that influence the technical inefficiency. Efficient units obtained from the previous step will be solved (Equation 2). This model shows the efficiency of the 0th (DMU_0) production unit ratio to the other production units.

$$\begin{aligned} &\theta^* = \min\theta \\ &\sum_{j=1,j\neq k}^{n} \lambda_j x_{ij} \leq \theta x_{i0} \qquad i = 1,2,\ldots,m \\ &\sum_{j=1,j\neq k}^{n} \lambda_j x_{rj} \geq Y_{r0} \qquad r = 1,2,\ldots,s \\ &y_j \geq 0 \qquad j = 1,2,\ldots,n \end{aligned} \tag{2}$$

Where:
λ is the vector of numeric values is non-negative,
x_i and y_r are respectively inputs and outcomes of the Jth board,
m = number of inputs,
s = number of outcomes,
n = number of panels,
θ = technical performance level of Jth board that is less than or equal to one.

Table 2. Characteristics of the selected "Rangeland Units" Structural

Variables	Rangeland Units (RU)	
	RMP-in	RMP-out
Number of RMP	24	21
Total area (ha)	684	481
Rangeland condition	Medium	Medium
Rangeland trend	Constant	Negative
Herd size allowed (number)		
Sheep	3173	970
Goat	2370	4336
Cow	1350	1300
Capacity (animal unit)	1154	961
Vegetation type	*Festuca ovina-Bromus tomentellus*	*Festuca ovina-Bromus tomentellus*

RMP = Range Management Plans

The value of 1 represents that the production unit is fully efficient and the production unit is on the efficient frontier (Coelli et al., 2005).

The variable return to scale (VRS) model obtained by adding $\sum_{j=1}^{n} \lambda_j = 1$ to the constant return to scale (CRS) model.

The efficiency value obtained from the above model for some units may be more than one (Charnes et al., 1978); for this reason, sometimes, this model is called Scale Efficiency-Data Envelopment Analysis (SE-DEA) (Charnes et al., 1978). If there is a difference between the technical efficiency of the board with variable return to scale (VRS) and constant return to scale (CRS) methods is the indication that there is scale inefficiency and the amount of it is the technical efficiency difference by VRS and CRS methods. The difference between the two technical efficiency is that $\mathrm{TE}_{\mathrm{VRS}}$ represents the technical efficiency without the scale efficiency effect, and thus, it measures the efficiencies due to only managerial performance. For this reason, it is also called the pure technical efficiency (Coelli et al., 2005). DEA scores are limited to the interval [0; 1], and accordingly, they only have the appositive probability of attaining one of the corner values. The two-limit Tobit model, which was generally used to model censored or corner solution data-limited both from below and above, is necessarily a miss-specification when applied to DEA scores as this method requires a positive probability to attain both corner values. Since the amount of efficiency is always between 0 (total or full inefficiency) and 1 (absolute or full efficiency) and cannot exceed. We used to censor regression model with bilateral censors (left and right censored). In literature, most of the studies have specified a censored regression model (Tobit) for the second stage. The logic for the use of Tobit model is that technical efficiency scores are between 0 and 1 and therefore censored regression should be used.

2.3.2 Variable descriptions

DEA was applied to the 6 rangeland units of the sample considering 5 outputs and 4 inputs. The output of the model includes the sales of caw, sheep and goats at weaning, for slaughter, and as livestock breeders, as well as other sales (meat, milk, cheese, wool) and inputs includes (livestock number, rangeland unit area and animal feed)[1].

Measurements were performed using DAEAP2.1 software. After measuring the efficiency of sampled rangeland units, multivariate regression was used to measure the practical factors. Equation 3 represented the Tobit regression model. The dependent variable will be censored when it is more than one or lower than zero (Equation 3).

$$\begin{aligned} y_i^* &= X\beta + U \\ y_i &= 0 && \text{if } y_i^* \le 0; \\ y_i &= y_i^* && \text{if } 0 \le y_i^* \le 1; \\ y_i &= 1 && \text{if } 1 < y_i^* \end{aligned} \tag{3}$$

Where:
β are vectors of explanatory variables and unknown parameters, respectively.
y_i^* is a latent variable.
y_i is the DEA score.

Tobit regression in the current study is described in (Equation 4).

$$y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} + U_i \tag{4}$$

Where,
y_i represents overall technical efficiency scores obtained from DEA results;
In the final model, the independent variables were: number of livestock (X_1), Education (X_2), Experience (X_3), the cooperative (dummy variable: X_4) breed (dummy variable:

1. Due to the variety in feed, the weight of each share in the livestock diet was used.

Table 3. Results of Socio-economic characteristics of respondents

Rangeland Units		Gender (%)		Age (Year)	Experience (Year)	Education	(%)
		Male	Female				
RMP-in	frequency	97.3	2.7	38	38	Elementary	52.6
	Mean			59.47	42.03	Uneducated	36.90
	Min			25	7	High school	2.6
	Max			80	65	University	7.9
RMP-out	frequency	100	0	44	44	Elementary	38.70
	Mean			62.8	45.8	Uneducated	50.00
	Min			35	15	High school	6.8
	Max			85	75	University	4.50
Total	frequency	98.7	1.2	82	82	Elementary	45.12
	Mean			61.29	44.07	Uneducated	43.90
	Min			25	7	High school	4.88
	Max			85	75	University	6.10

RMP = Range Management Plans

X_5), RMP (dummy variable: X_6); and U_i is the regression error.

The Kolmogorov-Smirnov test was used to test whether the sample of data was consistent with a specified distribution function or the Kruskal-Wallis test should be used as a nonparametric test to compare samples (Kalantari, 2010).

3. Results

3.1 Demographic characteristics of the (RUs)

The structural characteristics of rangeland units in the region indicate that the rangeland status was moderate according to the available information and from 82 respondents, 24 were RMP-in and 22 were RMP-out. In comparison to the rangeland units among three kinds of rangeland types in the studied area, the most of the rangeland units (56.10 %) were only in summer rangelands (Table 1).

The total number of implanted RMPs (24) and the area of them (684 ha) were more than RMPs-in. Rangeland condition trends were fixed and negative in rangeland units with and without RMP, respectively. Domestic sheep and goat were the dominant animal in RMP-in and RMP-out. Capacity of RMP-in was 193 animal units more than RMP-out. Vegetation type in both of them was the same (*Festuca ovina-Bromus tomentellus*) (Table 2).

Among the six variables included in the technical efficiency (TE) function (equation 4), four variables reflect the characteristics of the household head, namely experience, education level, age and gender assessed (Table 3). The average experience of surveyed ranchers was 44.07 years belonging to uneducated. Result of mean comparison of the rangeland units indicates that most of the experienced surveyed ranchers (45.8) belonged to RMP-out and most of them (50 %) were uneducated. Also, other characteristics of ranchers as the age and gender of ranchers in comparison with the studied rangeland units showed that most of the surveyed ranchers were (middle-aged) and male (Table 3).

3.2 Data Envelopment Analysis (DEA)

Results on the technical efficiency in each rangeland unit (with or without RMP) to determine whether a rangeland unit operates under Increasing Returns to Scale (IRS) or Decreasing Returns to Scale (DRS), Constant Returns to Scale (CRS) condition at the Data envelopment analysis (DEA) model shown in Tables 4 and 5. The average efficiency of the total samples estimated by taking into account the variable returns is 0.69. A great deal of technical efficiency is related to the scale efficiency. 0.78 of the total samples, and 0.81 samples with RMP is due to the efficiency of the scale size. The ratio of rangeland units with RMP is more than 0.7 About a quarter to a fifth of the RUs was decreasing returns to scale, which indicates the need to reduce the herd size to improve efficiency. The ratio of rangeland units with RMP is less (0.06) higher than rangeland units without RMP advised to increase the herd size to improve performance. About 10 % of rangeland units with RMP indicated as the full performance of technical efficiency and were on the border of the stochastic frontier production function.

The distribution of rangeland units with/without RMP gives further results as in Table 5. Within the first model (TE_{VRS}), except the only one out of rangeland unit, all the 5 rangeland units' (83.3 %) scores are superior to 0.5. The only one rangeland unit was the best on the frontier (score = 1) as parts of the RMP-in. 16.6 % (1 rangeland unit) of the RMPs-out had scores less than 0.5 (0.48), meaning it gets the lowest scores. For the second model (TE_{CRS}), five rangeland units (83.3 %) had scores over than 0.5. Then, only one rangeland unit (16.6 %) stands less than 0.5. In total samples, scores are generally less than 1 and average efficiency scores are respectively 0.69 (under VRS) and

Table 4. Results of Data Envelopment Analysis and summary of efficiency score

Statistic parameter	Scale Efficiency (SE)	Constant Returns to Scale (CRS TE)	Variable Returns to Scale (VRS TE)
Total sample	0.78 ± 0.22	0.54 ± 0.26	0.69 ± 0.26
RUs without RMP	0.77 ± 0.23	0.50 ± 0.24	0.66 ± 0.25
RUs with RMP	0.81 ± 0.21	0.58 ± 0.28	0.72 ± 0.26

RU = Rangeland Units
RMP = Range Management Plans

0.54 (under CRS). This finding was consistent with the idea according to which total samples do not provide forage to ranchers as much as possible. Since the level of efficiency is not equal to 1, they can do better to improve their policies to reach the optimum level of forage production. Also, 62.2 % of rangeland units were in the districts of Increasing Returns to Scale (TE_{IRS}). The size of the scale will increase the physical activity of the performance rate (Table 6).

3.3 Effective factors of technical efficiency

The estimation of the production function parameters is given in Table 7, specifying the parameters. The estimated values of the technical efficiency component (u) are in the column of other parameters. Total output is significantly affected by material inputs. If the material changes by 1 %, total output changes of range management plan increase by 0.208 %. Elasticity of inputs suggests that the effect of herd size ($X_1 - 0.00009$) and co-operative membership ($X_4 - 0.0604$) on production is negative, but statistical significance has not been demonstrated; so under certain circumstances, this value may be accepted and the model and may serve the needs of estimating technical efficiency. The significant positive effect was identified for education (0.2082), experience (0.0121), livestock breed (0.1797) and implementation of RMP (0.2084), indicating that they had a positive impact on technical efficiency.

4. Discussion

Herd size is one of the influential factors investigated in this study on forage production of selected rangeland units concluding implemented and not implemented RMP. Results showed that herd size (which is equal to animal unit) does not have a significant effect on efficiency. If efficiency indicators improve and if the ranchers have access to the desired activity, they will be able to increase the efficiency of their actions. The results are consistent with the results of (Fathizade Golshani et al., 2012; Aldesit, 2013) maintaining that a large proportion of the studied dairy farms have been ineffective and in the case of improving performance indicator scale, the maximum production capacity has been reached. However, it was contrary to the results of Zhao et al. (2020) presenting that rangeland production potential in rangeland units are under the influence of herd size, the share of households from agricultural lands and family size. The results shown in Table 5 indicate that more than 62 % of the investigated rangeland units were in an Increasing Returns to Scale (IRS); also, the sum of elasticity for the average holding based on the model is greater than 1 indicating an increasing return to scale (Table 5). It shows these rangeland units have not reached their optimal size yet. In order to reduce its average cost (or its average inputs consumption), it has to increase its size. Practically, this could be done either by internal growth (i.e. producing more output) or by merging with another rangeland unit which is also facing increasing returns to scale.

Table 5. Distribution of Rangeland Units under Variable Return to Scale, Constant Returns to Scale and Scale Efficiency assumptions

Return to scale	RMP-in (No.)			RMP-out (No.)			Total
	1	2	3	4	5	6	
TE_{VRS}	0.54	1.00	0.62	0.48	0.84	0.75	0.69
TE_{CRS}	0.57	0.59	0.58	0.40	0.53	0.57	0.54
SE	0.65	1.00	0.77	0.75	0.84	0.75	0.78

TE_{VRS} = Technical Efficiency at Variable Return to Scale
TE_{CRS} = Technical Efficiency at Constant Return to Scale
SE = Scale Efficiency
RMP = Range Management Plans

Table 6. The ratio of Rangeland Units in terms of return to scale (unit: percentage)

Return to scale	RUs with RMP	RUs without RMP	Total
TE_{IRS}	70.50	52.60	62.20
TE_{DRS}	20.40	23.70	21.90
TE_{CRS}	9.10	23.70	15.90

RUs = Rangeland Units
TE_{IRS} = Technical Efficiency at Increasing Returns to Scale
TE_{DRS} = Technical Efficiency at Decreasing Returns to Scale
TE_{CRS} = Technical Efficiency at Constant Returns to Scale
RMP = Range Management Plans

If, for some reasons, managers cannot influence the scale of a rangeland unit, they should not be held accountable for this source of inefficiency. Based on this, expanding the planting area of artificial grassland, improving the efficiency of resource utilization, and enhancing the supply capacity of livestock products are effective ways to increase the production level of traditional livestock husbandry in the studied region. Zhao et al. (2020) also obtained a similar conclusion.

Results showed that uneducated people of rangeland units without RMP were more than the implemented RMP. Therefore, having literacy has a significant effect on the efficiency of rangeland units. Also, on average, literate individuals had a higher efficiency of 0.2 units than illiterate ranchers. This issue especially considered the ways of raising and training ranchers. There were positive and significant differences between age, work experience, education, and the technical efficiency; according to it, technical efficiency of ranchers can be increased (Amaza et al., 2006; Krasachat, 2008; Mazhari and Khaksar Astane, 2009). Since livestock husbandry is a traditional job, there is a full multi collinearity between the age and experience of ranchers. This implies that the ranchers with more education respond more readily using the new technology and produce closer to the frontier output. Uzmay et al. (2009) came to the same conclusion. Therefore, the effect of these two factors on efficiency cannot be separated. On average, each 10-year increase in expertise adds up to 0.1 unit of efficiency improvement. The results of the research were consistent with Molaei and Sani (2015) that stated education, milk production per cow, and age were the practical factors on technical and environmental efficiency of dairy cattle in Sarab county, Iran. Also, Amaza et al. (2006); Krasachat (2008) and Bajrami et al. (2017) stated that factors such as experience, and level of education had a significant effect on technical efficiency.

Membership in the dairy cooperative doesn't affect efficiency. However, one of the goals of the cooperatives is to help producers increase their performance. Therefore, regional cooperatives did not succeed in this case. Koorkinejad et al. (2018) and Mahida et al. (2018) had the same opinion and stated that membership in the dairy cooperative due to more significant association of farmers to each other and strengthening trust and participation between them would promote the productive state and technical efficiency of the farmers. The effect of RMP is more than all the variables in the model aligned with Mazhari and Khaksar Astane (2009). According to the results, the average technical efficiency of the whole sample concerning variable returns was estimated about 0.7. The average technical efficiency in ranchers with implementing RMPs (0.72) was more than ranchers without RMPs (0.66). In terms of size, technical efficiency was, on average, 78 % of total samples, 81 % of rangeland units with RMP, and 77 % of rangeland units without RMP. Hence, a large part of the technical efficiency in the present study was related to the scale efficiency. Though economically, the activity is considered to be an important factor in ef-

Table 7. Results of Estimating the Effective Factors on Technical Efficiency Using Tobit Model in the studied area

Variables	Unit of Measurement	Coefficient	Standard deviation	Z value	Possibility
Herd size	Quantitative = Head	−0.00009	0.0006	−1.427	0.153
Education	Qualitatively-Literate = 1	0.2082	0.079	2.637	0.008
Experience	Quantitative-year	0.0121	0.0022	5.443	0.000
Co-operative membership	Qualitatively-membership = 1	−0.0604	0.1086	−0.556	0.578
Livestock breeds	Qualitatively-sheep breed Zel = 1	0.1797	0.083	2.165	0.030
Range Management Plans	Qualitatively-in RMP = 1	0.2084	0.085	2.452	0.014

ficiency, but perhaps because of the lack of very big and industrial livestock husbandry in the studied area, the effect of size is not apparent that this requires the improvement of performance indicators in other units through the allocation of financial resources. Kostlivý and Fuksová (2019) also evaluated the technical efficiency of Czech organic farms by parametric stochastic frontier analysis. They showed that the type of farming and the economic size of farms influence the farms' profitability. Totally, the estimated technical efficiency in this study indicates that beneficiaries, especially ranchers with implementing range plans, mainly benefit high technical efficiency that shows a large part of the potential and capacity of the customary systems in the studied sites used for production and as needed, optimal inputs are used. Lower technical efficiency of rangeland units without RMPs causes the loss of resources and an increase in the average cost of production. In case of efficient use of inputs, beneficiaries can produce the same amount of input and reduce production costs, they increase their benefits. Lower relative technical efficiency of rangeland units without RMP can be attributed to various management and economic factors governing livestock husbandry. These include the lack of appropriate and balanced feeds for all livestock especially weak livestock in the herd, extreme volatility of input prices, especially animal feed and unequal distribution of livestock, common and traditional use of rangelands, small size of rangelands and uneconomical in terms of livelihood, imbalance between (livestock, production and rangeland capacity), lack of winter rangelands for supplying livestock forage, lack of low rate banking facility to the beneficiaries, overgrazing, over capacity of beneficiaries in rangelands, and lack of supply of subsidized forage for equilibrium of livestock and rangeland. Based on statistics and information of RMPs of Natural Resources, Department of Mazandaran Province-Sari and questionnaires, a number of allowed livestock in the studied rangeland units (with and without RMP) were respectively 961 and 1154 animal units. It was suggested that for a successful implementation of the RMPs and more effective implementation in increasing efficiency in the rangeland units, other potentialities and potentials of rangelands to be identified and get revised according to the description of the services of the integrated RMP (multipurpose) and the use of traditional knowledge. In addition to the above, ranchers can create rancher's cooperative society in common rangeland units to use all rangelands potential. Creating ranchers' organizations and their associations, range management and traditional livestock is considered as a job and so, all the ranchers have to join the community to defend their rights. Obviously, if these conditions are met and based on the results of this research, ranchers are able to use existing production inputs to increase their production. To achieve this goal, it is necessary funds needed to improve performance indicators of production units, especially in units with less technical efficiency to be supplied. On the other hand, considering that the purpose of any economic activity is earning benefits, it's necessary to appropriately prevent from fluctuation of production input prices especially animal food.

5. Conclusion

Ranchers play a major role in generating income from rangelands and in safeguarding natural capital across a quarter of the world's land area. So, in this research, we constructed the Data Envelopment Analysis (DEA) method based on survey data. This technique creates efficiency indices by comparing the production function as an ecological variable of rangeland units, with and without RMP. We found that education and experience were effective in ranching and livestock husbandry and the implantation of RMP. The maximum value of technical efficiency in rangeland units with RMP was up to 70 % that was a bit higher than rangeland units without RMP advised to increase the herd size to improve performance. In summary, rangeland units with RMP suffer from an incompatibility of production scale more than a problem of management (in terms of use of resources for credits). Inefficiency was more related to a problem of "under optimal" scale than to a problem of management practices. Since our sample was composed of two management practices localized in the same area, it is not enough to talk about technical efficiency, but we must also consider the different technological grounds they have.

Ethical approval:
This manuscript does not report on or involve the use of any animal or human data or tissue. So the ethical approval does not applicable.

Authors Contributions:
All authors contributed equally to performing experiments, analyzing data, and writing the paper.

Availability of data and materials:
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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