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Functional Analysis of Cattle Fattening Farms: The Case of Erzurum Province

Yavuz Topcu and Nuray Demır
Department of Agricultural Economics, Ataturk University Collage of Agriculture, 25 240 Erzurum, Turkey

Abstract: Farms in local area were classified into four groups by taken into consideration the data of fattening period from 2002 to 2003 of 129 farms, which were under investigation, subjected to analysis of the production functions of cattle fattening farms. The relations among input-output and output-output have been researched by the functional analysis of cattle fattening. The production function has been estimated and input factors have been marginally analyzed and the effective coefficients (EC) of factors on production amount have been found. The relations between input and output have been analyzed through multiple regressions. For the estimation of the production function the Cobb-Douglas production model has been used.

Key words: Cattle fattening, farm, functional analysis

INTRODUCTION

The developments in the country's economy, the increasing importance of international relations and the adaptation efforts to the conditions of competition in foreign markets, economic activity in production necessitate rentability and rational production. Giving possibility to the comparisons in farms and among farms, helping to the farm planning if there are more than one activity in farms, using the scarce sources effectively in farm activities, enlarging employment possibilities, using the workforce in a balanced way and providing more profitable work environment are important both for the farms and the economy of the country. Cattle fattening has an important role in reducing inequality in the income distribution, disorder in the income, preventing the waste by using farm productions which are not used as raw material in industry and in the disappearance of risk and uncertainty which derives from the natural conditions and the market.

Cattle fattening farms in the investigation area are polycultural farms which are scattered, have small scale and they don't have meaningful dialog on the other hand they have no organizational structure and they use traditional production methods. This irrational structure in farms, in the production factors and product market, causes an ineffective situation in the formation of market price. Under these conditions, the decreasing production cost, included only certain input-output cost, will make increasing effect in farm's net income. Increasing cattle fattening farm's net income, certain input-output cost and using methods cause the decreasing of production cost.

The planting area concentrated feed plants farms 39.3% of planting area of farm plants on the other hand planting area of rough food plants is 14.2% in Erzurum[1]. In the region farms, economically active population is 68.9% per farms and inactive labor is 54.8%[2]. And in these farms both using these food plants and benefiting from inactive workforce are very important. Plant production can't be done because of nature conditions because winter conditions are very hard in November-May period in Erzurum. In this period, cattle fattening supplies money to the farm and there are advantages for farmer's essential needs. So cattle fattening are done in indoor areas without depending on inconvenient weather conditions and cattle are ready for sale in the end.

The reason of decreasing productivity is very changeable in the farms under investigation. The poor quality of material, used in production and rational usage of sources are among the most important problems. It is necessary to do these kinds of investigations to make an increase in the current period income of farms. It is also necessary to know the effect of the change which will be done in the farm organization.

The aim of this investigation was to analyze functionally in what ways the factors used in production in this area are mixed and their effects on income.

MATERIALS AND METHODS

The investigation consisted of data derived from the investigation which was made in cattle fattening farms in Erzurum, Pasinler, Horasan, Oltu and their villages, 19 March-30 July 2002 period and data derived from various

Corresponding Author: Dr. Yavuz Topcu, Department of Agricultural Economics, Ataturk University Collage of Agriculture, 25 240 Erzurum, Turkey Tel: + 90 (442) 231 13 93 E-mail: ipcioglu@atauni.edu.tr

farm institutes, statistics and from the former investigations.

In Erzurum, there were 3573 families who were engaged in cattle fattening under village conditions in the year 2002 and they have between 5 to 50 cattle[3].

It was reported that family who made cattle fattening under village conditions had generally less than 50 cattle and if they had more than 50 cattle, they were called big commercial farms[4,3]. For this reason farms which have more than 50 cattle were not investigated.

In the early study stage in Erzurum, farm families who were busy with cattle fattening in Erzurum (Center), Pasinler, Horasan, Oltu Districts and in their villages were included in this investigation in the view of the information taken from farm's cattle fattening records and from the office of Erzurum Provincial Directorate of Agriculture. On the other hand the difficulties applying questionnaire to the cattle breeders who made indoors cattle fattening was taken into consideration. Family farms which made cattle fattening in the determined indoors area consisted of 59.2% of the population from the respect of the farm numbers and 66.6% of the cattle numbers. Because of these reasons, the investigation area had enough qualities to represent farms that made cattle fattening in Erzurum.

Used method in the selection of sample villages: Systematic Sampling Method may constitute the first stage of other sampling methods. In an investigation on the physical input usage levels of some important farm products and their cost, firstly villages where these products were very common was chosen as objective. And then Simple Random Sampling Method was used with sampling from these villages[5].

The villages in Erzurum, Pasinler, Horasan and Oltu where the fattening cattle was common, were chosen by using Systematic Sampling Method.

Applied method in the allocation of groups and farms: In the selection of farms under investigation, 3 573 cattle fattening farms were taken as targets in Erzurum. In Erzurum (Center), Horasan, Pasinler and Oltu Districts and their villages. Four hundred and sixty five, 637, 650 and 365 farms were chosen, respectively and all of them have made indoors cattle fattening[3]. Total 2117 farms were used for pilot areas. Sampling farms were chosen with 5% probability from 2117 farms. Farms were grouped according to social-economic and technical conditions and financial structures (Table 1).

Applied method in the determination of econometric model: Four models as linear, semi-log and double log were tested for regression models for each group. In the estimation of models, The Smallest square method (OLS) had been used[6]. Conclusions were drawn by using this method in shazam being an econometric packet program.

Table 1: Grouping of farms according to social economic and technical conditions and financial structure of districts

Target areas	Groups	Farms number	Survey number
Horasan	I	650	40
Oltu	II	365	22
Erzurum Merk.	III	465	28
Pasinler	IV	637	39
Total		2117	129

The most important criterion in the determination of function type that was used in the econometrical analysis has been taken into consideration, determination coefficient (R^2), standard error and applied F test being the major determinants. Independent variables which took place in the function have been analyzed with the importance test of partly regression coefficients to see if they were different from zero or not.

The most suitable models had been chosen as statistics after solving autocorrelation, heteroskedasticity and multicollenearity problems. Although horizontal section data had been used; autocorrelation, multicollenearity and heteroskedasticity analysis have been done because of the same characteristics of farms which were subjected to analysis. Autocorrelation, multicollenearity and heteroskedasticity analysis had been done by taking into consideration Durbin-Watson d_h related to autocorrelation test, X^2 statistics related to heteroskedasticity test and regression coefficients (r) related to Correlation Matrix.

Functional model of factors

CA = f (IG, HB, BS, HA, YM, PM, BK, U_1, U_2)

Dependent variable

CA: Live weight increase obtained in farm during current period as kg,

Independent variables

IG: Labor amount as Man Work Unit (MWU),

HB: Fattening cattle numbers as Cattle Animal Unit (CAU),

BS: Total fattening period during current production period as day,

HA: Buying price of the fattening cattle as Million TL,

YM: The amount of daily ration given to the fattening cattle as kg during the current production period

PM: Marketing cost for animals sold out farm as Million TL. Because farms were far from selling areas, PM was included to the production function to measure the effect of PM that is among the]independent

ones. If farmers did not sell their cattle at convenient times and market, variable cost of farms will increase.

BK: Variable cost related to the capacity of the fattening cattle's barn during current period (Million TL),

U_1: Dummy for measuring the effects on the live weight increase of the species of native and hybrid,

U_2: Dummy has been used for measuring the effects of sex on the live weight increase of fattening materials used in the farms.

Used method in the interpretation economically of the production functions

Production elasticity: In Cobb-Douglas Production function, the coefficients of independent variables had given the marginal production elasticity of related inputs. The total elasticity of each production factors had shown the revenue according to scale of production function[7].

Average and marginal productivity: Average productivity was production quantity in response to one unit variable factor in the certain level of production. When Average Productivity (AP) was multiplied with the coefficient of the related factor (bi), Marginal Productivity (MP) was obtained. Marginal revenue (MR) was obtained by multiplying MP with price of product[8].

Effective coefficients of production factors (EC): These are used to determine how a production factor was effective in a certain production level. Effective coefficients of factors was determined that factor's MR is proportional to Factor's Price (FP)[7,8].

Applied method when doing marginal analysis: Although the signs of the factor's coefficients that belong production factors indicated if one determined factor was used more intensively or not in relation to other factors. EC brought up this condition clearly.

Average marginal productivity and geometric average (GA) were calculated from the estimated equation according to groups. MR was obtained by MP multiplied by product price (PP). The level of approximation to economic optimum has been determined by comparing FP with marginal product value (MPV) which was calculated by MPV of the production function. Being high or low of MPV is not alone very important. It is necessary to look at factor's EC to find the answer to the questions whether factors increase or decrease according to the availability.

Factor's effective coefficient (EC);
EC = 1 ⇒ effective usage of factors
EC > 1 ⇒ little usage of factors
EC < 1 ⇒ over usage of factors were determined.

RESULTS AND DISCUSSION

Econometric analysis: The most suitable double-log model had been determined by taking into consideration criteria which were used in the estimation of econometric models.

$$\text{Log CA} = \alpha+\beta_1 \log IG+\beta_2 \log HB+\beta_3 \log BS+\beta_4 \log HA+ \beta_5 \log YM + \beta_6 \log PM + \beta_7 \log BK + U_1 + U_2$$

According to F statistic tests and R^2 values, the models have been found meaningful in all groups.

Group farms I: Autocorrelation ($X_h^2 = 6.44 > X_c^2 = 3.33$) and multivarians problems had been found in the first group farms. Problems had been eliminated by doing heteroskedasticity and autocorrelation analysis. In Table 2, parameters have been calculated.

Partly regression coefficients of PM, IG and BK had been found meaningful at 5% important level statistically. BS, YM, race and sex had a negative effect on the live weight increase according to economic theory in these farms. bi coefficient of BS is higher negatively (Table 2). Extra factor will be supplied; even so, production amount will decrease related to BS. It had been analyzed that the farms exceeded optimum fattening period in this group, used over ration and generally they chose native race and female animals as fattening material. It has been seen that BH is the most effective on the live weight increase. When the total production elasticity (bi = 0.51) was taken into consideration, the farms got the decreasing returns to scale.

To analyze multicollenearity problem in this group, correlation matrix was given in Table 3. Since correlation coefficients among variables were not bigger than r = 0.80, there is not multicollenearity problem in this group.

Group farms II: Autocorrelation ($X_h^2 = 12.40 > X_c^2 = 3.33$) and multivarians problems have been observed in group II farms. By doing heteroskedasticity and autocorrelation analysis, problems had been eliminated and parameters have been calculated in Table 4.

Partly regression coefficient of HA has been found meaningful at 5% importance level statistically. YM, PM and sex have a negative effect on live weight increase according to economic theory in these farms, bi coefficient of YM is negative (Table 4). Extra factors are used; even so, production amount will decrease. On the other hand the height of PM will prevent the animals from transfer to the market, ration usage will increase, the optimum fattening performance will exceed and the marginal factor productivity will decrease. It had been observed that HA has the biggest effect on live weight

Table 2: Parameters concerning production function and related tests of group farm I

	$F_h = 10.04$		$F_c = 2.33$*		$d_L = 1.06$		$d_u = 2.00$		DW $d_h = 2.03$	
$R^2 = 0.76$	α	β_1	β_2	β_3	β_4	β_5	β_6	β_7	U_1	U_2
Coefficient	6.4035	0.1736	0.3676	-0.4038	0.2850	-0.3720	0.2292	0.2292	-0.1174	-0.0695
SE	3.2150	0.0676	0.2657	0.5836	0.1800	0.2118	0.0925	0.0786	0.1233	0.1240
t_h-value	1.9920*	2.5660*	1.3840	-0.6919	1.5830	-1.7560	2.2820*	2.9140*	-0.9497	-0.5605
p-value	0.0460	0.0100	0.1660	0.4890	0.1130	0.0760	0.0230	0.0040	0.3420	0.5750
Elasticity	0.7969	0.0827	0.1186	-0.2635	0.3092	-0.3870	0.1713	0.1835	-0.0058	-0.0058

*Meaningful according to 1.00 and 5.00%

Table 3: Correlation matrix related production factors of group farm I

	IG	HB	BS	HA	YM	PM	BK	U_1
HB	-0.3073							
BS	0.0684	0.0777						
HA	0.0239	-0.7295	-0.0400					
YM	-0.2261	0.0348	-0.2256	-0.0362				
PM	0.1119	-0.2180	-0.0319	0.0533	-0.2562			
BK	-0.0102	-0.4275	-0.2982	0.2999	-0.2014	-0.1018		
U_1	-0.0968	0.1210	0.1270	-0.1526	0.2518	-0.0968	0.1210	
U_2	-0.2712	-0.1070	-0.0059	0.1430	0.0194	-0.2713	-0.1069	-0.0059

Table 4: Parameters concerning production function and related tests of group farm II

	$F_h = 8.01$		$F_c = 2.74$*		$d_L = 1.06$		$d_u = 2.00$		DW $d_h = 2.04$	
$R^2 = 0.89$	α	β_1	β_2	β_3	β_4	β_5	β_6	β_7	U_1	U_2
Coefficient	0.2135	0.0609	0.0884	0.0599	0.9458	-0.0483	-0.1217	0.0082	0.1143	-0.0298
SE	2.5720	0.1747	0.3287	0.5001	0.2678	0.3749	0.1605	0.1497	0.1793	0.3434
t_h-value	0.0831	0.3485	0.2690	0.1199	3.5310*	-0.1289	-0.7582	0.0547	0.6374	-0.0865
p-value	0.9350	0.7330	0.7920	0.9070	0.0040	0.9000	0.4630	0.9570	0.5360	0.9320
Elasticity	0.0254	0.0283	0.0319	0.0379	1.0124	-0.0458	-0.0958	0.0067	0.0093	-0.0032

*Meaningful according to 1.00 and 5.00%

Table 5: Correlation matrix related production factors of group farm II

	IG	HB	BS	HA	YM	PM	BK	U_1
HB	0.3772							
BS	-0.3540	-0.2440						
HA	-0.3065	-0.7070	0.5174					
YM	0.4141	0.3590	-0.0902	-0.5328				
PM	-0.0419	0.0021	0.1919	0.0827	0.0304			
BK	-0.5606	-0.2361	-0.1865	-0.2534	0.0908	-0.5608		
U_1	0.2646	-0.1263	-0.1867	0.1580	0.1198	-0.1000	-0.1364	
U_2	-0.2821	-0.2045	0.3553	0.1199	-0.3956	-0.2098	0.1462	-0.4001

Table 6: Parameters concerning production function and related tests of group farm III

	$F_h = 20.71$		$F_c = 2.51$*		$d_L = 1.07$		$d_u = 1.83$		DW $d_h = 1.98$	
$R^2 = 0.91$	α	β_1	β_2	β_3	β_4	β_5	β_6	β_7	U_1	U_2
Coefficient	3.4893	0.0609	0.0884	0.0599	0.9458	-0.0483	-0.1217	0.0082	0.1343	0.2875
SE	3.4940	0.1120	0.2588	0.6013	0.2381	0.3384	0.1251	0.1085	0.1879	0.1796
t_h-value	0.9988	0.6192	0.8175	-0.3782	1.6000	0.0266	-1.5570	3.2270*	0.7148	1.6010
p-value	0.3310	0.5440	0.4240	0.7100	0.1270	0.9790	0.1370	0.0050	0.4840	0.1270
Elasticity	0.4305	0.0303	0.0737	-0.1473	0.4126	0.0910	-0.1240	0.2792	0.0101	0.0253

*Meaningful according to 1.00 and 5.00%

Table 7: Correlation matrix related production factors of group farm III1

	IG	HB	BS	HA	YM	PM	BK	U_1
HB	-0.3219							
BS	-0.0819	0.0403						
HA	0.1654	-0.6778	0.1572					
YM	-0.0145	0.1264	-0.4415	-0.2635				
PM	-0.2310	-0.0461	0.1048	-0.2486	0.2615			
BK	-0.1476	0.0320	-0.1992	-0.5650	-0.1261	0.0847		
U_1	-0.0883	0.2238	-0.2273	-0.1687	-0.0361	-0.2307	0.3626	
U_2	0.0848	-0.1243	-0.2422	-0.1800	-0.0518	-0.2937	0.4491	0.0753

Table 8: Parameters concerning production function and related tests of group farm IV

	$F_h = 19.31$		$F_c = 2.25$*		$d_L = 1.06$		$d_u = 2.00$		DW $d_h = 2.41$	
$R^2 = 0.86$	α	β_1	β_2	β_3	β_4	β_5	β_6	β_7	U_1	U_2
Coefficient	3.8413	-0.0611	1.0646	0.1651	-0.0199	0.0359	-0.0273	0.1640	0.0192	0.1276
SE	2.1080	0.1122	0.2467	0.3073	0.1772	0.1508	0.0766	0.0721	0.1076	0.1160
t_h-value	1.8220	-0.5442	4.3150*	0.5374	-0.1124	0.2379	-0.3569	2.2750*	0.1781	1.1000
p-value	0.0680	0.5860	0.0000	0.5910	0.9910	0.8120	0.7210	0.0230	0.8590	0.2720
Elasticity	0.4522	-0.0302	0.3658	0.1006	-0.0205	0.0316	-0.0208	0.1079	0.0016	0.0116

*Meaningful according to 1.00 and 5.00%

Table 9: Correlation matrix related production factors of group farm IV

	IG	HB	BS	HA	YM	PM	BK	U_1
HB	-0.2590							
BS	0.1771	-0.3906						
HA	0.2771	-0.8686	0.3269					
YM	0.0471	0.2671	-0.4379	-0.2509				
PM	-0.0671	-0.3234	0.1211	-0.0144	0.0872			
BK	-0.3098	-0.2574	0.0161	0.0987	-0.1897	-0.0769		
U_1	0.0031	0.4511	-0.1755	-0.4267	0.3466	-0.2135	-0.2092	
U_2	-0.4495	-0.1175	-0.0954	0.1030	-0.1428	0.1023	0.4111	-0.3725

Table 10: Related to functions, MP at GA of factors

Factors		Group I	Group II	Group III	Group IV
CA (Production)	GA	3900.13	5617.27	4737.50	5968.26
IG (β_1)	GA	65.12	61.32	44.93	74.81
	MP	16.83	7.75	8.54	-5.77
HB (β_2)	GA	15.07	23.60	20.55	20.98
	MP	92.51	21.72	19.95	300.79
BS (β_3)	GA	190.18	217.95	193.04	183.85
	MP	-8.42	1.80	0.06	5.59
HA (β_4)	GA*	7675.13	9299.55	9019.29	7414.72
	MP	0.16	0.56	0.53	-0.02
YM (β_5)	GA	4471.20	3253.50	3695.18	2079.03
	MP	-0.35	-0.10	-0.06	0.12
PM (β_6)	GA*	817.25	815.45	254.46	880.77
	MP	1.39	-1.43	-3.91	-0.27
BK (β_7)	GA*	912.34	1381.19	1320.76	352.73
	MP	1.57	0.05	0.06	3.73

* (Million TL)

Table 11: Related to functions, marginal product value (MPV) (Million TL) and factors' EC

Factors		Group I	Group II	Group III	Group IV
Product Price		1.59	1.34	1.44	1.32
IG (β_1)	MPV	26.76	10.39	12.30	-7.62
	FP	27.25	34.06	31.55	25.24
	E.C	0.98	0.31	0.39	-
HB (β_2)	MPV	147.09	29.11	28.73	397.04
	FP	509.29	394.05	438.89	353.34
	E.C	0.29	0.07	0.07	1.12
BS (β_3)	MPV	-13.39	2.41	0.08	7.38
	FP	78.65	77.92	83.12	90.70
	E.C	-	0.03	0.001	0.08
HA (β_4)	MPV	0.25	0.75	0.76	-0.03
	FP	1.00	1.00	1.00	1.00
	E.C	0.25	0.75	0.76	-
YM (β_5)	MPV	-0.56	-0.14	-0.09	0.16
	FP	27.32	27.10	32.70	17.89
	E.C	-	-	-	0.09
PM (β_6)	MPV	2.21	-1.92	-5.63	-0.36
	FP	1.00	1.00	1.00	1.00
	E.C	2.21	-	-	-
BK (β_7)	MPV	2.50	0.07	0.09	4.92
	FP	1.00	1.00	1.00	1.00
	E.C	2.50	0.07	0.09	4.92

increase. It can be said that farmer acted rational in the factor market. It had been analyzed that races have effect on the fattening performance. When the total production elasticity (bi = 0.99) is taken into consideration, the farms get the decreasing returns to scale.

To analyze the multicollenearity problem in this group, the correlation matrix is given in Table 5. Since correlation coefficient among variables were not bigger than r = 0.80, there was not multicollenearity problem in this group.

Group farms III: Autocorrelation ($X_h^2 = 6.44 > X_c^2 = 3.33$) and multivarians problems had been observed in the group farms III. By applying heteroskedasticity and autocorrelation analysis, problems have been eliminated and parameters had been calculated in Table 6.

Partly regression coefficient of BK had been found meaningful at 5% important level statistically. By complying with economic theory, YM and PM have a negative effect on the live weight increase in these farms. bi coefficient of YM has the biggest negative value, extra factors were used; even so, obtained production amount will decrease (Table 6). When fattening period increases, the optimum fattening period will exceed and MPV will decrease. On the other hand fattening performance is affected negatively by over PM, long BS and low bi coefficient of YM. It has been observed that HA has the biggest effect on live weight increase. So farmers had acted as rational in the factor market. On the other hand it was analyzed that BK is effective in fattening performance as well. Because this variable explains expenses related to capacity, HA had an effect in the fattening performance by connecting to HB. When the total production elasticity (bi = 0.99) is taken into consideration, the farms get the decreasing returns to scale.

To analyze the multicollenearity problem in this group, the correlation matrix was given in Table 7. As correlation coefficient among variables were not bigger than r = 0.80, there is not multicollenearity problem in this group.

Group farms IV: Multivarians problem ($X_h^2 = 6.15 > X_c^2 = 3.33$) had been observed in the IV. group farms. But autocorrelation problem hasn't been observed. By doing heteroskedasticity analyze, multivariance problem had been eliminated and parameters have been calculated in Table 8.

Partly regression coefficient of BK had been found meaningful at 5% important level statistically. By complying with economic theory, HA, IG and PM had a negative effect on the live weight increase in these farms. bi coefficient of IG is the biggest negative value (Table 8). Long fattening period and increased labor cost will affect CA increase negatively. Because HA, IG and PM will increase the production cost, expensive HA, IG and PM have to decrease. On the other hand fattening performance is affected positively by HB and YM. It had been determined that HB had the biggest effect on live weight increase. It can be said that the farmers had not acted rational in the factor and product markets. It has been analyzed that BK is effective in fattening performance, too. When the total production elasticity (bi = 1.32) is taken into consideration, the farms get the increasing returns to scale.

To analyze the multicollenearity problem in the group, the correlation matrix was given in Table 9. When the variables, except HA, among correlation coefficient were not bigger than r = 0.80, it has been observed that there is no multicollenearity problem but there is multicollenearity doubt between HA and HB in this group.

Marginal analysis: MP calculated from GA was shown in Table 10. On the other hand MPV of factors related to production functions, FP and factors' EC were shown in Table 11.

IG (β_1): Although this factor was near optimum (EC = 0.98) in the group farms I, it is overused in the II and III group farms. Because of the negative sign IG, it understood that the factor was overused in the group farms IV.

HB (β_2): This factor had been overused according to the farm capacity in the I, II and III group farms.

BS (β_3): It had been observed that fattening period was overused in all group farms.

HA (β_4): It had been observed that HA factor was overused in all group farms.

YM (β_5): Because of its negative sign, it was understood that used ration is overused in I, II and III group farms. Because of EC = 0.09, ration was overused in group farms IV, too.

PM (β_6): As marketing cost had a negative EC, except group farms I, in the other groups over expenses have been observed. It had been analyzed that this expense could be increased in the I group farms.

BK (β_7): Variable cost of the fattening barn related to the capacity can be increased in the group farms I and IV and this factor is overused in the group farms II and III.

Independent variables explained dependent variables at 5% importance level statistically in the all production functions. We have understood from production functions that the revenues according to the scale of farms were determined the increasing income in group IV farms and the decreasing income in the other groups farms. Calculated factors' EC explain whether the factors are used intensively or not.

In this study, it was aimed to determine whether the factors used in production had been used rationally or not. Generally; IG, BS, HA and YM were overused in all farms. HB must be increased in the group farms IV and it must be decreased in the others. Ration which is accepted the most important input of cattle fattening farms was overused in all farms and scarce resources were wasted because BS which is effective on fattening performance was maintained longer. For this reason, reorganizations would be done by taking into consideration EC in all farms.

By doing a new organization in farms, using male fattening material with high performance and using adapted races to environment conditions, over-ration usage and long fattening period must be approximated to optimum.

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