

EFFECT OF SELECTED FACTORS ON BASIC REPRODUCTION, GROWTH AND CARCASS TRAITS AND MEAT PRODUCTION IN TEXEL SHEEP

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Abstract

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The objective of this work was to determine the effect of lambing year, sire effect, parity of ewes' lambing (PL) and gender on selected indicators of meat production and fertility in a Texel sheep herd. The evaluation proceeded for a period of 5 years, when 356 ewe – lambs and 321 Texel ram – lambs were monitored. Processing of the data set was done by the SAS program, GLM procedure. The lambing year had a significant effect ($P < 0.05$; 0.01) on all indicators observed except litter size. The sire effect was found to be significantly ($P < 0.05$; 0.01) related to all indicators monitored. The significant differences ($P < 0.01$) were found in fat thickness and lambs' muscularity. The frequency of lambs' gender was not significantly affected by the litter size and number of lambs weaned. Lambs' gender affected the MLLT depth of lambs nonsignificantly. Litter size, as well as the number of weaned lambs, increased with the higher PL (1.44 with primiparas, 2.17 with ewes at the 5th and subsequent lambings, $P < 0.01$; resp. 1.31 with primiparas, 2.01 with ewes at the 5th and subsequent lambings, $P < 0.01$). The live weight at 100 days of age was significantly lower in lambs from the 5th and following litters, as well as the daily gain from birth till 100 days of age (DG 100) and MLLT depth in comparison to the 2nd, 3rd and 4th litters ($P < 0.05$). On the average, ram – lambs reached a higher live weight at 100 days of age (+1.79 kg, $P < 0.01$), and DG 100 in contrast to female (+17.22 g, $P < 0.01$).

sheep, Texel, meat efficiency, reproduction attributes, lamb

Sheep breeding is mostly oriented toward the production of slaughter lambs and their carcasses as the end product in the Czech Republic. For this purpose meat sheep breeds are intensively bred either in pure-breeding stocks or in some form of cross –breeding for carcasses of F1 production. A low fat thickness and a high rate of valuable meat parts are characteristic of the Texel breed. Under breeding conditions in the Czech Republic this breed has found reasonable utilization. This fact can be documented by the high ewe numbers in Performance Recording (PR).

The average consumption of mutton in the Czech Republic reaches 0.25 kg per inhabitant (Holá, 2010). Pindák and Milerski (2009) stated

that meat production in sheep breeding currently belongs among the primary performance attributes. However, fertility and the maternal attributes of ewes, the growth intensity of lambs and their carcass value are also important performance traits (Milerski, 2007). Jakubec *et al.* (2001) pointed that carcass yield, defined as the weight of a slaughtered body expressed in percentage share of live weight before slaughtering, is an important parameter linked to carcass value. Further, they added that the carcass yield of sheep ranged from 45–50%. Kremer *et al.* (2004) found that lambs from Texel rams showed the highest carcass yield (44.9% on the average) compared to Corridale, Southdown, Hampshire Down, Suffolk and East Frisien.

Mutton composition, as quoted by Ingr (2003), represents 70–75% water, 18–22% protein, 2–3% fat, 1.7–2% minerals, and 0.9–1.0% ash without nitrogen. The noticeable muscularity of Texel sheep is documented by Navajas *et al.* (2008). Also, Bünger *et al.* (2009) reached similar conclusions, adding that Texel offspring showed a significantly lower proportion of intramuscular fat. The above-mentioned performance traits predetermine this breed for F1 commercial crossing, as published by Picardi *et al.* (2010), who pointed out significant changes in the carcass body and especially leaner meat after fattening of cross – breeds regressively bred with Texel. According to the findings summarized, it can be assumed that basic factors of breeding affect production traits of Texel sheep. Knowledge of the level and significance of these relationships enables its use for modification of herd management focusing on a higher level of reproduction and meat performance.

The objective of this work was to determine the effect of lambing year, sire effect, PL and gender on selected indicators of meat production and fertility in a Texel sheep herd.

MATERIALS AND METHODS

The selected farm for study is situated in a foothills area, altitude cca 450m above sea level. The farm manages a total area of 154.85 ha of agricultural farmland, and the basic stock amounts to 102 ewes and 4 rams. The average rainfall in this area fluctuates by about 730mm per year, and the average annual temperature is 8 °C.

The monitoring was performed as a field test within a pure-breed population of Texel. Data of the Performance Recording from 2005–2009 period were used, and 677 lambs were observed in all. Lambs came from the mating of eight Texel rams comprising three different types (German – GT, Dutch – DT and French – FT). The Tiger (GT) line sired 182 lambs, the Tobias (GT) line 73 lambs, the Tristan line (GT) 143 lambs, the Tristan line 2 (GT) 11 lambs, the Tirol line (GT) 107 lambs, the Tadeas line (DT) 66 lambs and the Tamer line (FT) 24 lambs. A total of 138 lambs were born to primiparous, 199 at the 2nd parity of lambing, 146 at the 3rd parity, 142 at the 4th parity and 52 lambs at the 5th and subsequent parity of lambing.

Reproductive indicators such as the litter size (LS) and the number of weaned lambs at 100 days of age (WL) were monitored and recorded. Lambs' birth weight (BW) (weighted 2005–2006 or blank fixed 2007–2009) and live weight at 100 days of age (LW 100) (weighed) were recorded as well. Subsequently the daily gain from birth till 100 days of age (DG 100) was calculated. BW at lambs finally wasn't included in the study because from year 2007 birth weight was fixed and not weight like in years 2005 and 2006. Thus, statistically significant differences are not caused by the statistical model, but by a change

in methodology in management of the herd, and therefore no informative value is attached to them.

The muscle depth (musculus longissimus lumborum et thoracis – MLLT) was measured by using ultrasound Aloka 550 by 5 MHz linear probe, as well as fat thickness on the back behind the last rib at 100 days of age. Total muscularity, expressed subjectively by a qualified classifier, was evaluated from 1–5. The classification is based on the meat: fat ratio and the total muscularity of lambs with the emphasis on muscularity of the rumps. In accordance with these variables, the influence of lambing year, sire effect, PL and lamb gender were evaluated. Statistical evaluation was performed using the statistical program SAS – GLM (SAS/STAT® 9.1., 2009).

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + e_{ijklm}$$

Y_{ijklm}value of dependent variable (litter size, number of weaned lambs, weight at 100 days of age, daily gain from birth till 100 days of age, MLLT depth, fat thickness, muscularity),

μgeneral value of dependent variable,

A_ifixed effect of i^{th} – year of lambing ($i = 2005$, $n = 174$; $i = 2006$, $n = 103$; $i = 2007$, $n = 146$; $i = 2008$, $n = 130$; $i = 2009$, $n = 124$),

B_jfixed effect of j^{th} – sire effect ($j = \text{TYG}$, $n = 182$; $j = \text{TOB}$, $n = 73$; $j = \text{TRI}$, $n = 147$; $j = \text{TRI2}$, $n = 11$; $j = \text{TIR}$, $n = 107$; $j = \text{TAD}$, $n = 66$; $j = \text{TEO}$, $n = 67$; $j = \text{TAM}$, $n = 24$),

C_kfixed effect of k^{th} – parity of ewes' lambing ($k = 1$, $n = 138$; $k = 2$, $n = 199$; $k = 3$, $n = 146$; $k = 4$, $n = 142$; $k = 5+$, $n = 52$),

D_lfixed effect of l^{th} – lamb gender ($l = \text{ram lambs}$, $n = 321$; $l = \text{ewe lambs}$, $n = 356$),

e_{ijklm}residual error.

Differences among the variables were evaluated at the levels of statistical significance $P < 0.05$; $P < 0.01$.

RESULTS AND DISCUSSION

The influence of lambing year

The year of lambing had a significant effect ($P < 0.05$; 0.01) on all indicators monitored except the LS as presented in Table I. In 2005, conclusively lower values were found in LW 100, DG 100, MLLT depth and fat thickness in contrast to other years ($P < 0.01$). These findings confirmed the significant effect of lambing year and different conditions in individual years.

Within PR's published in yearbooks for the relevant years by Bucek *et al.* (2008), (2009), (2010) there is recorded for pure – breed sheep LW 100 30.9 kg (2007); 28.1 kg (2008); 29.3 kg (2009); and DG 100 for the years 2006 and 2005, which amount to 274 g (2007), 246 g (2008) and 260 g (2009). Bucek *et al.* (2007) presented at Texel breed similar DG 100 for the years 2006 and 2005 which amounted to 225 g and 247 g, respectively. If we evaluate these results by the values reached in the monitored herd,

I: The effect of lambing year

		A. 2005 (n = 174)	B. 2006 (n = 103)	C. 2007 (n = 146)	D. 2008 (n = 130)	E. 2009 (n = 124)
LS	LSM ± SE	1.89 ± 0.06	1.89 ± 0.06	1.87 ± 0.07	1.76 ± 0.06	1.75 ± 0.07
WL	LSM ± SE	1.71 ± 0.06 ^b	1.55 ± 0.07 ^{aCDe}	1.79 ± 0.06 ^B	1.77 ± 0.06 ^B	1.76 ± 0.06 ^b
LW 100 [kg]	LSM ± SE	22.99 ± 0.67 ^{BCDE}	32.08 ± 0.79 ^{ACDe}	28.77 ± 0.62 ^{AB}	28.75 ± 0.66 ^{AB}	29.35 ± 0.69 ^{Ab}
DG 100 [g]	LSM ± SE	187.29 ± 6.45 ^{BCDE}	271.01 ± 7.59 ^A	257.03 ± 5.93 ^A	257.36 ± 6.35 ^A	261.22 ± 6.64 ^A
MLLT [mm]	LSM ± SE	20.71 ± 0.47 ^{BCDE}	25.05 ± 0.55 ^A	25.46 ± 0.43 ^A	26.18 ± 0.46 ^{AE}	24.23 ± 0.49 ^{AD}
Fatness [mm]	LSM ± SE	2.61 ± 0.10 ^{BCDE}	2.96 ± 0.11 ^A	2.93 ± 0.09 ^A	3.14 ± 0.09 ^A	3.09 ± 0.10 ^A
Muscularity	LSM ± SE	3.18 ± 0.12 ^{Bd}	3.59 ± 0.14 ^{Ac}	3.29 ± 0.11 ^b	3.46 ± 0.11 ^a	3.32 ± 0.12

a, b, c, d, e – $P < 0.05$; A, B, C, D, E – $P < 0.01$; different letters confirm statistical significance

Key: Litter size – LS; Number of weaned lambs – WL; Birth weight – BW; Live weight at 100 days of age – LW 100; daily gain from birth till 100 days of age – DG 100; The fat thickness – Fatness; The MLLT muscle depth – MLLT

we find LW 100 practically reached the population average of the given breed in 2009. Afterwards, the monitored herd exceeded the value of the population average by 0.65 kg in 2008, in contrast to 2007, when the monitored herd reached a weight 2.13 kg lower at 100 days of age.

The DG 100 exceeded the population average by 1.22 g in 2009, by 11.36 g in 2008 and by 16.01 g in 2006. In contrast, in 2007 and 2005 the DG 100 in the monitored herd was 16.97 g, respectively 59.71 g below the population results. A positive finding within the monitored herd was an increase of lambs' growth indicators at 100 days of age during the period monitored, that can be explained by genetic progress (positive breeding program) and by proceedings collectively described as management of the herd. On the other hand we can note lower differences in DG 100 between PR's published in yearbooks and monitored herd.

The influence of sire effect

A statistically significant influence ($P < 0.05$; 0.01) of sire effect was determined in all traits evaluated

as presented in Table II. The significant differences ($P < 0.01$) were found in the level of MLLT depth, fat thickness and muscularity. The lowest LS in relation to sire was found in the Teofil line, when significant differences among Tygr, Tristan and Tirol rams were detected ($P < 0.05$). The highest WL, according to sire effect, was found for the Tobias line. Statistical significance was determined in comparison with the Teofil ram ($P < 0.05$). This fact can predict higher viability of lambs from various sires. The best growth parameters – LW 100, DG 100, and MLLT depth – were achieved by lambs of the Tristan 2 line. Comparison of the progeny of this sire with the second ram of the Tristan line is also interesting. The Tristan 2 as an offspring of the Tristan was completely reared on the studied farm and exceeded the results of his own sire in all monitored traits except LS (nevertheless, a non-significantly higher value of lambs weaned (0.01 lamb) was reached by Tristan 2). We can conclude positive genetic progress in the evaluated herd and suitable selection in the herd turnover. The lowest layer of subcutaneous fat was demonstrated in the lambs of the Tygr, Tristan

II: The sire effect

		A. TYG (n = 182)	B. TOB (n = 73)	C. TRI (n = 147)	D. TRI2 (n = 11)	E. TIR (n = 107)	F. TAD (n = 66)	G. TEO (n = 67)	H. TAM (n = 24)
LS	LSM ± SE	1.93 ± 0.04 ^{fg}	1.88 ± 0.08	1.89 ± 0.05 ^g	1.79 ± 0.18	1.87 ± 0.06 ^g	1.77 ± 0.08 ^a	1.69 ± 0.08 ^{acc}	1.85 ± 0.13
WL	LSM ± SE	1.74 ± 0.04	1.83 ± 0.07 ^g	1.74 ± 0.05	1.75 ± 0.17	1.70 ± 0.06	1.76 ± 0.07	1.57 ± 0.08 ^b	1.63 ± 0.13
LW 100 [kg]	LSM ± SE	27.57 ± 0.47 ⁱ	27.80 ± 0.83	27.82 ± 0.55 ⁱ	29.95 ± 1.89	27.98 ± 0.65 ⁱ	26.74 ± 0.79 ⁱ	29.85 ± 0.85 ^{acdf}	29.41 ± 1.38
DG 100 [g]	LSM ± SE	237.18 ± 4.54 ^g	238.81 ± 7.91	244.52 ± 5.28	262.01 ± 18.15	242.10 ± 6.24 ^g	232.34 ± 7.60 ^g	260.04 ± 8.11 ^{acf}	257.26 ± 13.23
MLLT [mm]	LSM ± SE	22.88 ± 0.33 ^{BdcFGH}	24.75 ± 0.58 ^{Ac}	23.34 ± 0.39 ^{bfG}	25.55 ± 1.32 ^a	24.06 ± 0.45 ^a	24.66 ± 0.55 ^{Ac}	24.44 ± 0.59 ^{AC}	24.93 ± 0.96 ^a
Fatness [mm]	LSM ± SE	2.72 ± 0.07 ^{dc}	2.87 ± 0.12	2.68 ± 0.08 ^{Def}	3.40 ± 0.26 ^{aCh}	2.99 ± 0.09 ^{ac}	2.96 ± 0.11 ^c	3.20 ± 0.12 ^h	2.75 ± 0.19 ^{dg}
Muscularity	LSM ± SE	3.10 ± 0.08 ^{BEg}	3.57 ± 0.14 ^{AC}	3.11 ± 0.10 ^{BEg}	3.32 ± 0.32	3.30 ± 0.11 ^{ACf}	3.64 ± 0.14 ^c	3.48 ± 0.15 ^{ac}	3.44 ± 0.24

a, b, c, d, e, f, g, h – $P < 0.05$; A, B, C, D, E, F, G, H – $P < 0.01$; different letters confirm statistical significance

Key: Litter size – LS; Number of weaned lambs – WL; Birth weight – BW; Live weight at 100 days of age – LW 100; daily gain from birth till 100 days of age – DG 100; The fat thickness – Fatness; The MLLT muscle depth – MLLT

and Tamer lines ($P < 0.05$). The best muscularity of lambs was determined in the Tadeas, Tobias and Teofil lines. Navajas *et al.* (2008) also pointed out the differences in muscularity between rams within the Texel and Scottish Blackface; however, they mentioned low differences (under 4%). The differences among sires exceeded the 4% in our observation. The differences ranged from maximum to minimum values by 12.4% (LS) and 14.2% (WL); differences in indicators of meat production by 11% (LW 100, DG 100, and MLLT depth), except for the fat thickness, where the difference amounted to 21%. Štolc *et al.* (2009) note that there are qualitative and quantitative differences in rams' ejaculate among sires depending on their age. Therefore ram selection markedly influences reproduction results.

We can summarize that lambs of the French type of Texel reached a significantly higher level of growth parameters expressed in LW 100 and DG 100. In contrast, the Dutch type showed a greater depth of MLLT when lower LW 100 and DG 100 were detected simultaneously. This fact corresponds to the highest muscularity value of the Dutch type. These results completely correlate with the characteristics described by Horák *et al.* (2005), who stated that a lower body frame, short legs and marked musculature are typical for this type.

Effect of ewes' lambing parity

The results presented in Table III documented the lowest LS in primiparas (differences from 0.23 to 0.73, $P < 0.01$), which increased up to the 3rd PL, whereas such significant differences were not found in subsequent PL. The results correspond to those of Horák *et al.* (2007), who concluded that ewes reached their highest fertility from the 3rd to the 5th PL, which coincides with the completion of their body growth. We can observe a similar trend in WL simultaneously. These results document that the losses of lambs weaned did not change significantly in relation to higher PL. Gootwine and Rozov (2006) and Dwyer *et al.* (2005) with a view on PL describe a lower BW in primiparas lambs in comparison to lambs from the 2nd and 3rd PL. Similarly Jakubec *et al.* (2001) noted that older ewes usually have heavier

lambs. These findings we can't confirm because in our case BW in lambs wasn't included in this study.

We can summarize that the most statistically significant differences ($P < 0.01$) in LW 100, DG 100, and muscularity were observed among primiparous ewes and ewes at the 2nd, 3rd and 4th PL. In this connection Peeters *et al.* (1996) found a lower average daily gain in live weight at 100 days of age in lambs from mothers up to one year old; however, they added that compensatory growth was observed. This fact wasn't completely confirmed in our study.

The decline of growth parameters in lambs of mothers at the 5th and subsequent PL, as regards LW 100 and DG 100, as well as MLLT depth ($P < 0.05$), was significant compared to ewes between the 2nd and the 4th PL. Differences in ewes between the 2nd and the 4th PL were not statistically significant. Kern *et al.* (2010) found in a sample of 3000 Texel ewes the average longevity of 3,7 lambings. This number can be connected to the results we determined, concretely that ewes after 4th PL showed lower meat utility attributes. We can also state that the influence of PL did not affect the fat thickness.

IV: The effect of lambs' gender

		A. ram – lambs (n = 321)	B. ewe – lambs (n = 356)
LS	LSM ± SE	1.84 ± 0.04	1.83 ± 0.04
WL	LSM ± SE	1.73 ± 0.04	1.70 ± 0.04
LW 100 [kg]	LSM ± SE	29.28 ± 0.44 ^B	27.49 ± 0.43 ^A
DG 100 [g]	LSM ± SE	255.39 ± 4.17 ^B	238.17 ± 4.14 ^A
MLLT [mm]	LSM ± SE	24.15 ± 0.30	24.50 ± 0.30
Fatness [mm]	LSM ± SE	2.85 ± 0.06 ^B	3.04 ± 0.06 ^A
Muscularity	LSM ± SE	3.29 ± 0.08 ^b	3.45 ± 0.07 ^a

a, b – $P < 0.05$; A, B – $P < 0.01$; different letters confirm statistical significance

Key: Litter size – LS; Number of weaned lambs – WL; Birth weight – BW; Live weight at 100 days of age – LW 100; daily gain from birth till 100 days of age – DG 100; The fat thickness – Fatness; The MLLT muscle depth – MLLT

III: The effect of ewes' lambing parity

		A. 1. (n = 138)	B. 2. (n = 199)	C. 3. (n = 146)	D. 4. (n = 142)	E. 5.+ (n = 52)
LS	LSM ± SE	1.44 ± 0.06 ^{BCDE}	1.67 ± 0.05 ^{ACDE}	1.95 ± 0.06 ^{ABc}	1.94 ± 0.06 ^{ABc}	2.17 ± 0.09 ^{ABcd}
WL	LSM ± SE	1.31 ± 0.05 ^{BCDE}	1.64 ± 0.05 ^{ACDE}	1.77 ± 0.05 ^{ABc}	1.85 ± 0.05 ^{AB}	2.01 ± 0.09 ^{ABc}
LW 100 [kg]	LSM ± SE	26.91 ± 0.61 ^{BCD}	29.23 ± 0.52 ^{Ac}	29.65 ± 0.60 ^{Ac}	29.30 ± 0.58 ^{Ac}	26.85 ± 1.01 ^{bcd}
DG 100 [g]	LSM ± SE	232.91 ± 5.82 ^{BCD}	254.76 ± 4.94 ^{Ac}	259.25 ± 5.79 ^{Ac}	255.45 ± 5.59 ^{Ac}	231.54 ± 9.72 ^{bcd}
MLLT [mm]	LSM ± SE	23.67 ± 0.43 ^{bcd}	24.91 ± 0.36 ^{ac}	25.04 ± 0.42 ^{ac}	24.77 ± 0.41 ^{ac}	23.23 ± 0.71 ^{bcd}
Fatness [mm]	SLM ± SE	2.87 ± 0.09	2.93 ± 0.07	3.06 ± 0.08	2.98 ± 0.08	2.87 ± 0.14
Muscularity	LSM ± SE	3.09 ± 0.11 ^{BCD}	3.49 ± 0.09 ^A	3.51 ± 0.10 ^A	3.54 ± 0.10 ^A	3.21 ± 0.18

a, b, c, d, e – $P < 0.05$; A, B, C, D, E – $P < 0.01$; different letters confirm statistical significance

Key: Litter size – LS; Number of weaned lambs – WL; Birth weight – BW; Live weight at 100 days of age – LW 100; daily gain from birth till 100 days of age – DG 100; The fat thickness – Fatness; The MLLT muscle depth – MLLT

Effect of lambs' gender

According to the Table IV the frequency of gender was not statistically different with regard to LS and the number of weaned lambs. On the average, ram – lambs had a LW 100, resp. DG 100 by 1.79 kg higher, respectively 17.22 g higher compared to ewe – lambs ($P < 0.01$). These results are in opposite with Kuchtík *et al.* (2010), Kuchtík *et al.* (2011) who found no significant effect on growth between sexes, although they confirm higher daily gains by males. The level of DG 100 defined in the breed standard for Texel is 250 g per day for ram and for ewe – lambs 200 g per day – thus, in both cases the results in the monitored herd were exceeded by 5.39 g per day in rams, respectively 38.17 g per day in ewes. A lower

level of back fat was found in rams (-0.19 ; $P < 0.01$), while higher muscularity was noted in ewes ($+0.16$, $P < 0.05$). At the same time MLLT muscle also measured 0.35 mm higher in females; however, the difference was not statistically significant. Horák *et al.* (2005) mentioned the higher thickness of cutlets of ewes. An identical conclusion was also reached by Johnson *et al.* (2005), who noted that ewes, Texel cross-breeds, reached a higher carcass yield and muscularity. In contrast, rams had less fat thickness. Our results confirm this fact, because a 0.19 mm lower layer of fat was measured at ram – lambs ($P < 0.01$). Also Jeremiah *et al.* (1998) point out a lower fat thickness and higher cohesiveness of ram – lambs when assessing meat quality.

SUMMARY

The effect of lambing year, PL, sire effect and gender of lamb on traits of reproduction and meat performance was evaluated in Texel sheep in this study. The influence of the sire was found to be an important element. Differences in reproduction indicators among rams were detected at a level of 12.4% in LS and 14.2% in WL and in indicators of meat performance about 11% except for the fat thickness, where the difference amounted to 21%. The most significant differences ($P < 0.01$) were found in MLLT depth, fat thickness and lamb muscularity depending on the sire. No significant differences were determined in selected traits observed among lambs born in the 2nd, 3rd, and 4th litters ($P < 0.01$). On the other hand, primiparas reached a lower level of reproduction performance traits: LS and WL ($P < 0.01$). Similarly, lambs born in the 5th and subsequent PL demonstrated a decline in LW 100 and DG 100 and MLLT depth ($P < 0.05$). When compared the gender of lambs, rams – lambs showed a higher level of LW 100 DG 100 and fat thickness ($P < 0.01$). In contrast, the depth of MLLT was measured 0.35 mm higher in ewe – lambs.

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