# Influence of selected factors on growth performance of Suffolk lambs and their crossbreds

# Vliv vybraných faktorů na růstové schopnosti jehňat plemene suffolk a jejich kříženců

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## Abstract

The monitoring was performed in one year period in selected population of Suffolk sheep (SF, n = 257) and their crossbreds with Merinolandschaf (SF × ML, n = 87). Total of 627 lambs (SF, n = 463; SF × ML, n = 164) were observed in breeding conditions of two semi-extensive flocks. Lambs' live weight at 100 days of age (LW100); *musculus longissimus lumborum et thoracis* (MLLT100) depth and backfat thickness (BT100) at the same age were assessed. Effects of breed, ewes' live weight at mating, litter size, sex of lambs and ewe's age as linear regression were evaluated using SAS 9.1. Significant differences ($P < 0.05$) in LW100, MLLT100 and BT100 between SF and SF × ML were observed. All the evaluated traits of growth performance were also influenced ($P < 0.05$) by ewes' live weight at mating. The highest lambs' growth performance traits were detected in lambs of ewes with highest live weight at mating (group of ≥ 80.7 kg). Significant differences ($P < 0.05$) were observed among singles, twins and triplets lambs as well. Significantly higher LW100 was marked in ram lambs compared to ewe lambs ($P < 0.05$).

**Keywords:** backfat thickness, *musculus longissimus lumborum et thoracis* depth, sheep, ultrasound measurements

## Abstrakt

Sledování probíhalo během 1 roku u čistokrevných bahnic plemene Suffolk (SF; n = 257) ovcí a jejich kříženců s plemenem merinolandschaf (SF × ML; n = 87). Celkový počet 627 jehňat (SF, n = 463; SF × ML, n = 164) byl sledován ve 2 polointenzivních chovech. U jehňat byly hodnocena živá hmotnost jehňat ve 100 dnech věku (LW100), hloubka svalu *musculus longissimus lumborum et thoracis* (MLLT100) a tloušťka vrstvy podkožního tuku (BT100) ve stejném věku. Při vyhodnocení byly zohledněny faktory: plemenné příslušnosti, živé hmotnosti v době zapouštění, četnosti vrhu, pohlaví jehněte a lineární regrese na věk matek. Statistické vyhodnocení bylo provedeno programem SAS 9.1. Statisticky významné rozdíly ($P < 0,05$) byly pozorovány u LW100, MLLT100 a BT100 v závislosti na plemenné příslušnosti (SF vs. SF × ML). Průkazné rozdíly ($P < 0,05$) u všech hodnocených

parametrů byly zjištěny v závislosti na živé hmotnosti bahnic v době zapouštění, kdy nejvyšších hodnot dosahovala jehňata od matek s nejvyšší živou hmotností (≥ 80,7 kg). Průkazné rozdíly byly pozorovány také mezi jedináčky, dvojčaty a trojčaty ($P < 0,05$) Vyšší ukazatel LW100 byl zjištěn u beránků ve srovnání s jehničkami ($P < 0,05$).

**Klíčová slova:** ovce, hloubka svalu *musculus longissimus lumborum et thoracis* depth, tloušťka vrstvy podkožního tuku, ultrazvukové měření

## Detailní abstrakt

Sledování probíhalo během 1 roku u čistokrevných bahnic plemene Suffolk (SF; n = 257) ovcí a jejich kříženců s plemenem merinolandschaf (SF × ML; n = 87). Celkově bylo sledováno 627 jehňat (SF, n = 463; SF × ML, n = 164) ve 2 chovech s polointenzivním chovem ovcí. Zatímco krmná dávka ovcí byla složena z pastevního porostu a senáže, jehňata byla navíc intenzivně přikrmována vojtěškovými granulemi v průměrné dávce 400 g*den$^{-1}$. Ve věku 100 dní byla u jehňat zjišťována živá hmotnost (LW100) a byly prováděny ultrazvuková měření pomocí přístroje Aloka 500 a 5 MHz lineární sondy: hloubka svalu *musculus longissimus lumborum et thoracis* (MLLT100, mm) a tloušťka vrstvy podkožního tuku (BT100, mm). Při vyhodnocení byly zaznamenány a zohledněny následující faktory: podíl krve SF, živá hmotnost matek v době zapouštění, četnost vrhu, pohlaví jehněte a lineární regrese na věk matek. Statistické vyhodnocení bylo provedeno programem SAS 9.1. na $P < 0,05$. Statisticky významné rozdíly byly pozorovány u LW100, MLLT100 a BT100 mezi jehňaty SF vs SF × ML. Průkazné rozdíly ($P < 0,05$) u všech hodnocených parametrů byly zjištěny v závislosti na živé hmotnosti matek v době zapouštění, kdy nejvyšších hodnot dosahovala jehňata od matek s nejvyšší živou hmotností (≥ 80,7 kg). Naproti tomu nejnižší hodnoty ukazatelů LW100 a BT100 byly pozorovány u ovcí s nejnižší živou hmotností při zapouštění (≤ 69,9 kg). Průkazné rozdíly byly pozorovány také mezi jedináčky, dvojčaty a trojčaty ($P < 0,05$), s nejvyšší růstovou intenzitou jedináčků u všech sledovaných ukazatelů růstu. Průkazně vyšší hodnota LW100 byla zjištěna u beránků ve srovnání s jehničkami ($P < 0,05$).

## Introduction

Growth performance of sheep belongs to the most important parameters influencing the profitability. As a reaction to the buyer's preference the meat producers are requesting lambs that fulfill the conditions of age, body weight, body fat coverage, and meat quality indicators (Freer and Dove, 2002). Number of studies focused on factors influencing the parameters of growth performance in the in vivo assessed animals (Koycegiz et al., 2009; Esmailizadeh et al., 2011) as well as in the lamb carcasses (Atti and Mahouachi, 2009; Abdullah et al., 2010).

Previous studies confirmed significant differences of growth performance in depending on breed (Milerski et al., 2006; Maxa et al., 2007), ewe's live weight at mating (Abdel-Mageed and El-Maaty, 2012; Aliyari et al., 2012; Vatankhah et al., 2012), litter size (Kuchtík and Dobeš, 2006; Cloete et al., 2007), sex of lambs (Mohammadi et al., 2010, Ptáček et al., 2011).

It is presumed that these relations could be applied also in breeds of meat purpose sheep. All these factors are closely connected to flock economy which is documented by partial economic values expressed by Wolfová et al. (2009) or Krupová et al. (2012). Moreover the flock profitability in Suffolk sheep population in Czech Republic

is profitable only with governmental subsides 15.3 € or 15 % expressed by profit to costs ratio. On the other hand the loss of -2.1 € or -2.5% expressed by profit to costs ratio was published by Wolfová et al. (2009) in case of no governmental subsides. Therefore it is important to monitor factors effecting growth performance of lambs to improve the whole profit per ewe and year.

The aim of this study was to evaluate the lambs' growth performance traits depending on effects of breed, ewe's live weight at mating, litter size or sex of lambs in Suffolk sheep and their crossbreeds.

## Material and Methods

### Flock characteristics

The monitoring was carried out in 2 flocks of Suffolk sheep purebreds (SF; n = 257) and their crossbreds with Merinolandschaf (SF × ML; n = 87). The total number of 627 lambs (SF, n = 463; SF × ML, n = 164) were observed during the period of 1 year. The genetic portion of SF × ML crossbreds was above 75 % of SF blood.

Flock 1 was located in the altitude of 300 m above sea level, with the average annual rainfall of 750 mm*year$^{-1}$ and average annual temperature of 8.2 °C. The sheep spent the entire year at the pasture. The lambing season occurred from half of April to the end of May.

Flock 2 was located in the altitude of 320 m above sea level, with the average annual rainfall of 800 mm*year$^{-1}$ and average annual temperature of 7.7 °C. After the grazing season the sheep were housed in the pen with the possibility of pasture grazing. Lambing season was from the half of April to the end of May.

The feed ration during the grazing season (from April 15$^{th}$ to October 15$^{th}$) in both flocks consisted of the grazing pasture only. There was no flushing effect applied before the mating. The sheep had access to mineral lick and water (ad libitum) during the whole year. The feed ration consisted of haylage (5 kg per head*day$^{-1}$) and hay (*ad libitum*) during the non-grazing period.

The food ration of lambs consisted of mother's milk, grazing pasture, hay (*ad libitum*) and concentrates (alfalfa granules for lambs; Mikrop Čebín, a.s., Čebín, Czech Republic). The average amount of concentrate supplements was 400 g per head*day$^{-1}$ from birth till 100 days of age, with the maximal ration of 750 g per head*day$^{-1}$ at the time of evaluating.

### Traits and their evaluation

The growth performance parameters of lambs' live weight (LW100, kg), *musculus longissimus lumborum et thoracis* (MLLT100, mm) and backfat thickness (BT100, mm) at 100 days of age were evaluated. The LW100 was obtained with the use of tensometric scales designated for the weighing of small ruminants VHD (My Weigh, Germany). The MLLT100 and BT100 were measured behind the last thoracic vertebra, according to official methodology used in Recording System of Performance (Milerski, 2007). The ultrasound Aloka 500 (Hitachi Aloka Medical, Ltd.; Tokyo, Japan) and 5 MHz linear probe (UST-5011U) were used.

The ewes' live weight at mating (LW; kg) ±0.1 kg as basic independent factor was marked with the use of tensometric scales designated for the weighing of small ruminants VHD (My Weigh, Germany).

To evaluate impact of the independent variables on lambs growth performance, following equation was applied:

$$Y_{ijklm} = \mu + BREED_i + LW_j + LS_k + SEX_l + b(AGE) + e_{ijklm}$$

$Y_{ijklm}$ = value of the dependant variable (LW100; MLLT100; BT100);

$BREED_i$ = breed (i = SF purebreds, n = 463; i = SF × ML crossbreds, n = 164);

$LW_j$ = ewes' live weight at mating (j = LW ≤ 69.9 kg, n = 152; j = LW 70.0 to 80.7 kg, n = 293; j = LW ≥ 80.8 kg, n = 182);

$LS_k$ = litter size (k = singles, n = 90; k = twins, n = 450; k = triplets, n = 87);

$SEX_l$ = sex of the lamb (l = ram lambs, n = 322; l = ewe lambs, n = 305);

b(AGE) = linear regression to the age of the ewe;

$e_{ijklm}$ = residual error.

Significant differences were observed on $P < 0.05$.

The statistical analysis was performed using SAS 9.1 (SAS/STAT® 9.1., 2009), general linear model (GLM) procedure. The sheep were divided into 3 groups according to their body weight at mating ($\bar{x}$ -0.5 s <; $\bar{x}$ -0.5 s to $\bar{x}$ + 0.5 s; > $\bar{x}$ + 0.5 s): 1. LW ≤ 69.9 kg; 2. LW = 70.0 to 80.7 kg; LW ≥ 80.8 kg. Further information about breed, age of ewe, sex of lambs and litter size were marked and evaluated. The Tukey-Kramer method was applied for comparison and evaluation of significant differences between least square means.

## Results and Discussion

### Effect of breed

Results of Suffolk purebred and their crossbreds are presented in Table 1. Significantly higher values ($P < 0.05$) of all the growth performance attributes were observed in SF lambs compared to SF × ML crossbreds (+5.38 kg in LW100; +3.99 mm in MLLT100 or + 0.65 mm in BT100). There was not evident obvious heterosis in sheep with genetic portion above 75 % of SF sheep and purebred animals. Oppositely these animals achieved in average lower values of growth performance. Differences could be thus explained mainly by factor of flock as previously documented by Maxa et al. (2007) or Milerski et al. (2006). As presented by Wolfová et al. (2009) values of total revenues and costs were 86.0 € and 88.1 € in Suffolk population in Czech Republic. According to their results the average flocks are slightly losses (-2.1 €). Therefore it is important to improve growth performance traits to overturn flock economics into positive profitability. As presented in our study there is considerable variability in growth performance traits among particular sheep flocks.

Table 1. Effect of breed on lambs' growth performance traits

| | LW100 (kg) | MLLT100 (mm) | BT100 (mm) |
|---|---|---|---|
| | LSM ± SE | LSM ± SE | LSM ± SE |
| SF (n=463) | 40.93 ± 0.437[a] | 31.04 ± 0.246[a] | 4.78 ± 0.066[a] |
| SF × ML (n=164) | 35.25 ± 0.570[b] | 27.05 ± 0.323[b] | 4.22 ± 0.087[b] |

SF – Suffolk purebreds; SF × ML – Suffolk and Merinolandschaf crossbreds; LW100 – lambs' live weight at the age of 100 days (kg); MLLT100 – *musculus longissimus lumborum et thoracis* of lambs at the age of 100 days (mm); BT100 – backfat thickness of lambs at the age of 100 days (mm); LSM – least square means; SE – standard error of LSM; a,b – means with different superscripts in columns differ at $P < 0.05$

**Effect of ewes' live weight at mating**

Results of effect of ewe's live weight at mating on subsequent growth performance traits of their lambs are presented in Table 2. Significantly highest values of growth performance traits were observed in lambs of ewes with highest LW (> 80.8 kg). The lowest values of LW100 or BT100 were marked in ewes with lowest LW (≤ 69.9 kg). Significant ($P < 0.05$) differences -3.33 kg in LW100 or -0.35 mm in BT100 were detected compared to ewes with highest LW. Significantly lowest MLLT100 (-1.11 mm; $P < 0.05$) was observed in LW 70.0 to 80.7 kg compared to LW ≥ 80.8 kg. These findings are in accordance with study of Aliyari et al. (2012), who observed increase of lambs' live weight at weaning (age of 120 days) together with increased live weight of their mothers at mating in Afshari sheep ($P < 0.05$). Kenyon et al. (2004) or Kenyon et al. (2011) documented the positive effect of ewes' live weight at mating on the live weight of lambs at 100 days of age ($P < 0.05$) using Kent crossbreds. The positive effect of ewes' live weight at mating on subsequent growth performance of their lambs was also observed in local Iranian Lori-Bakhtiari sheep published by Vatankhah et al. (2012).

In study of Wolfová et al. (2009) mature weight was expressed negatively by economic values. They explained the heavier Suffolk mature weight was, the higher increase in feed costs for maintenance and growth of heavier ewes or rams occurred. As addition the higher costs for the prolonged period of rearing female and male replacement were not covered by the increased revenue from sale of heavier culled ewes and rams. However our results confirmed a positive relation between ewes' live weight (in our case measured at mating) and subsequent growth performance of their offspring. The higher mature weight increases costs connected to feed ration. On the other hand it enhances benefits in the form of higher growth performance of their lambs. As the byproduct the higher slaughter price of these animals is also obtained, despite the economic aspects described by Wolfová et al. (2009). Monitoring of ewe's live weight in meat purpose sheep (in our case Suffolk purebred or crossbreds at mating) appears to be a practical and effective tool of flock management to increase their subsequent lambs' growth performance.

Table 2. Effect of ewes' live weight at mating on subsequent growth performance traits of their lambs

| | LW100 (kg) | MLLT100 (mm) | BT (mm) |
|---|---|---|---|
| | LSM ± SE | LSM ± SE | LSM ± SE |
| LW ≤ 69.9 kg (n = 152) | 36.66 ± 0.664[a] | 28.96 ± 0.372 | 4.33 ± 0.100[a] |
| LW 70.0 to 80.7 kg (n = 293) | 37.63 ± 0.484[b] | 28.53 ± 0.273[a] | 4.50 ± 0.073 |
| LW ≥ 80.8 kg (n = 182) | 39.99 ± 0.556[c] | 29.64 ± 0.314[b] | 4.68 ± 0.086[b] |

LW ≤ 69.9 kg – ewes with live weight at mating lower than 69.9 kg; LW 70.0 to 80.7 kg – ewes with live weight at mating in range from 70.0 to 80.7 kg; LW ≥ 80.8 kg – ewes with live weight at mating higher than 80.8 kg; LW100 – lambs' live weight at the age of 100 days (kg); MLLT100 – *musculus longissimus lumborum et thoracis* of lambs at the age of 100 days (mm); BT100 – backfat thickness of lambs at the age of 100 days (mm); LSM – least square means; SE – standard error of LSM; a,b,c – means with different superscripts in columns differ at P < 0.05

**Effect of litter size**

As it was expected, the highest LW100 (P < 0.05) was observed in singles vs. twins (+5.64 kg) and triplets (+6.81 kg) lambs as presented in Table 3. Similar results were previously observed by Kuchtík and Dobeš (2006) monitoring the Wallachian and East Friesian sheep crossbreds. Cloete et al. (2007); Petrović et al. (2009); Mohammadi et al. (2010) also reported higher growth performance in singles compared to lambs from multiple litters. Significant differences in LW100 of twins vs. triplets (1.17 kg; P < 0.05) were observed in our study as well. There was also a significant decrease in ultrasound measurements traits with increasing number of lambs in the litter (P < 0.05). Highest values were observed in singles with significant differences (P < 0.05) compared to twins (+1.52 mm in MLLT100; +0.47 mm in BT100) or triplets (1.80 mm in MLLT100; +0.51 in BT100). Milerski et al. (2006) documented significantly (P < 0.05) higher MLLT100 and BT100 in singles vs. twins or triplets of Suffolk, Charollais, Texel and Romney lambs.

The meat sheep breeders prefer two lambs born and reared per litter, despite the fact that singles showed generally better growth performance traits (P < 0.05). The ewes with two lambs in litter produced totally higher live weight at 100 days of age per litter (+30.96 kg or +47.7 %, respectively) compared to ewes with singles. This fact represents an important role in improving flock economics documented also in study of Wolfová et al. (2009) by highest economic importance for litter size. On the other hand, problem with rearing the triplets was reported from evaluated flocks. Based on our results and in agreement with Wolfová et al. (2009) it is important to select animals in to reproduction based on their litter size. However it is necessary to respect maternal abilities of meat-purpose sheep, especially with rearing all lambs in litter (Ptáček et al., 2013).

Table 3. Effect of litter size on lambs' growth performance traits

| | LW100 (kg) | MLLT100 (mm) | BT 100 (mm) |
|---|---|---|---|
| | LSM ± SE | LSM ± SE | LSM ± SE |
| Singles (n = 90) | 42.24 ± 0.716[a] | 30.15 ± 0.402[a] | 4.83 ± 0.108[a] |
| Twins (n = 450) | 36.60 ± 0.368[b] | 28.63 ± 0.210[b] | 4.36 ± 0.057[b] |
| Triplets (n= 87) | 35.43 ± 0.821[b] | 28.35 ± 0.461[b] | 4.32 ± 0.122[b] |

LW100 – lambs' live weight at the age of 100 days (kg); MLLT100 – *musculus longissimus lumborum et thoracis* of lambs at the age of 100 days (mm); BT100 – backfat thickness of lambs at the age of 100 days (mm); LSM – least square means; SE – standard error of LSM; a,b – means with different superscripts in columns differ at $P < 0.05$

**Effect of sex of lambs**

The results of lambs' sex on their growth performance traits are presented in Table 4. Significantly higher values of LW100 (+3.70 kg; $P < 0.05$) was observed in ram lambs compared to the ewe lambs, as confirmed by Cloete et al. (2007), Petrović et al. (2009) or Mohammadi et al. (2010). According to Stanford et al. (2001) or Abdullah et al. (2010) the effect of lamb sex is one of the most important factors influencing ultrasound measurements of lambs. This finding was not entirely obvious from our study. Non-significantly higher MLLT100 (+0.07 mm) was observed in ram lambs which corresponded with results published by Ptáček et al. (2011). De Siqueira et al. (2001) even reported higher levels of muscle coverage in ewe lambs of the Ile de France x Corriedale crossbreds. In accordance with their results non-significant variability of lambs' sex in BT100 trait was observed in our study as well. These findings corresponded to study published by Tejeda et al. (2008). Contrary, Milerski et al. (2006) or Ptáček et al. (2011) reported significantly ($P < 0.05$) higher BT100 in Suffolk and Charollais ewe lambs.

There were no significant differences in MLLT100 or BT100 in relation to sex of lambs. As result the common fattening of ram lambs and ewe lambs can be performed with no negative effect on both parameters of ultrasound measurements. However ram lambs were more perspective from the profitability point of view due to their higher LW100 as expressed economic values in Suffolk population published by Wolfová et al. (2009).

Table 4. Effect of lamb sex on lambs' growth performance traits

| | LW100 (kg) | MLLT100 (mm) | BT100 (mm) |
|---|---|---|---|
| | LSM ± SE | LSM ± SE | LSM ± SE |
| Ram lambs (n = 322) | 39.94 ± 0.465[a] | 29.08 ± 0.263 | 4.52 ± 0.071 |
| Ewe lambs (n = 305) | 36.24 ± 0.492[b] | 29.01 ± 0.276 | 4.49 ± 0.074 |

LW100 – lambs' live weight at the age of 100 days (kg); MLLT100 – *m. longissimus lumborum et thoracis* of lambs at the age of 100 days (mm); BT100 – backfat thickness of lambs at the age of 100 days (mm); LSM – least square means; SE – standard error of LSM; a,b – means with different superscripts in columns differ at $P < 0.05$

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