Animal welfare in organic pig production
– Does leg health in growing-finishing pigs improve by change of sire breed?

Summary
Growing-finishing pigs with Hampshire or Duroc sires reared in Swedish commercial organically certified herds were studied from insemination of the mother sow until slaughter. Clinical leg health was individually assessed at 13 and 24 weeks of age and individual slaughter performance was recorded at the slaughter plant. The results show that the proportion of growing finishing pigs with severe clinical leg health disorders is low (<8%) in commercial organic herds in Sweden. However, a high proportion of pigs had milder forms of disorders, and these disorders were developed during the later parts of the rearing period. There were no differences in clinical leg health between offspring of Hampshire and Duroc sires. Thus, there are no evidence that leg health can be improved in Swedish organic pig producing herds by choice of sire breed. However, offspring to Hampshire sires grew faster than offspring to Duroc sires, indicating economically and resource efficiency advantages of using Hampshire sires in organic production in Sweden.

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Figure 1. Offspring of Hampsire (black) and Duroc (brown) boars during assessment of exterior and movement in the project.

Background

In Sweden, the proportion of pigs from organic herds with leg joint remarks at slaughter increased from 4 to 8 % from 1997 to 2008 (Heldmer and Lundeheim, 2010). Most previous studies regarding leg health in organic pig production have focused on infectious inflammation (Erysipelothrix rhusiopathiae). However, there are indications that a significant proportion of organic pigs with discarded joints at slaughter in Sweden, have suffered from osteochondrosis (Heldmer, 2009). Moreover, previous studies are based on data from slaughter while the clinical leg health of live pigs has not yet been thoroughly investigated in commercial organic herds.

In attempts to reduce join discards and improve leg health, commercial organic pig producers in Sweden has showed an increased interest in alternative genetic material as both osteochondrosis and leg weakness are heritable in pigs (Lundeheim, 1987; Stern et al., 1995). Besides animal welfare concerns, poor leg health is also associated with environmental load and production economy as poor leg health has been found to be associated with reduced slaughter weights (Lundeheim, 2010).

There are few published reports concerning differences in leg health between pig breeds when pigs are raised in extensive environments, such as organic production environments. However, breed comparisons have been performed in two smaller studies. One of the studies concluded that the incidence of osteochondrosis (registered at slaughter) was lower for pigs with Yorkshire x Landrace dam and Duroc sire than for pigs with Yorkshire x Landrace dam and Yorkshire sire (Lundeheim et al., 1995). However, no such differences were found for the incidence of osteochondrosis between (Yorkshire x Landrace) x Hampshire and (Yorkshire x Landrace) x Yorkshire pigs. In another study it was concluded that Yorkshire x Duroc gilts deviated less from the desired exterior, leg conformation and locomotion than Yorkshire x Landrace gilts (Leufvén, 2004).

The majority of the organic pigs slaughtered in Sweden are crosses between Yorkshire x Landrace dams and Hampshire sires, the typical breed cross used in conventional Swedish pig production. Besides Hampshire sires, it is practically and economically feasible for Swedish pig producers to access Norwegian Duroc sires. It is not currently realistic to import equivalent commercial breeds from other countries due to e.g. risks for importing foreign infectious diseases and costs related to import and management of such a breed.

In summary, there are reasons to speculate that Duroc progenies have better leg health than Hampshire progenies in organic outdoor production. If such differences exist, change of sire breed would be a practically and economically feasible measure for producers to improve pig leg health.

Aim

The overall aim with this study was to map variation in clinical pig leg health and growth in pigs reared in commercial organic herds. The specific aim was to investigate differences in clinical locomotion, lameness, swollen joints, leg joint remarks at slaughter and slaughter performance between offspring of available sire breeds (Hampshire or Duroc) reared in Swedish commercial organic herds.

Material and methods

The experiment was performed according to Swedish regulations regarding use of animals in experiments.

Animals, herds and housing

In total, 907 pigs origin from 97 litters and reared in four organically KRAV certified commercial growing-finishing pig herds were included in the study. Landrace-Yorkshire sows were inseminated with non-mixed semen (one boar per dose) from AI boars of Duroc or Hampshire breeds with known identity. Herdsmen recorded the identity of the boar at each insemination. The two sire breeds were evenly distributed among sows in each herd and production batch. The first inseminations were carried out in September 2011 and the last pigs in the study were slaughtered in Match 2013. The four herds were integrated or external integrated with 40 to 160 sows in production and were located in the central parts of Sweden between latitude 59° and 61°.

In the herds, all sows farrowed indoors in Swedish conventional, individual loose-housed farrowing pens. Two weeks after farrowing the sows and their piglets were moved to deep-straw family pens (during the non-vegetative season) or on pasture (during the vegetative season, May to September) in groups with 4 – 10 sows and their piglets per group. In the family pens the sows were loose-housed with the possibility to access an outdoor area with concrete floor. On pasture the pigs had access to either huts where they could sleep and find shadow, or access to a stables connected to the pasture. The piglets were weaned 6-7 weeks after farrowing.

The fattening pigs were kept on pasture during the vegetative period of the year. The rest of the year all pigs were kept in deep-straw pens with outdoor access with concrete flooring. The growing-finishing pigs were kept in the same group from weaning to slaughter.

All animals were fed according to the SLU feeding norm and KRAVs feeding regulation (SLU, 2011, KRAV, 2012b). All pigs in the study were slaughtered at the same slaughter plant at approximate 6 month of age and a live weight of 120kg.

Registrations

We followed the pigs from insemination to slaughter. Herdsmen counted the number of live- and still born piglets in each litter at the day of farrowing. For individual identification of pigs, herdsmen marked all piglets with electronic ear tags before they reached 2 weeks of age.

To identify the individual pig on farm and the carcass at the slaughter plant, a hand-scanner was used to read the identification number from the ear-tag (HHR 3000 Pro V2 HandHeld Reader, approved for reading ISO 11784/11785 transponders (BioControl AS, 2012)). Moreover, all pigs were tattooed with an individual number approximately two weeks before slaughter, to ensure identification at the slaughter plant if the ear-tags got lost in the slaughter process.

Clinical leg health was recorded at two occasions on farm. Locomotion, lameness, swollen joints, back- and leg conformation were individually scored for all pigs on farm at approximately 13 and 24 weeks of age (90±19.5 and 170±17.4 days of age). These two occasions correspond to the start and the end of the finishing period (just before slaughter). The protocol used was based on the protocol used by the breeding organisation Nordic genetics' breeding (*Figure 2*). All pigs were assessed in a confined area of 5 to 10 m^2 with dry solid flat floor, either in the side alley when pigs were housed in stalls or on the transport wagon when pigs were housed in huts on pasture. One trained research assistant performed all the locomotion, lameness, swollen joint assessments, back- and leg conformation.

At slaughter, slaughter weight, carcass leanness (percentage meat in the carcass) and leg joint remarks were recorded for each individual pig. A research technician was present at the slaughter plant when pigs from the study were slaughtered,.

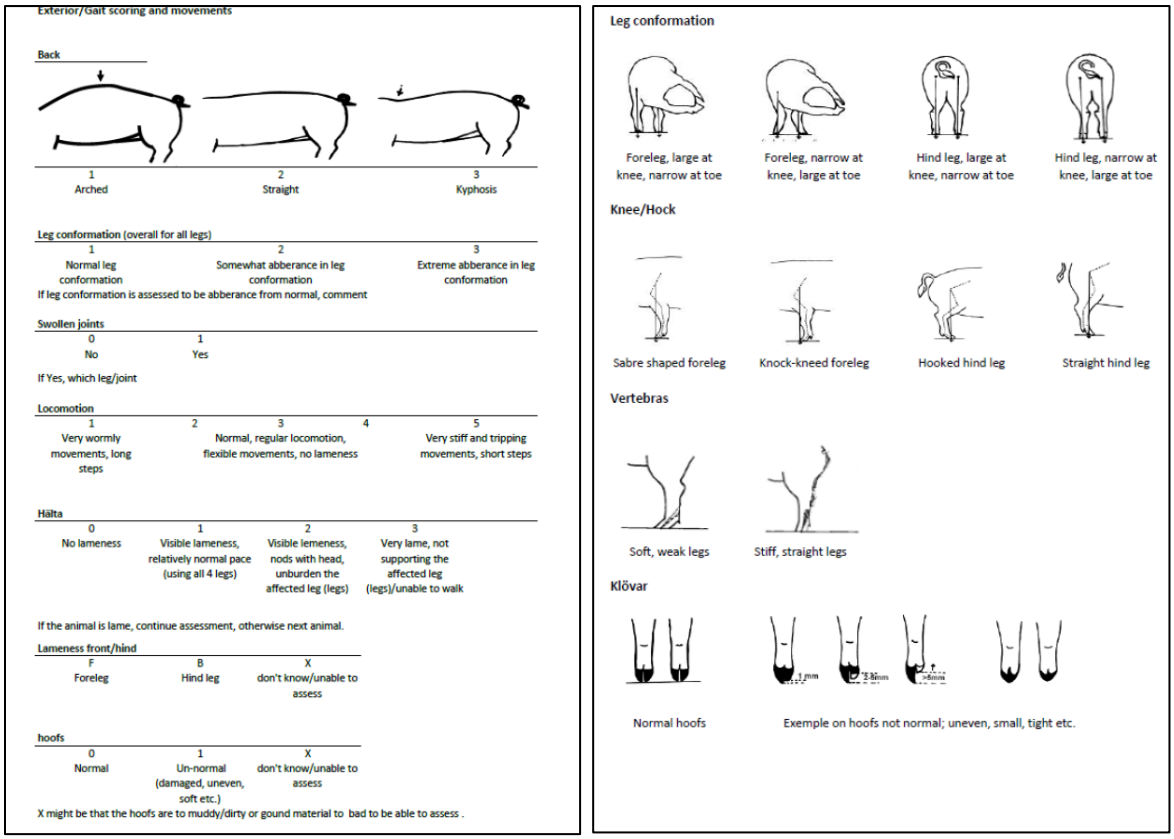

Figure 2. Protocol for exterior and gait assessments

Statistical analysis

Statistical analyses were performed using the Statistical Analysis Systems; SAS 9.2 (SAS, 2014). Data from registrations about sire, litter and pig id and data from exterior and gait assessments as well as data from slaughter were merged and edited. Descriptive statistics were estimated using PROC FREQ and PROC MEANS. Assessment scores for locomotion, lameness, swollen join, back- and leg conformation were transformed into binomial parameters were 0 = normal and 1 = not normal before the statistical analyses.

Differences between sire breeds in gestation length, number of live born and number of stillborn piglets were analysed with MODEL 1 using PROC GLM. The corresponding differences in slaughter weight and carcass lean meat percent were analysed with MODEL 2 and differences in weight gain was analysed with MODEL 3, using PROC MIXED in both cases. Binomial variables (scored normal or not normal) of locomotion, lameness, swollen join, back- and leg conformation scores as well as join remarks at slaughter (yes or no) was analysed with logistic regression using PROC GLIMMIX (binomial distribution and logit link) with MODEL 3.

MODEL 1: y = sire breed + gender + e

MODEL 2: y = sire breed + gender + herd + slaughter age + birth sow + e

MODEL 3: y = sire breed + gender + herd + birth sow + e

In all models, y is the dependent variable and e is the residual. Sire breed (Hampshire or Duroc), gender (female or castrate) and herd (A, B, C or D) were included as fixed effects, slaughter age was included as a continuous covariate and birth sow was included as a random effect.

Residuals of all continuous (not binomially distributed) dependent variables were examined for normally distribution using PROC UNIVARIATE considering Shapiro-Wilks test and a normal probability plot. All residual variables were found to be normally or approximately normally distributed.

The effect of season was considered and included in the effect of birth sow, as no sows farrowed twice in this study. For the variables analysed with MODEL 1, season was found not significant and thus not included in the statistical model. Least square means are indicated with LSM and standard error is indicated with SE.

Results and discussion

From the 97 litters with known sire born in this study 907 pigs with reliable individual records were included in the analyses. Of these 453 pigs had a Hampshire sire and 454 pigs had a Duroc sire.

The clinical leg health in the pigs declined over the rearing period (*Figure 3 a-e*) as the proportion of pigs with non-normal locomotion, lameness, leg conformation and swollen joints was higher week 24 than week 13. The reason for this finding is probably due to the

fact that the legs and joints had been under pressure in the outdoor rearing environment during this period. However, the proportion of pigs with severe leg problems (locomotion score 1 or 5, lameness score 2 and 3 or swollen joints) was low (<8%), both week 13 and week 24. This indicates that the clinical leg health in pigs in organic herds is generally good. Possible sub clinical leg problems (e.g. osteocondrosis) are thus hard to determine on farm, but needs more thorough investigations of carcasses as suggested by Etterlin et al. (2015).

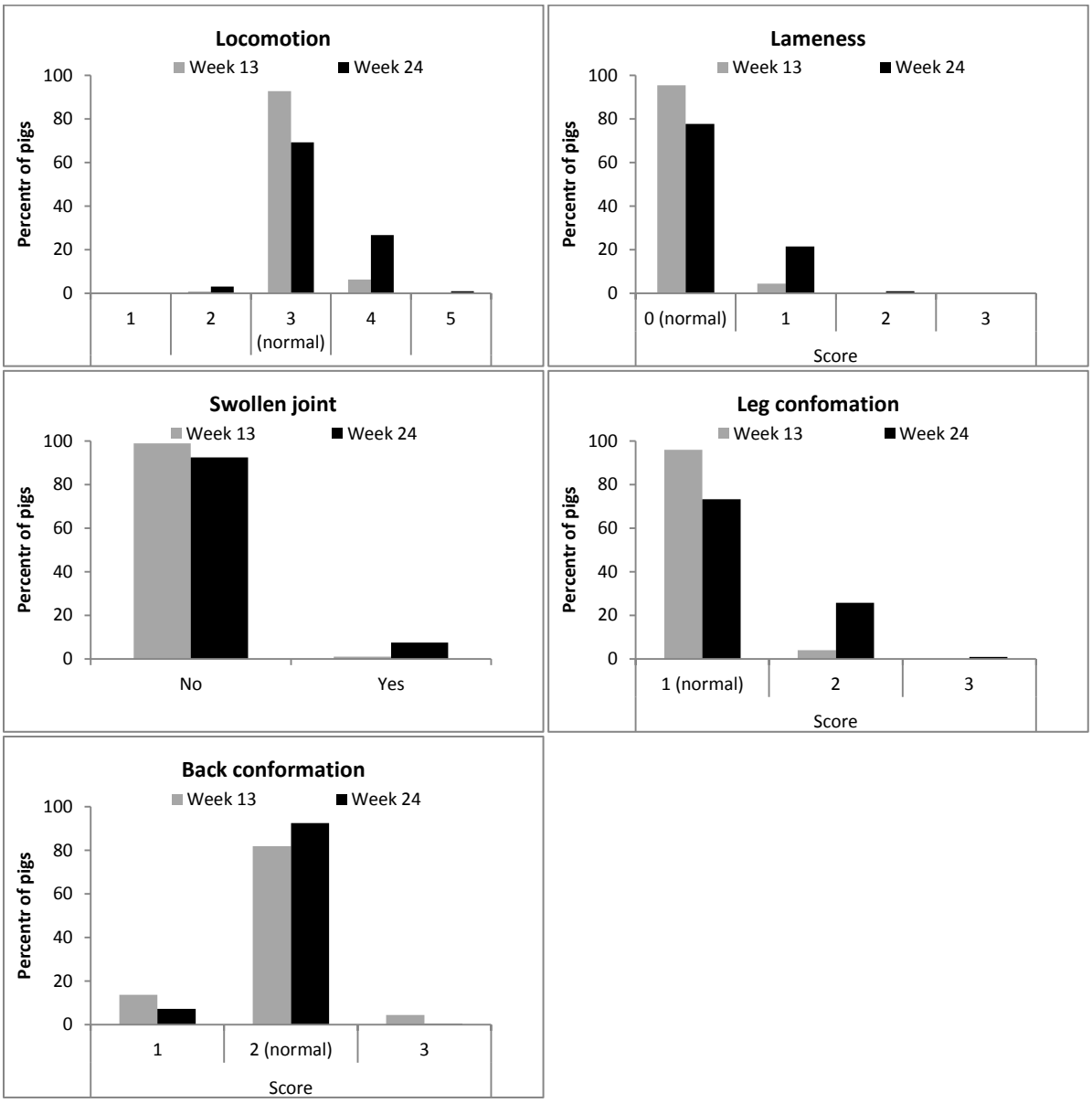

Figure 3 a-e. Distribution of exterior and movement scores at first and second observation occasions (at 13 and 24 weeks of age)

We also found a low proportion of pigs with non-normal back conformation scores (*Figure 3 a-e*), and this low proportion actually reduced from week 13 to week 24. There are probably two reasons for this decrease over the rearing period; that the pigs "grew into their backs" as they got older (anatomic development differs between body parts in different stages of the

growth) and that pigs with the most severe back malformations were culled between 13 and 24 weeks.

There were no clear differences in clinical leg health between pigs with Hampshire sires and pigs with Duroc sires (*Table 1*). In fact, the prevalence patterns of all leg health measurements for offspring with the two sire breeds followed each other, both measurements from week 13 and week 24. This finding verifies the good quality of the leg health protocol used.

Slaughter weight and meat percent in carcass did not differ significantly between offspring to the two sire breeds, even though there was a tendency for Hampshire offspring to be heavier at slaughter (*Figure 4*). This lack of clear difference was an expected result as the producers are very careful in sending pigs to slaughter with a slaughter weight within the best paired weight range. However, the age when the pigs reached the best paid slaughter weight in these organic herds was lower for offspring to Hampshire compared to offspring to Duroc sires, as indicated by higher growth rates (*Figure 5*).

The variation found in clinical leg health and slaughter performance was affected by gender, herd and birth sow as indicated in *Table 2*.

Tabel 1. Differences between Hampshire and Duroc sired pigs in leg health measurments and sow and litter performance.

	Hampshire sire		**Duroc sire**			
	LSM	**±SE**	**LSM**	**±SE**	**N**	**p**
Leg health (% pigs not scored normal)						
Back conformation week 13	13.6	2.88	19.2	3.44	641	0.177
Back conformation week 24	6.6	1.90	11.2	2.51	691	0.131
Leg conformation week 13	4.6	1.60	3.7	1.34	642	0.681
Leg conformation week 24	27.7	3.69	32.9	3.81	691	0.270
Swollen joint week 13*	1.5		0.1		642	
Swollen joint week 24	10.3	2.19	7.1	1.71	691	0.236
Locomotion week 13	8.0	1.98	5.2	1.44	642	0.207
Locomotion week 24	35.3	4.09	35.8	3.90	690	0.918
Lameness week 13	3.0	1.19	3.0	1.17	642	0.983
Lameness week 24	27.4	3.37	26.3	3.15	691	0.798
Leg join remarks at slaughter* (% of pigs)	1.3		1.3		614	
Sow and litter performance						
Gestation length (days)	116	0.4	116	0.3	95	0.188
Number live born	11.1	0.77	12.3	0.70	97	0.183
Number stillborn	1.3	0.55	1.0	0.50	97	0.650
Proportion still born (%)	7.2	2.93	7.1	2.67	97	0.972

*Analyse did not converge, mean values given

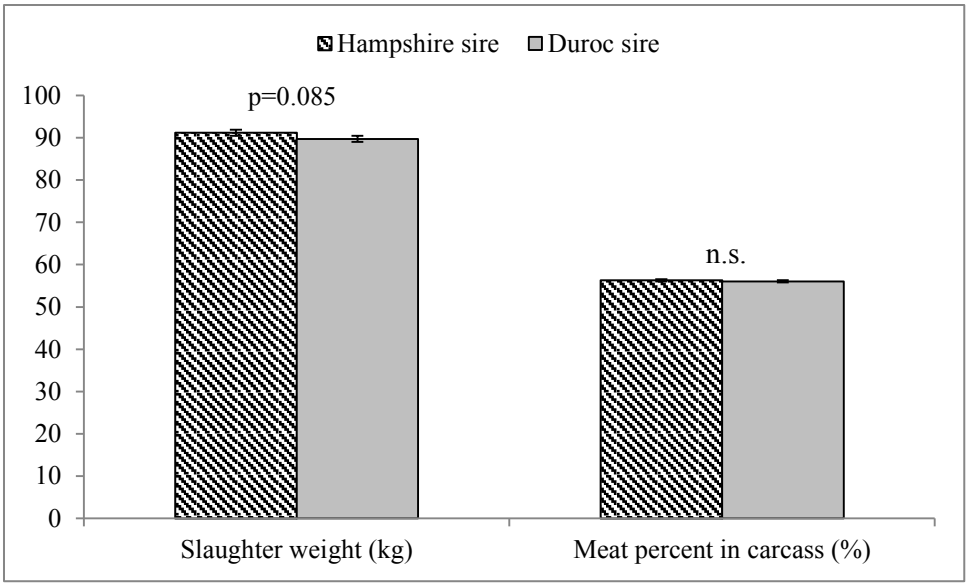

Figure 4. Slaughter weight and Meat percent in carcass for Hampshire and Duroc offspring. LSM and SE. n.s. = not significant

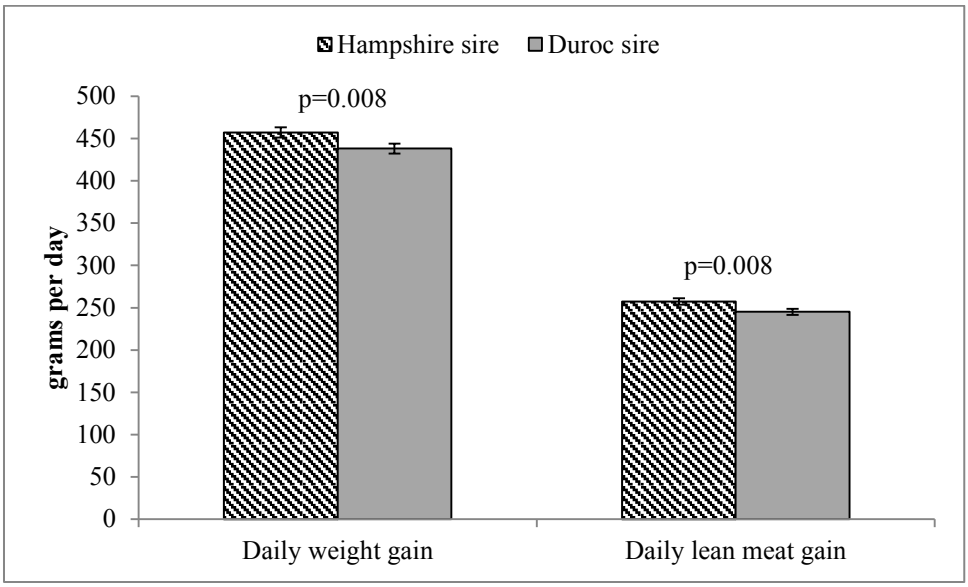

Figure 5. Daily weight gain and daily lean meat gain for Hampshire and Duroc offspring. LSM and SE.

Table 2. Impact of effects included in the statistical models. P values given when p<0.1.

	Effect				
	Breed	**Gender**	**Herd**	**Slaughter age**	**Birth sow**
Sow and litter performance					
Gestation length (days)	n.s.	-	n.s.	-	-
Number live born	n.s.	-	0.016	-	-
Number stillborn	n.s.	-	n.s.	-	-
Proportion still born (%)	n.s.	-	n.s.	-	-
Slaughter performance					
Slaughter weight (kg)	0.085	0.156	0.010	0.000	0.000
Meat percent in carcass (%)	n.s.	0.000	0.000	0.059	0.000
Growth (g/day)	0.008	0.000	n.s.	-	0.000
Lean meat growth (g/day)	0.008	0.008	0.001	-	0.000
Leg join remarks at slaughter (% of pigs)	*		*		*
Leg health (% pigs not scored normal)					
Back conformation week 13	n.s.	n.s.	n.s.	-	0.000
Back conformation week 24	n.s.	n.s.	0.035	-	0.000
Leg conformation week 13	n.s.	n.s.	n.s.	-	0.000
Leg conformation week 24	n.s.	0.009	0.001	-	0.000
Swollen joint week 13	*	*	*	-	*
Swollen joint week 24	n.s.	0.012	0.008	-	n.s.
Locomotion week 13	n.s.	n.s.	n.s.		n.s.
Locomotion week 24	n.s.	n.s.	0.010		0.000
Lameness week 13	n.s.	0.034	n.s.	-	n.s.
Lameness week 24	n.s.	n.s.	0.012	-	n.s.

*Analyse did not converge, mean values given
n.s. = not significant
- = not included in the statistical model

Conclusions

We conclude that the proportion of growing finishing pigs with severe clinical leg health disorders is low (<8%) in commercial organic herds in Sweden. However, a high proportion of pigs have milder disorders, and these seem to be developed during the later parts of the rearing period (between 13 and 24 weeks of age). We also conclude that there are no differences in clinical leg health between pigs sired by Hampshire and Duroc in organic herds. Thus, there are no evidence that leg health can be improved in Swedish commercial organic herds by changing sire breed. Another reason for organic producers to choose Hampshire sires is the higher growth rate found in Hampshire offspring reared in organic herds.

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