OVERVIEW OF GROWTH, ENERGY STATUS AND NUTRITIONAL MANAGEMENT OF WEANLING HORSES IN WINTER IN DIFFERENT HOUSING SYSTEMS

ÜLEVAADE VARSSADE KASVUST, ENERGIABILANSIST, SÖÖTMISPIDAMISTINGIMUSTEST TALVISEL AJAL ERINNEVATES TALLITÜÜPIDES

Graduation Thesis in Veterinary Medicine

Curriculum in Veterinary Medicine

Supervisor: professor Toomas Orro

Tartu 2016
The aim of this work is to observe the growth, growth rate, growing conditions, and housing practices of weanling horses in cold loose-housings compared to traditional warm housing stables during winter. The study observed the growth of 69 weanling horses in five cold loose-housing stables and seven warm housing stables during one winter season. Horses were examined twice during this study with the interval between examinations being 65 days. The age of horses in the first examination was from 139 to 232 days. As Finnish coldblood horses are thought to be more cold resistant than Standardbreds and warmblood riding horses, the horses were observed according to breed. The breed categories were Finnish coldbloods (n = 19) and warmbloods (Standardbreds) (n = 50); Standardbred had two subcategories – trotting and riding horses. Eleven Finnish coldbloods were in cold loose housing and eight in standard stables. From warmbloods 28 were in cold loose housing and 22 in standard stables. The body condition score (BCS) was used to evaluate the energy status and feeding and heart girth to measure the growth and growth rate. This study suggests that warmblood weanlings may grow better in cold loose housing than in traditional stables. However, more studies are needed with larger sample size to confirm these results.
Eesti Maaülikool
Kreutzwaldi 1, Tartu 51014

**Autor:** Ida Elisa Tiainen

**Pealkiri:** Ülevaade varssade kasvust, energiabilansist, söötmi-pidamistingimustest talvisel ajal erinevates tallitüüpides

**Lehekülgi:** 38

**Jooniseid:** 3

**Tabelete:** 4

**Osakond:** kliinilise veterinaarmeditsiini osakond

**Uurimisvaldkond:** kliiniline veterinaarmeditsiin

**Juhendaja:** prof. Toomas Orro

**Kaitsmiskoht ja aasta:** Tartu 2016


Märksõnad: *varss, vabapidamine, kasv*
**TABLE OF CONTENTS**

ABSTRACT ........................................................................................................................................... 2  
LÜHIKOKKUVÕTE .......................................................................................................................... 3  
LIST OF ABBREVIATIONS ............................................................................................................ 6  
INTRODUCTION ................................................................................................................................. 7  
ACKNOWLEGMENTS .......................................................................................................................... 7  
1. REVIEW OF THE LITERATURE ................................................................................................. 8  
   1.1. Estimated growth and aspects affecting the growth rate ............................................. 8  
   1.2. Calculations of digestible energy ............................................................................. 8  
   1.3. Feeding recommendations for foals ...................................................................... 10  
   1.4. Growth rate and nutritional management ............................................................ 11  
   1.5. Effect of climate on energy intake and growth .................................................... 12  
   1.6. Effects of protein quality and limiting amino acids ........................................... 14  
   1.7. Different feeds and feeding ratios effecting the growth rate .................................. 14  
   1.8. Influence of trace mineral concentrations to growth ........................................ 15  
   1.9. Quality aspects of forage ......................................................................................... 16  
   1.10. Housing practices in Finland ............................................................................... 16  
2. AIMS OF THE STUDY ............................................................................................................. 18  
3. MATERIALS AND METHODS .................................................................................................. 19  
   3.1. Characteristics of the foals .................................................................................... 19  
      3.1.2. Age .................................................................................................................. 19  
   3.2. Health assessment ..................................................................................................... 20  
   3.3. Body condition score ............................................................................................... 20  
   3.4. Growth ....................................................................................................................... 21  
   3.5. Overview of housing and management ................................................................. 22  
      3.5.1. Warm housing overview ................................................................................ 22  
      3.5.2. Cold loose-housing overview ....................................................................... 22  
      3.5.3. Feeding ............................................................................................................ 22  
      3.5.4. Water ............................................................................................................... 23  
   3.6. Climate ......................................................................................................................... 23
3.7. Statistical analysis .............................................................................................................. 23

4. RESULTS ............................................................................................................................. 24
   4.1. Health assessment ........................................................................................................ 24
   4.2. Body condition score .................................................................................................. 24
   4.3. Growth ......................................................................................................................... 25

5. DISCUSSION ....................................................................................................................... 27

6. CONCLUSION .................................................................................................................... 30

SUMMARY ........................................................................................................................... 31

KOKKUVÕTE ......................................................................................................................... 33

REFERENCES ...................................................................................................................... 35
LIST OF ABBREVIATIONS

ADG Average daily gain
BCS Body condition score
BW Body weight
CP Crude protein
DM Dry matter
DE Digestible energy
FCB Finnish coldblood horse
HG Heart girth
Mcal Megacalorie (4.19 Mcal = 1 megajoule)
ME Metabolizable energy
MJ Megajoule (1MJ = 4.19 megacalorie)
MTT MTT Agrifood Research Finland
NRC National Research Council U.S
OCD Osteochondritis
SLU Swedish University of Agricultural Sciences
WB Warmblood horse

DEFINITIONS

Weanling A foal post weaning till 12 months of age
Yearling A horse from 12 months to 24 months of age
INTRODUCTION

The breeding programs of racehorse have moved towards early maturing and start of a career. A common complaint amongst horse trainers is that foals mature late (Saastamoinen 1990). Standardbred and Finnish coldblood horse breeders select increasing numbers of early maturing horses. At the same time conformational and musculoskeletal abnormalities have become a big concern to breeders and trainers. The aims of an early career start for Standardbred horses means an intensive training program at a young age. On average, the breaking and training of foals starts at 18 months (Saastamoinen 1990). Standardbred horses are allowed to participate in races at the age of 2 years on 1st of January of that year and Finnish coldblood horses from the 1st of September of that year (Suomen Hippos 2016).

In search of the housing systems providing the best possible growth and welfare for weanlings and yearlings, cold loose-housing has become a popular keeping system. Cold loose-housing has been seen as a cheaper and easier solution than a traditional stable. It requires less human labor when working with the horses primarily because of the reduced amount of daily duties such as stable cleaning and taking the horses outside and back for the night. Cold loose-housing also provides a more natural environment for the horses by improving welfare through enhanced social contact and freer movement.

Though Finland has a long and cold winter, there are few studies about the effects of a cold climate on a weanling’s growth and energy intake (Autio et al. 2008). For example, MTT Agrifood Research Finland’s feeding recommendations (MTT 2010) do not have specific advice for weanlings in cold housing environment.

The aim of the presented study is to observe the growth, growth rate and growing conditions, and housing practices of weanling horses in cold loose-housings compared to traditional stables.

ACKNOWLEDGMENTS

Thanks to Reija Junkkari, Ell, and Minna-Liisa Heiskanen, PhD, (Equine Information Center), Ian Oliver and Elisabeth Dorbek-Kolin, DVM, for guidance, and stables for participating to this study.
1. REVIEW OF THE LITERATURE

1.1. Estimated growth and aspects affecting the growth rate

The major factors affecting the growth of a horse described in Autio (2008) are: breeding, nutrition, stress, amount of exercise, environment and climate. The latter is particularly important with respect to energy need (Autio 2008). Balanced nutrition is important for optimum growth rate and development of a foal. It is also a factor that can be easily manipulated to increase the growth rate (Lawrence 2008). Most breeders prefer fast growth and maturing. Their interests are also economical because average prizes in sales tend to be bigger for an early maturing foal (Lawrence 2008). Skeletal growth is fast during the first year of life: weanling of fast growing breeds, such as Thoroughbreds and Standardbreds, should reach approximately 94% of their mature height at withers and 65% of body weight in the age of 12 months (Lawrence 2008). These horse breeds reach averagely 84% of height at withers and 46% of mature body weight at the age of six months. 90% of mature body weight and 97% of wither height are on average reached at the age of 22 months (Lawrence 2008). During the first months the foal grows on average 1.3 kg per day and 0.5 kg per day as a yearling (Lew 2009).

According to Lawrence (2005), the extremely fast growth rate predisposes to developmental orthopedic disease. The slow growth periods that follow to rapid growth periods may lead to developmental disorders. The growth rate should be maintained in moderately steady course (Lawrence 2005). In other study by Rosenlew (2009) foals younger than 12 months of age with osteochondritis dissecans (OCD) had also glucose intolerance which causes the rise of insulin levels in blood.

1.2. Calculations of digestible energy

There are different measures of energy used in the introduced literature. Digestible energy (DE) is used in United States and Great Britain (Harris 1997). Metabolizable energy (ME) is used in Finland (MTT 2010). Net energy is used in France (Harris 1997). Two units are used side by side: the joule (J) in Europe and calorie (cal) in United States when 1 MJ = 4.19 Mcal (Harris 1997). Figure 1 (Harris 1997) shows how the final value for digestible energy is derived. Determining the energy value of the feeds is done using prediction equations (Harris 1997). These calculations are derived from works by Lawrence (2008) and MTT (2010).
Energy for maintenance is defined as “the daily food intake that maintains constant body weight and body composition of a healthy adult horse with zero energy retention at a defined level of activity in comfortable surroundings.” by Harris (1997). Relationship between digestible energy and metabolizable energy is presented in Equation 1.

\[ 1 \text{ MJ DE} \approx 0.86 \text{ MJ ME} \quad (1) \]

Digestible energy for maintenance is calculated from the Equation 2 (Lawrence 2005).

\[ DE \text{ (Mcal)} = 1.4 + 0.03 \text{ BW (body weight, kg)} \quad (2) \]

The digestible energy needed for certain average daily gain (ADG) can be calculated from Equation 3 (Lawrence 2005).

\[ DE \text{ (Mcal)} = [1.4 + 0.03\text{BW(kg)}] + (4.81 + 11.17x-0.023x^2) \text{[ADG(kg)]} \quad (3) \]

Metabolizable energy of concentrate is calculated from digestible crude protein (dCP), digestible crude fat (dCFat), digestible crude fiber (dCF) and digestible nitrogen free extract (dNFE) as shown in the following Equation 4 (MTT 2010).

\[ ME \text{ (MJ/kg DM)} = (15.2 \times dCP + 34.2 \times dCFat + 12.8 \times dCF + 15.9 \times dNFE) / 1000 \quad (4) \]
Metabolizable energy of forage is calculated using digestible organic matter in dry matter (DM) (D-value) (MTT 2010). Metabolizable energy for silage and grass presented in the Equation 5 (MTT 2010)

\[ ME (MJ) = 0.016 \times D-value \]  

Equation 5

Analogic to previous the metabolizable energy for hay in the Equation 6 (MTT 2010)

\[ ME (MJ) = 0.0169 \times D-value - 1.05 \]  

Equation 6

Digestible crude protein is calculated multiplication from crude protein and feed crude protein digestibility (MTT 2010).

1.3. Feeding recommendations for foals

There are only few studies about the effects of cold climate on growing horse (Autio et al 2008). The official feeding requirements rarely include specific tables for cold loose-housed foals. Furthermore, the different units make the comparing of nutrient contents laborious. Energy can be given as metabolizable- or digestible energy, MJ or Mcal. Also feed intake can be given as dry matter intake or feed intake Such as ‘fed’. According to MTT (2010) the feed DM intake of a weanling horse is on average 2.5-3 % from body mass. This makes 6.25-7.5 kg DM for a 250 kg foal, which is the same rate than in studies by Cymbaluk et al. (1989) and Autio (2008).

The requirements previous presented in the MTT study (2010) for a 6 to 12months foal with an estimated mature body weight 550kg is 64.4 MJ/d ME, 550 g/d digestible crude protein lysine 0.5-0.6% in feeding portion or 0.55 g/MJ. The effect of cold climate increases these previous values of energy intake by around 1.4%/grade. In Autio (2015d) the nutrient recommends for weanlings is 59 MJ/d ME, digestible crude protein 500 g/d, calcium 33 g/d and 22 g/d phosphorus. The diet should consist of 80% forage feeds and 20% concentrates. The concentrate proportion should not exceed 2-2.5 kg/d. The evaluation of the foal’s body mass should be quite precise. The stable keeper should keep up the nutrient compositions during the different stages of growth (Autio 2008). The DE requirement according to U.S. National Research Council (NRC) is 16.2 Mcal for rapidly growing foals, based on a foal of 6 months, with average daily gain (ADG) of 0.8 kg/day and an estimated mature size of
560kg (Lawrence 2005). Kentucky Equine Research Center recommends 16.8 Mcal DE for same growth rate and age (Lawrence 2005).

According to Lew (2009) a 6 months old foal should receive at least 2.75 Mcal/kg DE, consisting of crude protein 13.1 % and lysine 0.55 %. Concentrate feeding should be based to the age of foal, the younger the foal the faster the growth. The increase of concentrate feeding could be 0.45 kg per month of age, so a foal in the age of 6 months could receive at least 2.7 kg daily. The portion size should not exceed 2 kg as fed. The feeding recommendation for 6 month-old foal on average is 3.2 kg concentrates, 16% crude protein and forage or grass 4.1 kg/day (Lew 2009).

1.4. Growth rate and nutritional management

The optimal feed for growing horses is good quality grass (Lawrence 2005), but due to climatic issues in Nordic countries it is never, available throughout the year. The quality of pastures varies among the season and years depending also on the fertilization and natural botanic culture or seed mix used (Ringmark 2014). The diet of horses is based on forage and concentrates. The variation in nutrient content of these feeds is vast (Autio 2015c). The most important peace in equine nutrition is good quality hay (Autio 2015b). This is especially important for weanlings because of their great daily energy need and the smaller daily feed intake compared to adult horses. "A foal in the age of 6 months should eat at least 3-4 kg forage and 0.5-1 kg concentrates, as fed, daily" (Autio 2015d). However, the amount of forage given depends on the nutrient content of the feed. If the dry matter content in the feed is low it should be given more, kg as fed (Lew 2009). For example, in pasture grass the dry matter content is on average 14-20 % DM and dry hay less than 85 % DM. Therefore, a horse can eat green grass more than dry hay (Autio 2015c). Late cut “old” hay only fills the gut with non-absorbable fiber and according to Autio (2015d) adequate amount of forage depends upon the dry matter content, which varies between 5-10 kg, as fed, daily. For an adult horse of 500 kg BW recommends 1.5-2 % dry matter of body weight.

To provide adequate levels of energy and protein to a growing foal it is dependent upon what kind of feeds are used (Lew 2009). For example, alfalfa hay and clover forages provide more protein than timothy hay. The total protein and metabolizable energy intake consists of whole diet, so with high quality forage, concentrates and protein supplements it is easy to exceed nutrient recommendations. Overfeeding of energy and protein leads to fast increase of body mass which might predispose the foal to OCD (Lew 2009).
Cymbaluk et al. (1990) studied the growth of 18 colts from 6 to 24 months of age. It was found that the *ad libitum* fed horses were bigger at age of 24 months, but *ad libitum* fed foals also had more conformational and musculoskeletal abnormalities. Some of the conformational abnormalities were suggested to be inheritable (Cymbaluk et al. 1990). Phosphorus content in the diet did not correlate to growth or dietary energy intake and gender of the foals did not affect the daily weight gain (Cymbaluk and Christison 1989). The horses in *ad libitum* feeding had on average DE intake of 21.3 Mcal, which is 33% higher than NRC recommendation for 6-12 month old foals (Cymbaluk and Christison 1989). Conclusion was that the DE intake may be 20-60 % above the NRC recommendation. Horses in their study also grew faster than expected and were on average heavier at the age of 12 months than predicted. The breed of the horse was thought to influence in some manner but the feeding management with high DE intake was concluded to cause the fast growth (Cymbaluk and Christison 1989).

In the study by Saastamoinen (1990b) of inheritable factors for growth rate measurements the correlations were widely negative. Variation of the measurements was largest at birth, decreasing with age. Variety was smallest in the height measures, which indicates these to be the best values to predict mature measures of the horse. There was positive correlation between body size and growth rate at the age of 12 months. Saastamoinen (1990b) pointed out that no heritability estimates for growth rate in horses were found in literature. He also suggested that the growth rate could be associated to the foal’s activity during pasture season and nutrition through the dam’s milk quality could be affected by grazing.

In Saastamoinen study (1990a) about the influence of birth month, birth year, gender and mare size to growth of the foal, statistically significant influence to most growth measurements was birth year. The dam’s size influenced most of measures and ADG of the foal. Large mares had larger and faster growing foals. This might also reflect the breeding program’s selection of early maturing and fast growing horses.

### 1.5. Effect of climate on energy intake and growth

In optimal environmental conditions the heat loss is minimal and the energy needed to maintain the body temperature is at the smallest level. Beside the air temperature, the wind speed and precipitation affect the heat loss of a horse (Autio 2008). In Cymbaluk and Christison’s study (1989) cold stress increased the weight-scaled digestible energy intake. Autio et al. (2008) found that mass-specific ME intake increased only in autumn and early
winter. The lower critical temperature (LCT), where the temperature started to affect the ME intake, was found to be -11°C (Autio et al. 2008). Precipitation alone did not affect the DE intake in the Cymbaluk and Christison’s study (1989), but they noted that in the cold weather the precipitation is snowing which could have less effect on horses’ insulation, when hair coat does not become wet through.

In Autio et al. (2008) in weanling horses in a cold loose housing system average hay intake was 4.4 ± 1.2 kg DM/d. In November it increased 3.7 ± 0.8 kg DM/d, in December 0.4 ± 0.8 kg DM/d, while in January and February 4.3 ± 0.9 kg DM/d. Silage with oats and protein supplement (1.6 ± 0.4 kg DM/d 1.0 ± 0.2 and 0.5 ± 0.2 kg DM/d) was given on average. Total dry matter intake was on average 7.5 ± 1.3 kg/d which is a little higher than in Cymbaluk and Christison’s (1989) study about forage fed horses. On average the metabolizable energy intake was 24.6% higher compared to MTT requirements for growing horses with estimated mature body weight of 500 kg and 15% higher than the fast growth recommendation of the Swedish University of Agricultural Sciences (SLU) (Autio et al. 2008). In the end of the both studies, (Cymbaluk and Christison 1989, Autio et al. 2008) foals had relatively high body condition score in ad libitum feeding. The general conclusion in both studies was that DM intake in ad libitum feeding was greater than nutritional need. Both researchers marked also that the horses were in good body condition at the start of the studies. According to Autio et al. (2008) “The energy intake of growing horses should be adjusted to BW, ADG, BCS, the level of acclimatization and to the changing weather conditions to guarantee maintenance and normal growth in cold conditions”. Author also reminded that a feeding method according to only BCS does not include the effects of body weight and the effect of weight gain on energy need.

Ponies and Finnish coldblood horse have thicker winter hair coat than warmblood horses and differences in heat loss were found using a thermographic camera. At the air temperature +15°C there was no difference between breeds. At +2°C light and warmblood type horses started to lose more heat than Finnish coldblood and ponies (Autio et al. 2006). Autio et al. (2006) refers to MacCormack and Bruce’s study (1991), about the size as a factor in determining heat loss, to be directly proportional to the effective surface area involved in heat exchange. Autio et al. (2006) studied adult horses and according to Minna-Liisa Heiskanen (personal communication 2014) it is likely that in weanling horses the differences in heat loss are greater.

According to Autio (2008), autumn to early winter seems to be the problematic time for weanlings. During that time the foals may suffers from stress caused by weaning and
possible changes in stabling. And in the case of cold loose-housing, foals have not yet acclimatized to cold weather and the energy need in cold loose-housing is harder to evaluate due to varying weather conditions and the activity of the horses. Active moving in weanlings was small and did not differ between cold loose housed and stabled foals. On average loose-housed weanlings used their time mainly on eating and only 5% on activity, such as play (Autio 2008).

1.6. Effects of protein quality and limiting amino acids
The most important protein supply for a horse is by foraging. However crude protein is not used as a measure of energy content in feeding; energy sources are primarily carbohydrates and fat. The quantity of limiting amino acids such as lysine in the forage or protein supplement measure the quality of total protein in the feed (Autio 2015).

Saastamoinen and Koskinen (1993) found that difference between protein intake was statistically insignificant to the ADG of foals. However, the ADG of the poor quality protein group was below the normal or moderate growth rates according to both Saastamoinen (1990) and NRC (1989), although the skeletal measures were in normal range when compared to Saastamoinen’s study (1990). The high quality protein fed horses were on average heavier than poor protein quality group horses at the age of 12 months but there was no difference between groups at the age of 18 months (Saastamoinen and Koskinen 1993). Also the growth rate of *m. longissimus dorsi* was higher between the ages of 7 to 10 months in the high quality protein group; after that the growth rate was similar in both groups. At the age of 12 months the difference in size of *m. longissimus dorsi* was statistically significant (Saastamoinen and Koskinen 1993).

Lawrence (2005) lists lysine to be the most limiting and threonine as second most limiting amino acid. He refers to Ott and Asquith’s (1986) results for daily recommendations of 2.1 g/Mcal DE lysine and 50 g/Mcal DE crude protein for weanling horse. The study by Tanner et al (2014) found that the whole-body protein synthesis was lower in horses receiving the recommended crude protein diet. The dietary lysine intake was at recommended level, so it was hypothesized that one or more amino acid might have been restricting the protein synthesis.

1.7. Different feeds and feeding ratios effecting the growth rate
Horses are monogastric herbivores designed to digestion and utilization of high fiber diets with microbial fermentation primarily in the hindgut (Harris 1997). Therefore, the base of feeding is good quality forage and concentrates are primarily used to satisfy the energy and
protein requirements (Autio 2015c). The forage feeds are commonly made from timothy hay or alfalfa and coastal grass which have higher protein and energy values; forage feeding can be done by mixing these feeds in different ratios (Lew 2009). The idea of pelleted feeds, concentrates and forages, is to provide easy digestibility and uniform diet. From pelleted feeds the horse cannot sort out different components (Lew 2009).

The effect of feed form and processing of feeds affects growth through the digestibility and energy concentration of the feed. This has been studied with equal diet ingredients processed differently by Andrew et al. (2006). Horses fed with pelleted diet had on average 50% higher ADG than horses fed with separately given hay and grain mix. There was no difference in blood plasma glucose levels between the groups. The researchers point out that the feeding period was short and the difference between groups may even out at some level in longer study (Andrew et al. 2006). When yearlings were fed with either alfalfa hay or coastal bermuda grass hay and both groups received the same concentrate, at 12.7% of CP, the growth in all measures (body weight, hearth girth, body length, height at withers and croup height) was higher in the group that received alfalfa hay (Ott et al. 2002).

Ringmark (2014) listed some health problems that are described in the literature being influenced by both high concentrate feeding and intensive training of a young horse. These include: colic, rhabdomyolysis, gastric ulcers, altered cartilage development and stereotypic behaviors. Young racehorses have usually high energy requirements during intensive training and therefore their diet includes high concentrate proportions (Ringmark 2014). Ringmark (2014) studied the possibility that forage-only diets and the effect of 30% reduced intensity training distance for young Standardbreds and general conclusion was that it is possible to feed the horses from breaking to 3 years old and get them into race condition without any starch-rich feeds. Also the experimental training program with the 30% reduced high intensity training was as effective as the traditional control training program (Ringmark 2014).

1.8. Influence of trace mineral concentrations to growth

The majority of commercial concentrate feeds and trade mineral supplements are balanced to meet the daily requirements and ratios of the feeds target group, e.g.: growing foals (Autio 2015c). The Finnish Equine Information Center defines that the content of one mineral element can affect the absorption of other trace minerals, for example, calcium and phosphorus; or cooper and zinc (Suomen Hevostietokeskus Tietopankki 2016). When the diet is gathered from many different supplements the balances and contents of minerals may
change leading to excess intake of one mineral over another. However, once again good quality hay is the main source of trace minerals (Rosenlew 2009). Lawrence (2005) refers to Cymbaluk and Smart’s review (1993) and agrees with their warnings that excessive zinc in diet causes copper deficiency due to competing with the copper transport mechanism; the optimal ratio appears to be 1Cu:4-5 Zn (Lawrence 2005). Inorganic mineral supplements absorb poorly, mainly because of their vast molecule mass. (Rosenlew 2009) To some extent it is possible to improve the microelement content in forage by field fertilization (Suokangas 2009).

Ott and Johnson (2001) made a study about the effect of trace mineral concentration to growth. Neither breed, gender nor the different trace mineral feeding affected the feed intake. The feeding experiment had no effect on the body measurements between groups except for the hip height gain and the hoof growth, both of which were higher in the proteinated mineral feeding group (Ott and Johnson 2001).

1.9. Quality aspects of forage
Unlike nutrient content, the hygienic quality of feeds is relatively easy to detect (Autio 2015c). The quality of the silage and hay varies between years, season and weather, but also with botanical state at cutting, species in grass seed mixture, fertilization and soil type (Ringmark 2014). Furthermore, this affects the preservation of forage. The amount of plastic layering (e.g.: 6+ layers) does not alone affect the preservation. More important is the correct cut time and weather during the cutting (Suokangas 2009).

The pasture needs attention, that care is often neglected (Lawrence 2005). Pasture should not be old long grass, but the optimum height of grass is 20-25 cm (Lew 2009). The feed, silage or hay, hygiene in outdoor feeding is harder to maintain (Autio 2008). Horses housing in groups makes the forage feed intake hard to observe due to the group hierarchy and limited observation possibilities. The concentrate feeding is easy to arrange but still the risk of imbalanced feeding is higher in cold loose-housing than in traditional warm housing stables (Autio, 2008).

1.10. Housing practices in Finland
Hyyppä (2009) made a study about housing and feeding of foals in Southern Finland. Author noted that only 25% of stables based feeding on nutrient content; most stable keepers based their feeding programs on visual estimates of foal’s body weight. According to nutrient content analyzes, done in this study, the foals received crude protein at adequate levels in most of the stables. The calcium and phosphorus ratio was correct in all stables but only in
10 stables the given amount was sufficient. Of the stables, 80% had also lacks of vitamins in the diets. All stables had routine de-worming plan for foals, yet 25% of the stables had problems with parasites. 60% of the stables handled the foals daily, 10% two to four times a week, 10% once in week and 10% once in month. 60% of the stables had no accidents with these foals. Hyyppä (2009) pointed out the need of guidance especially in foals feeding but was also concerned about adequate hoof care and abilities to correct conformation deformities of the legs.
2. AIMS OF THE STUDY

The aim of the study is to observe the growth, growth rate and growing conditions, and housing practices of weanling horses in cold loose-housings compared to traditional warm stables.
3. MATERIALS AND METHODS
The Study was carried out between November 2014 and January 2015 in the Savo region of Finland. Participating voluntarily in the study were 12 stables, of which 5 were using loose-housing and 7 warm-housing practices. The observation interval was 65 days with the following measurements being taken: heart girth and body condition score. Furthermore, heart and respiratory rate, body temperature, discharge from the nostrils and eyes, swelling of lymph nodes, miscellaneous injuries and swellings (particularly of the legs) were recorded. Blood samples, culture form nasal discharge and fecal samples were collected and then sent for analysis at the Laboratory at the University of Helsinki.

Forage samples were analyzed by Sei Lab Oy. The concentrate feeding of the foals was recorded by interviewing the stable keepers. The nutrient content of the concentrate diets was not made as part of this study.

The foals were grouped to Finnish coldblood and warmblood horses. The group of warmblood foals included Standardbred foals and warmblood riding horse weanlings.

3.1. Characteristics of the foals
In total there were 69 foals in the study, of which 19 were Finnish coldblood horses (9 colts, 10 fillies) and 50 warmblood weanlings (27 colts, 23 fillies). Of the latter group 8 were Finnish riding horses and 42 Standardbred. The estimated body weight for the foals was between 500 and 550 kg. Clinically sick foals were included but those with abnormalities such as cardiac murmurs and orphan foals were not. Eleven Finnish coldbloods were in cold loose housing and eight in standard stables. From warmbloods 28 were in cold loose housing and 22 in standard stables.

The warmbloods in this study were Finnish warmblood trotters and Finnish warmblood riding horses. Most of Finnish warmblood trotters are Standardbreds and crossbreds of Standardbred and French trotter. These horses reach on average a wither height of 160 cm and body weight of 500-550 kg (Suomen Hippos 2015b). Finnhorse has different types of breeding selections. In this study majority of Finnhorse foals were trotters, only few were riding horses. The average a wither height is for both types 156 cm (Suomen Hippos 2015a).

3.1.2. Age
The foals in this study were on average 186 days at the first examination, varying between 139-232 days as shown in Table 1.
Table 1. Age of horses in the first examination according to breed, days

<table>
<thead>
<tr>
<th></th>
<th>All foals</th>
<th>Finnish coldblood foals</th>
<th>Warmblood foals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age, days</td>
<td>186</td>
<td>179</td>
<td>188</td>
</tr>
<tr>
<td>Minimum age, days</td>
<td>139</td>
<td>151</td>
<td>139</td>
</tr>
<tr>
<td>Maximum age, days</td>
<td>232</td>
<td>213</td>
<td>232</td>
</tr>
</tbody>
</table>

3.2. Health assessment

A health assessment of the foals was made and measurements of the body temperature, heart rate and respiratory rate were recorded. Lymph nodes of the head and thread were palpated and any ocular or nasal discharge was recorded. Blood samples were collected and analyzed for fibrinogen, and legs were checked for any swelling or wounds. A foal was deemed sick if body temperature was 38.6°C or higher, or, 38.3°C or higher if one or more clinical symptoms were found, e.g.: enlarged lymph nodes.

3.3. Body condition score

The body condition score (BCS) was evaluated in scale of 1-5, which was a learned practical habit. This scale matches to the Henneke et al. (1983) scale of 1-9 (described below) that is widely used in the literature. The target score in this study is 3-3.5. For scoring the foal the areas palpated and evaluated were the neck and withers, backbone and flanks, shoulders and ribs.

BCS scale (Henneke et al. 1983):

1) 1 – poor: no fat can be felt;
2) 1.5 – very thin: slightly fat covering the spine, points of buttock prominent;
3) 2 – thin: slight fat cover over the spine and ribs. Vertebrae can’t be visually identified, ribs visually identifying, thin neck;
4) 2.5 – moderately thin: slight fat cover over the spine and ribs. Vertebrae can’t be visually identified, ribs visually identifying, points of hip aren’t visually detected;
5) 3 – moderate: back is flat, not fatty or ridge. Vertebrae can’t be visually identified, ribs aren’t visually identifying but easily palpating, points of hip aren’t visually detected:
6) 3.5 – moderately fleshy: fat cover over the withers, neck, back and ribs, ribs can be felt;
7) 4 – fleshy: fat layer on neck, shoulders, back, withers and between ribs, ribs can be felt;
8) 4.5 – fat: Difficult to feel the ribs, fatty back shoulders and neck;
9) 5 – extremely fat: Impossible to feel the ribs, fatty back shoulders and neck, round fatty body, obviously fat.

3.4. Growth
The heart girth measure was measured 2.5 cm behind the highest point of withers (Figure 2.). This measure was used to evaluate the growth and growth rate of foals. Originally the plan was to use ADG (kg) body weight calculated using the Equation 7:

\[
\text{Heart girth (m)}^3 \times 90 = \text{kg BW} \quad (7)
\]

This equation is addressed to foals and is described by Autio (2015). However, according to Minna-Liisa Heiskanen (personal communication 2014) this model correlates poorly to actual body weight of foals, the heart girth (cm) was used instead to measure the growth. Calculated body mass was used for feed analyzes, for later research. Mean values were compared between keeping systems and average values of all foals.

![Figure 2](image)

*Figure 2.* Figure showing the heart girth measurement position (Autio 2015a)
3.5. Overview of housing and management

3.5.1. Warm housing overview
Horses were stabled during the night in individual boxes, one stable had also group boxes of 2-3 foals. Daytime, on average 6-8 hours per day, the foals were grouped in pens. Stables were cleaned usually once a day. The space requirements for horses kept in individual stalls are defined in Government Decree on the protection of horses (2010) according to the height of a horse. The foals in the study were approximately 1.30-1.40 m. For them the minimum space needed is 5-6 m². Horses kept in groups the space minimum for a foal under 12 months of age is 50% of the individual stall space requirement (Government Decree on the protection of horses, 2010). In this case 2.5-3 m². All stables fill the requirements according to their stable type.

3.5.2. Cold loose-housing overview
Cold loose-housing stable consists of insulated sleeping hall with deep litter bedding (in this study peat or straw or both), entrance shelter and paddock and horses have free access to sleeping hall and paddock. In the stables in this study deep litter beddings were cleaned 1-2 times per year. Bedding material was added on average once a week. Feeding place was outside in every stable. All stable keepers handled their foals daily. Minimum space requirement for a foal under 12 months of age in cold loose-housing is 40% of individual stall space (Government Decree on the protection of horses, 2010). This means 2-2.4m² per horse. All cold housing stables fill this space requirement. Every stable had a possibility to isolate a sick horse at some manner.

3.5.3. Feeding
Only three stables had nutrient content analyzed hay or silage. All cold loose-housed weanlings had hay or silage \textit{ad libitum} outdoors. All warm housed weanlings got their hay or silage outdoors \textit{ad libitum} or in portions 2-3 times a day. All foals received concentrates individually 2-3 times a day. Commonly the concentrate ratio consisted of oats and protein supplement, mineral- and vitamin supplement ADE and salt. The units used to measure the concentrate portion in stables varied from kilograms and liters to cups and buckets. Mainly the concentrate feeding did not chance during winter. Concentrate feeding was mostly based on visual assessment of individual foal, a skinny foal got a bigger portion. Body weight, BCS and weight gains were not measured in the stables routinely. The concentrate portion
size was variable. Some stables exceed the Equine Information Center’s (Hevostietokeskus 2015) recommends to maximum concentrate proportion (2.5 kg/day).

3.5.4. Water
In cold loose-housing systems water supply was mostly a container or automatic waterers inside the halls. All stables checked the water supply daily, mostly twice a day, and cleaned them regularly. Some of the warm housed foals had water supply also outdoors. In the stable the water supply was a bucket or automatic waterer. Adequate information about the water quantity of the foals received and the possible restrictions were not available in all stables. Therefore, water is left out as a growth and energy intake factor in this study.

3.6. Climate
During the study the mean temperatures and precipitations were recorded by Finnish Meteorological Institute in Kuopio, Savilahti (Finnish meteorological institute 2015), which is located on average in the middle of the study field. In November mean temperature was 0.2°C and mean precipitation of the month was 42.3mm. For 15 days mean temperature was below 0°C, from which 4 days temperature was below -10°C and for 21 days it was raining. In December the mean temperature was -3.3°C and temperature was below 0°C for 17 days and below -10°C for 4 days. Mean precipitation of the month was 54.3 mm and for 4 days it was not raining. January was on average coldest month during this study, mean temperature -6.8°C, and the daily mean temperature stayed below 0°C for 28 days and below -10°C for 9 days. 24 days it was raining, precipitation of month was on average 62.6 mm.

3.7. Statistical analysis
The associations between growth of foals and stable type in both breeds were studied using a linear mixed models. In these models hearth girth changes (cm) between beginning and end of the study and change of body condition scores of foals were used as outcome variables. Stable type, breed and their interaction were included as explanatory variables. Gender of foals were included to both models and stable were included as random factor. Statistical software SAS/STAT 9.4 (SAS Institute Inc., Cary, NC, USA) was used for these models.
4. RESULTS

4.1. Health assessment
Study included 69 foals. The amount of clinically sick foals, sick in one or both examinations, was 24.6% (n = 17). 26% from all warmblood foals (n = 50) and 21% of all Finnish coldblood foals were clinically sick. Majority of sick foals (n = 14) were in cold loose-housing stables (n = 39). 42.9% of cold loose-housed warmblood foals (n = 28) were clinically ill. 18.8% (n = 2) of Finnish coldblood foals in cold loose-housing (n = 11) and 25% (n = 2) in warm housing were sick. Only one of warm housed warmblood foals from 22 were clinically ill.

4.2. Body condition score
In the first examination 50% of warmblood foals in cold loose-housing were thin or moderately thin having a body condition score 2-2.5 when 32% of all warmblood foals got the same scores. Only 10.5% of all Finnish coldblood foals had a score 2-2.5 in the first examination. In the first examination 6% (n = 3) warmblood foals and 36.8% (n = 7) Finnish coldbloods were fat of extremely fat (Table 2.). None of the foals were in poor or very thin condition in either examination.

In the second examination 20% of all warmblood horses and 5.3% of Finnish coldblood horses were in thin to moderately thin condition. 35.7% of cold loose-housed warmbloods still had a score below the target scores.

Table 2. Body condition scores (BCS) according to housing system and breed

<table>
<thead>
<tr>
<th>BSC</th>
<th>All foals</th>
<th>Foals in cold loose-housing</th>
<th>Foals in warm housing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>warmblood foals</td>
<td>Finnish coldblood foals</td>
<td>warmblood foals</td>
</tr>
<tr>
<td>2-2.5</td>
<td>16</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>3-3.5</td>
<td>31</td>
<td>40</td>
<td>10</td>
</tr>
<tr>
<td>4-5</td>
<td>3</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>(%)²</td>
<td>32</td>
<td>20</td>
<td>10.5</td>
</tr>
</tbody>
</table>

¹First examination; ²second examination; ³the amount of thin to moderately thin horses in the group (%)

24
4.3. Growth

On average Finnish coldblood foal’s heart girth in the beginning of the study was 140 cm and 146.8 cm in the end of the study (Table 3.).

**Table 3.** Average hearth girth growth and heart girth of Finnish coldblood foals (n = 19), both cold-loose- (n = 11) and warm housing (n = 8) included, cm

<table>
<thead>
<tr>
<th>Finnish coldblood foals</th>
<th>Mean ±SD</th>
<th>Colts</th>
<th>Fillies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth, cm</td>
<td>6.8 ± 2.2</td>
<td>6.1 ± 2.6</td>
<td>7.5 ± 1.7</td>
</tr>
<tr>
<td>Heart girth in 1 examination, cm</td>
<td>140.0 ± 5.6</td>
<td>141.5 ± 5.6</td>
<td>138.7 ± 5.6</td>
</tr>
<tr>
<td>Heart girth in 2 examination, cm</td>
<td>146.8 ± 5.5</td>
<td>147.6 ± 5.9</td>
<td>146.2 ± 5.4</td>
</tr>
</tbody>
</table>

Warmblood weanlings were smaller, on average 137.1 cm in the first examination and 144.8 cm in the second examination (Table 4.). In both breeds fillies were on average a bit smaller than colts. In both examinations on average biggest foals were Finnish coldblood horses in the cold loose-housings (n=11). On average smallest foals were warmblood weanlings in cold loose-housing stables (n=28).

**Table 4.** Average growth and heart girth of warmblood foals (n = 50), both cold loose- (n = 28) and warm housing (n = 22) included, cm

<table>
<thead>
<tr>
<th>Warmblood foals</th>
<th>Mean ±SD</th>
<th>Colts</th>
<th>Fillies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth, cm</td>
<td>7.7 ± 3.1</td>
<td>7.5 ± 2.8</td>
<td>7.9 ± 3.4</td>
</tr>
<tr>
<td>Heart girth in 1 examination, cm</td>
<td>137.1 ± 6.3</td>
<td>137.4 ± 6.9</td>
<td>136.8 ± 5.8</td>
</tr>
<tr>
<td>Heart girth in 2 examination, cm</td>
<td>144.8 ± 5.7</td>
<td>144.9 ± 5.7</td>
<td>144.7 ± 5.8</td>
</tr>
</tbody>
</table>
There were no statistically significant differences between stable type and breed in body condition scores. Warmblood foals’ heart girth increased more in cold loose-housing stables compared with Finnish coldblood foals in cold housing ($P = 0.047$). Warmblood foals’ heart girth increased significantly more in cold loose-housing than in warm housing ($P = 0.038$) (Figure 3).

**Figure 3.** Model based leased square means (LSMeans) (±SEM) of heart girth changes (cm) in foals during study period by breed and housing.
5. DISCUSSION

The data from the body condition scores is adequate to estimate the energy status. A skinny horse has used its energy deposits (fat) for maintenance and growth. This means that the feeding has not been balanced to meet the energy need. But the data collected from heart girth, and used to evaluate growth without other measurements as wither height, is unreliable. This measure alone correlates poorly to mature measures (Saastamoinen 1990).

The amount of thin foals in the first examination especially among the cold loose-housed warmblood weanlings, was distressing. On the other hand some of the keepers thought that the foal with a score 2.5 was not skinny. Also a fat to obviously fat foal, score 4.5-5, was not a problem to most of the keepers and were considered normal. According to interviews the keepers generally react to weight lost by adding concentrate feeding and deworming the foals. But only few of the stables made changes in diets during the study. To observe the energy status and welfare of the foal, the body condition score is the easiest measure for the stable keepers to get. Yet most of the stables did not measure it routinely by palpation. This should be done because through the thick winter hair coat it is impossible to score the foals visually.

The amount of skinny foals dropped a bit and body condition scoring showed weight gain by the end of the study. The results correlate to previously presented studies of cold climate effects. The energy intake increased in the autumn and early winter when the horses were not acclimatized to cold environment. The cold resistance between the breeds, evaluated from body condition scoring, suggests that Finnish coldblood horse copes better than warmblood horse in cold loose-housing but the difference in this study was statistically insignificant. Yet the variation of stable size and amount of Finnish horses was small.

Over all this study was too short and started too late in the early winter. Therefore, it represents the differences between stables more than housing systems. For statistical analyzes the amount of horses was small so variation between individuals as well as between stables can be vast. For more reliable results the body condition score and heart girth should have been taken earlier, for example pre and post weaning, and more often during the observation period. Also the wither height, according to literature (Saastamoinen 1990), would have been a better measurement for the calculation of the body mass and growth rate. For this study there was no adequate information, from all foals, about the weaning age and diet during weaning and autumn.
To estimate the effect of heritance to body size or growth rate, precise measures of the dams should have been gathered. Only small part of mares are brought in stud book, or measured in horse show. All the stallions are in stud books, so their measures are easily available, and there is some statistics of their offspring’s body measures from foal shows. So the results in this study could have been compared to them, like in Ringmark’s (2014) study.

The average heart girth of all foals in the first examination was 137.9 cm. In cold loose-housing the foals heart girth was 136.3 cm, on average, and in warm housing the average was 140 cm. Foals were on average smaller compared to foals in Saastamoinen’s studies (1990), average HG of 139.4 cm, but then again the breeding program, especially of Finnish coldblood horse, has moved towards lighter and sportier type.

The cold loose-housing environment increases the energy needs in early winter when the horses have not acclimatized to cold climate (Autio and Heiskanen 2005, Autio 2008). In the cold loose-housing warmblood (Standardbred) weanlings were smaller than average weanlings in this study, but their growth rate was the greatest and significantly higher than warmblood weanlings in warm housing and Finnish breed in cold housing. The group of clinically ill foals was the biggest among the cold loose-housed warmblood foals and the body condition score was on average lower than in other groups. This finding should be studied further on.

About 75% of stables in this study did not base their feeding to nutrient content analyzed forage. Most of stables also bought, at least some portion of forage without nutrient content analyze. This situation is same as in Hyypä’s study (2009). Although cold loose-housing has, in this study, shown its shortcomings in growth, feeding, health, and handling difficulties of foals, it yet has many advantages in aspects of animal welfare. This housing system provides more natural environment for horses: free movement abilities, ad libitum feeding and a group to ensure social contacts. With further research and copying the best practical management solutions it could be the best place for growing horses.

Our suggestions to improve the stable management: outdoor feeding places should be on hard surface, the roof could also cover the foals not just the forage. The feeding place should be designed to be easy to clean. Also space per horse should be guaranteed (0.6m per horse). Feeding, also in warm housings, should be based on nutrient content analyzed forage. Refusal feed and spoiled forage should be collected off. Insulated hall should be designed so that it is easy to clean and having good air quality and no draft. Many cold loose-housing halls were dim, with better lights it is easier to observe the horses when they are tied up for
feeding. Some stable keepers used headlight which seemed to be well working and easy solution. Handling should be every day routine.
6. CONCLUSION

Finnish coldblood foals had the biggest heart girth measure and on average best body condition scores in the end of the study. This might indicate that the Finnish coldblood foals grow well in *ad libitum* feeding or in cold loose-housing or both. Statistically the breed did not affect the BSC. The energy need in early winter was greater when the horses were not yet acclimatized to cold climate. In the cold loose-housing warmblood (Standardbred) weanlings were smaller than average weanling in this study, the group of clinically ill foals was biggest among them and the body condition score was on average lower than in other groups. Controversially warmblood weanlings in gold loose-housing grow better from all other groups. At the same time their average hearth girth measure was small in the end of the study and this suggests that warmblood weanlings may grow better in cold loose housing than in traditional stables. However, more studies are needed with larger sample size to confirm these results.
Overview of growth, energy status and nutritional management of weanling horses in winter in different housing systems

SUMMARY

The breeding programs of racehorse have moved towards early maturing and start of a career and common complaint amongst horse trainers is that foals mature late. Standardbred and Finnish coldblood horse breeders select increasing numbers of early maturing horses. At the same time conformational and musculoskeletal abnormalities have become a big concern to breeders and trainers. The aims of an early career start for Standardbred horses means an intensive training program at a young age.

In search of the housing systems providing the best possible growth and welfare for weanlings and yearlings, cold loose-housing has become a popular keeping system. Cold loose-housing has been seen as a cheaper and easier solution than a traditional stable. Cold loose-housing also provides a more natural environment for the horses by improving welfare through enhanced social contact and freer movement.

The aim of this work is to observe the growth, growth rate, growing conditions, and housing practices of weanling horses in cold loose-housings compared to traditional warm housing stables during winter. The study observed the growth of 69 weanling horses in five cold loose-housing stables and seven warm housing stables during one winter season. Horses were examined twice during this study with the interval between examinations being 65 days. The age of horses in the first examination was from 139 to 232 days.

As Finnish coldblood horses are thought to be more cold resistant than Standardbreds and warmblood riding horses, the horses were observed according to breed. The breed categories were Finnish coldbloods (n = 19) and warmbloods (Standardbreds) (n = 50); Standardbred had two subcategories – trotting and riding horses. Eleven Finnish coldbloods were in cold loose housing and eight in standard stables. From warmbloods 28 were in cold loose housing and 22 in standard stables. The body condition score (BCS) was used to evaluate the energy status and feeding and heart girth to measure the growth and growth rate.

Finnish coldblood foals had the biggest heart girth measure and on average best body condition scores in the end of the study. This might indicate that the Finnish coldblood foals grow well in *ad libitum* feeding or in cold loose-housing or both. Statistically the breed did not affect the BSC. The energy need in early winter was greater when the horses were not yet acclimatized to cold climate. In the cold loose-housing warmblood (Standardbred)
weanlings were smaller than average weanling in this study, the group of clinically ill foals was biggest among them and the body condition score was on average lower than in other groups. Controversially in the same time warmblood weanlings in gold loose-housing grow better from all other groups. At the same time their average hearth girth measure was small in the end of the study and this suggests that warmblood weanlings may grow better in cold loose housing than in traditional stables. However, more studies are needed with larger sample size to confirm these results.
Ülevaade varssade kasvust, energiabilansist, söötmi-pidamistingimustest talvisel ajal erinevates tallitüüpides

KOKKUVÕTE

Võistlus hobuste aretusprogrammid on liikunud varajase kõpsemise ja karjääri varajase alustamise teed. Samas on hobuse treenerite hinnangul sagedane probleem see, et varsad kõpsevad hilja. Soojavereliste ja Soome külmavereliste võistluskobuste treenerid valivad üha sagedamini treenimiseks vara kõpsevaid varssu. Samal ajal on sellistel varssadel esinevad kehaesituse ja lihaste ja luude arengu probleemid sagedased. Soojavereliste hobuste varajane võistluskarjääri algus tähendab intensiivse treeninguperioodi nooremas ees alustamist.

Vabapidamisega külmtallid on saanud populaarseks tänu sellele, et need võimaldavad head kasvu ja heaolu tingimusi varssadele ja noorhobustele. Vabapidamisega tallid on odavam pidada ja väiksema töökoormusega kui traditsioonilised tallid. Lisaks on vabapidamisega tallides elukeskkond, mis vastab paremini hobuste loomulikele käitumisvajadustele (vabam liikumine, sotsiaalsed kontaktid jne).


Soome külmavereliste varssadel oli kõige suurem rinnaümbermõõt ja keskmiselt parem kehakonditsioon uuringu lõpus. See viitab sellel, et Soome külmaverelised varsad kasvavad hästi ad libitum toitumise puhul ja/või tunnevald annast hästi külmtallis. Siiski ei esinenud statistilist erinevust kehakonditsioonis tõugude vahel. Energiavajadus oli varssadel
REFERENCES


13. **Finnish meteorological institute.** [WWW]


15. **Heiskanen, M-L.** (2015) *Personal communication*


   https://portal.mtt.fi/portal/page/portal/Rehutaulukot/Ruokintasuositukset/Hevoset (23.05.2015).


31. **Suomen Hevostietokeskus Tietoportti.** The Official website (01.03.2016) http://www.hevostietokeskus.fi/index.php?id=810&kieli=3


Non-exclusive licence for depositing the final thesis and opening it for the public and the supervisor’s (supervisors’) confirmation for allowing the thesis for the defence

Hereby I, **Ida Elisa Tiainen**

(18/08/1988).

1. grant Eesti Maaülikool, the Estonian University of Life Sciences, a free-of-charge non-exclusive licence to store the final thesis titled “**Overview of growth and energy status and nutritional management of weanling horses in winter in different housing systems**”, supervised by Toomas Orro for

1.1. preservation;

1.2. depositing a digital copy of the thesis in the archive of DSpace and

1.3. opening it for the public on the Web until the validity of the term of protection of copyright.

2. I am aware that the author retains the same rights as listed in point 1;

3. I confirm that by being issued the CC licence no rights deriving from the Personal Data Protection Act and the Intellectual Property Rights Act have been infringed.

Author of the final thesis …………………………………………………

(signature)

In Tartu, ______________

____________________________________

The core supervisor’s approval for the final thesis to be allowed for defence

This is to confirm that the final thesis is allowed for defence.

Toomas Orro ……………………………………….. …………………………………

Supervisor’s name and signature Date

**Institute of Veterinary Medicine and Animal Sciences**

**Estonian University of Life Sciences**