

# The effects on animal welfare, production and economy when using feed blocks for sheep

Effekten på djurvälstånd, produktion och ekonomi vid  
användning av foderblock till får

*Ebba Ekholm*



## **The effects on animal welfare, production and economy when using feed blocks for sheep**

Effekten på djurvälstånd, produktion och ekonomi vid användning av foderblock till får

*Ebba Ekholm*

**Supervisor:** Katarina Arvidsson Segerkvist, Swedish University of Agricultural Sciences

**Department:** Department of Animal Environment and Health

**Assistant Supervisor:** Annelie Carlsson, Swedish University of Agricultural Sciences

**Department:** Department of Animal Environment and Health

**Examiner:** Elisabet Nadeau, Swedish University of Agricultural Sciences

**Department:** Department of Animal Environment and Health

**Credits:** 30 credits

**Level:** A2E

**Course title:** Degree project in Animal Science

**Course code:** EX0872

**Programme:** Agricultural Science Programme – Animal Science

**Course coordinating department:** Department of Animal Breeding and Genetics

**Place of publication:** Uppsala

**Year of publication:** 2019

**Cover picture:** Ebba Ekholm

**Online publication:** <https://stud.epsilon.slu.se>

**Keywords:** feed blocks, sheep, ewes, growing lambs, economy, welfare, health, production

**Sveriges lantbruksuniversitet**  
**Swedish University of Agricultural Sciences**

Faculty of Veterinary Medicine and Animal Sciences  
Department of Animal Environment and Health



## Preface

This master's thesis is 30 credits within the programme Animal Science at the Department of Animal Environment and Health at the Swedish University of Agriculture (SLU) in Skara.

I sincerely want to thank the advisors, farm owners and sheep that were involved in this study for their time, willingness to be a part of my study and for the interesting chats.

I further want to thank my supervisors Annelie Carlsson and Katarina Arvidsson Segerkvist for their on-going support and enthusiasm.

A very special thank you to my family and friends. And last but not least thank you to my beloved sheep, who throughout my life have reminded me of my greatest passion and are the reason for my choice of education.

## Abstract

Feed blocks are a feed product where certain ingredients are mixed together, to create a solid block. The goal is to provide the animals with a small supply of nutrients at a time, such as energy, protein and minerals. In large sheep countries like the UK, the feed blocks fill a function under certain conditions. According to manufacturers of feed blocks there is a growing interest among Swedish sheep farmers today to learn more about these feed blocks. The goal of this study was to contribute with useful information about feed blocks and their positive and negative effect on sheep.

This study involved qualitative interviews with two feed advisors and seven Swedish sheep farmers that use feed blocks for their herds. The aim with the farm interviews was to get a deeper understanding of how the farmers experienced using feed blocks and what possible pros and cons this may lead to. Furthermore, example feed rations were calculated to see what effects it may have to include feed blocks in a feed ration, both on a nutritional and financial level.

In the interviews with the feed advisors, both agreed that the feed blocks should be used as a complementary feed and not as a replacer of concentrate. They both mentioned the difficulty of products that are imported, since there is no proven effect here in Sweden, an unclear nutrient content of the blocks and the fact that the blocks are expensive. A positive aspect is that the blocks are easily provided. Depending if they are used correctly and in combination with the other feed stuffs, the advisors think feed blocks may prove as a good option.

The farmers all started using feed blocks due to the stress they experienced during the feeding of concentrate. The blocks were most commonly used for ewes around lambing, but the blocks were commonly also used for slaughter lambs. All farmers were of the opinion that the blocks provide a more evenly distributed feed intake for all sheep. Less stress and an easier workload were also factors all these farmers mentioned. The majority of farmers mentioned that the blocks were in fact an expensive way to feed sheep.

The feed rations were calculated for a ewe weighing 70 kg with two lambs and prove that all the requirements cannot be fulfilled with a medium quality roughage and a feed block during late pregnancy and lactation. Furthermore, the feed rations with the blocks proved more expensive, both per day and per MJ, than using concentrate feed. The feed rations with the feed block were calculated to show the differences in nutrient values and price, but according to the manufacturers the blocks should be used as a complement and not a replacer of concentrate.

## Sammanfattning

Foderblock är en foderprodukt som består av en blandning av utvalda ingredienser som bildar ett kompakt block. Målet är att förse djuret med små mängder av näringsämnen åt gången, såsom energi, protein och mineraler. I stora färländer såsom Storbritannien fyller foderblocken en funktion under vissa förhållanden. Enligt tillverkare av foderblock verkar det finnas ett ökande intresse bland svenska färbönder att lära sig mer om dessa foderblock. Målet med denna studie var att bidra med användbar information om foderblock och deras positiva och negativa effekt på får.

Denna studie involverade kvalitativa intervjuer med två foderrådgivare samt sju svenska färbönder som använder foderblock till sina besättningar. Målet med gårdsintervjuerna var att få en djupare förståelse för hur lantbrukarna upplevde att foderblocken fungerade och vilka möjliga för- eller nackdelar detta kan leda till. Ytterligare beräknades några exempel foderstater för att se vilken effekt det kan leda till om man inkluderar foderblock i foderstaten, både på en näringsmässig och ekonomisk nivå.

I intervjuerna med foderrådgivarna ansåg båda att foderblock borde användas som ett komplement och inte som en ersättning av kraftfoder. Båda poängterade problematiken med produkter som importeras, då ingen effekt bevisats i Sverige, ett oklart näringsinnehåll av foderblocken samt att foderblocken är dyra. En positiv aspekt var att blocken är lätta att utfodra med. Beroende på om de används rätt och i kombination med andra fodermedlen, tycker rådgivarna kan foderblock vara ett bra alternativ.

Alla de intervjuade lantbrukarna började använda foderblock på grund av stressen de kände vid utfodring av kraftfoder. Det var vanligast att blocken gavs till tackor, framförallt runt lamning, men vanligen gavs blocken även till slaktlamm. Alla lantbrukare tyckte att blocken bidrar med ett jämnare foderintag hos alla får. Mindre stress och en lättare arbetsbörda var också faktorer som alla nämnde. Majoriteten av lantbrukarna nämnde även att blocken faktiskt var ett dyrt sätt att utfodra fåren.

Foderstaterna beräknades för en tacka på 70 kg med två lamm och visar att det inte går att uppfylla alla behov med ett grovfoder av medelkvalitet och foderblocken i sen dräktighet och laktation. Vidare visade sig foderstaterna med blocken att vara dyrare, både per dag och per MJ, jämfört med kraftfoder. Foderstaterna med foderblocken beräknades för att påvisa skillnaderna närings- och prismässigt, men enligt tillverkarna ska blocken användas som komplement och inte som ersättning till foder.

## Populärvetenskaplig sammanfattning

**Att utfodra sina får på rätt sätt, så att de mår bra och presterar som de ska, är väldigt viktigt för svenska fårägare. Många utfodrar med det de alltid utfodrat, medan andra söker efter nya utfodringsmetoder som både gynnar fåren och är smidiga för de själva. För det senare nämnda, har en relativt ny utfodringsmetod börjat bli populär, nämligen de så kallade foderblocken. Dock på grund av dess utländska ursprung och brist på svensk forskning, är det svårt att i dagsläget avgöra om dessa block faktiskt är revolutionerande eller inte.**

Först och främst bör begreppet foderblock redas ut och vilken effekt de sägs ha. Ett foderblock är i sin helhet en balja med ett fast innehåll som fåren själva kan gå fram och äta ifrån när de önskar. Dessa block sätts ut i hagen eller stallet vid behov och byts vanligen ut när de tar slut. Blocken är tänkta att förse fåren med näring och energi och kan ses som ett alternativ till att utfodra pellets eller spannmål, vid sidan av att man utfodrar ett hö, ensilage eller liknande som bör vara fårens huvudföda. Ytterligare är blocken smidiga att ställa ut och djurägare sägs spara tid på att utfodra sina får med dessa block. Många fördelar kan presenteras, men med många fördelar brukar det även finnas nackdelar. Detta undersöktes bland annat i detta examensarbete.

För att försöka komma närmare sanningen om hur väl foderblocken fungerar för får, utfördes i denna studie intervjuer med gårdar som använder sig av foderblock samt rådgivare som har erfarenhet av dessa block. Resultaten visar att foderblockens charm ligger i att de är lätta att arbeta med då fårägare tycker det är skönt att slippa den annars dagliga utfodringen. Vanligast är att tackor utfodras med blocken och oftast sätts de in i perioder då tackans näringsbehov ökar, nämligen när hon börjar närma sig lamning.

Även beräkningar på foderblockens innehåll och tackans näringsbehov i olika faser av året jämfört med traditionella utfodringssätt utfördes. Dessa beräkningar visade att blocken vara dyra och kunde inte förse högdräktiga tackor eller tackor som diar sina lamm med rätt mängd näringsämnen om tackan har minst två lamm. Således måste ytterligare foder kompletteras så att tackorna inte blir undernärda, vilket kan få konsekvenser för deras, men även lammens hälsa och leder till en ännu dyrare foderstat.

De tidigare nämnda faktorerna kan vara viktiga att ha i åtanke om man funderar på att börja använda foderblock för sina får. Helst bör man själv eller med hjälp av en foderrådgivare, försöka räkna på hur pass väl foderblocken kan täcka näringsbehoven i ens egen flock och fundera över om detta är ett alternativ som är att föredra, samt om blocken passar in i budgeten man satt för fåren. Dessa resultat kan ses som en början i att lära sig mer om blocken, men med ytterligare svensk forskning skulle oklarheter kring dessa block kunna klaras upp vilket möjligtvis skulle kunna öka deras användning.

# Table of content

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Introduction</b>                         | <b>8</b>  |
| 1.1      | Purpose and goal                            | 8         |
| 1.2      | Questions and hypotheses                    | 8         |
| <b>2</b> | <b>Literature review</b>                    | <b>10</b> |
| 2.1      | Definition of feed blocks                   | 10        |
| 2.2      | Components                                  | 10        |
| 2.3      | Different types of feed blocks              | 11        |
| 2.3.1    | Urea-molasses multinutrient blocks (UMMB)   | 11        |
| 2.3.2    | Polyethylene glycol (PEG)-containing blocks | 12        |
| 2.3.3    | Medicated and mineral containing blocks     | 13        |
| 2.4      | Manufacturing                               | 13        |
| 2.5      | Feed blocks in the world                    | 14        |
| 2.5.1    | The United Kingdom                          | 14        |
| 2.5.2    | Sweden                                      | 14        |
| 2.5.3    | Other parts of the world                    | 15        |
| 2.6      | Disadvantages                               | 16        |
| 2.7      | Marking of feed products                    | 17        |
| 2.8      | Economy                                     | 17        |
| 2.9      | Feeding and nutrient requirements           | 18        |
| <b>3</b> | <b>Materials and method</b>                 | <b>19</b> |
| 3.1      | Type of interview                           | 19        |
| 3.2      | The advisors                                | 19        |
| 3.3      | The farmers                                 | 19        |
| 3.4      | Selection of the farms                      | 20        |
| 3.5      | The farm visits                             | 20        |
| 3.6      | Short presentation of the farms             | 21        |
| 3.7      | Feed rations                                | 21        |
| 3.7.1    | The ewe                                     | 21        |
| 3.7.2    | Roughages                                   | 22        |
| 3.7.3    | Concentrate                                 | 23        |
| 3.7.4    | The feed blocks                             | 23        |
| <b>4</b> | <b>Results</b>                              | <b>25</b> |
| 4.1      | Summaries of advisor interviews             | 25        |
| 4.1.1    | Advisor A                                   | 25        |
| 4.1.2    | Advisor B                                   | 26        |
| 4.2      | Summaries of the farmer interviews          | 27        |



|          |   |           |
|----------|---|-----------|
| 4.2.1    | How they initially heard of the feed blocks | 27        |
| 4.2.2    | The use of feed blocks                      | 27        |
| 4.2.3    | Adaptation to the blocks                    | 28        |
| 4.2.4    | Inside or outside                           | 28        |
| 4.2.5    | Groups                                      | 28        |
| 4.2.6    | Periods                                     | 29        |
| 4.2.7    | Production and reproduction                 | 29        |
| 4.2.8    | General health                              | 29        |
| 4.2.9    | Pros and cons                               | 29        |
| 4.2.10   | Feeding                                     | 30        |
| 4.2.11   | Minerals                                    | 30        |
| 4.2.12   | Economy                                     | 30        |
| 4.2.13   | Marking of the feed blocks                  | 30        |
| 4.2.14   | Future                                      | 31        |
| 4.3      | Feed rations                                | 31        |
| <b>5</b> | <b>Discussion</b>                           | <b>33</b> |
| 5.1      | Interviews with the advisors                | 33        |
| 5.2      | Interviews with the farmers                 | 34        |
| 5.2.1    | The farmers                                 | 34        |
| 5.2.2    | The use of feed blocks                      | 34        |
| 5.2.3    | Adaptation to the blocks                    | 35        |
| 5.2.4    | Effect of weather                           | 35        |
| 5.2.5    | Groups                                      | 36        |
| 5.2.6    | Production and reproduction                 | 36        |
| 5.2.7    | Effect on general health                    | 36        |
| 5.2.8    | Effect on teeth                             | 37        |
| 5.2.9    | Minerals                                    | 37        |
| 5.2.10   | Stress and ranking                          | 37        |
| 5.2.11   | Economy                                     | 38        |
| 5.2.12   | Table of content                            | 38        |
| 5.2.13   | Future                                      | 39        |
| 5.3      | Miscellaneous                               | 39        |
| 5.3.1    | Recommendations for daily intake            | 39        |
| 5.3.2    | Directions for use                          | 40        |
| 5.3.3    | Medicated blocks                            | 40        |
| 5.4      | Feed rations                                | 40        |
| 5.4.1    | Difficulties                                | 40        |
| 5.4.2    | Choices                                     | 41        |
| 5.4.3    | Conclusions from the feed rations           | 41        |

|                          |           |
|--------------------------|-----------|
| <b>6 Conclusions</b>     | <b>43</b> |
| <b>7 Future research</b> | <b>44</b> |
| <b>8 References</b>      | <b>45</b> |
| <b>Appendix</b>          | <b>47</b> |

# 1 Introduction

According to UK manufacturers of feed blocks there is a growing interest among some Swedish sheep farmers today to learn more about the feeding method called feed blocks. This is due to good reviews from countries such as the UK that are presented by the resellers, but probably also based on the fact that users of feed blocks in Sweden recommend them to their neighbours or friends. The question that follows, however, is if the positive effects in another country can be applied in a country like Sweden, which is what this report focuses on. In the UK for example, sheep are generally kept in a very specialized hill, upland and lowland system, with breeds adapted for these specific conditions (NSA, 2018). Even though some research abroad points in a direction of positive effects, a few drawbacks have been found such as the nutritional status of the chosen ingredients and a certain requirement for adaptation of the sheep to the blocks when they are first introduced (Lobato and Pearce, 1980; Salem and Nefzaoui, 2003). Furthermore, there are indications that suggest that the feed blocks are quite an expensive type of feeding (Hyby Cig Cymru, 2018). All of these factors combined lead to several questions that would be interesting to investigate, which in turn lead to the choice of topic for this master's thesis.

## 1.1 Purpose and goal

The purpose of this report was to gather information on how providing feed blocks to a sheep herd can affect animal health and production as well as farm economy and labour in comparison to a traditional feed ration.

## 1.2 Questions and hypotheses

Questions this report aims to answer are as following:

- What is the exact definition of feed blocks and what do they contain?

- In comparison to a traditional feed ration, how do they cover the nutrient requirements and how much do they cost per animal per day?
- In which situations and for which categories of sheep are they the most or the least justifiable to use?

The hypotheses for this report are:

- Replacing concentrate feed with feed blocks will not cover the nutrient requirements of ewes with two lambs or more in late pregnancy and early lactation.
- Replacing concentrate with feed blocks will generally be more expensive for the farmer.

## 2 Literature review

The aim of the literature review was to provide a foundation for the practical part of this report, which consists of interviews with both feed advisors as well as farmers, who utilize feed blocks for their sheep herds.

### 2.1 Definition of feed blocks

A feed block is a product where different ingredients are mixed together, to create a solid block from which the animals are supposed to lick. This provides the animals with a small supply of nutrients, since they only ingest small amounts at a time. Feed blocks are mainly used for ruminating animals such as cows, sheep and goats. Since this report only focuses on sheep, it is important to note that lambs under the age of three months should not be fed feed blocks. This is due to the fact that their fore stomachs have not fully developed yet and the blocks aid in keeping a good microbial balance in the rumen (Salem and Nefzaoui, 2003).

The feed blocks resemble the solid mineral blocks that are used in Sweden but should, however, not be confused with them. In comparison to the mineral blocks, feed blocks aim to provide not only minerals but also energy and protein. This has earned feed blocks the name multinutrient blocks or a self-fed supplement and is categorized as an additional supplementation of nutrients. The blocks further aim to decrease the amount of concentrate feed used, which in term is said to decrease feed costs. However, important to stress is that feed blocks should never be the only source of feed for sheep, they always need some type of roughage as their main source (Salem and Nefzaoui, 2003; Bowman and Sowell, 1997). Moreover, feed blocks can be added as an emergency solution in unexpected situations, such as drought, to avoid problems that may occur (Makkar *et al.*, 2007).

### 2.2 Components

A feed block usually consists of three main parts: the main ingredients, a binder and a preserver. Ingredients chosen as the main part of the feed block vary considerably between regions. The main function of these feedstuffs is either to provide energy, fibre, protein or nitrogen (Salem and Nefzaoui, 2003). A main issue in many parts of the world is to supply sheep with sufficient nutrients to satisfy their requirements. This is mostly due to the harsh environments that they are raised in as well as the constant increase in the world's sheep population (Salem *et al.*, 2004). Since farmers want to keep their feed costs low, this may restrict the feedstuffs that can be used to keep the blocks financially justifiable. However, an environmental and financial advantage with feed blocks is often that by-products from the agro-industry are utilized

such as molasses and olive cake (Salem *et al.*, 2004). Additionally, crop residues such as straw and twigs may be utilized (Salem and Nefzaoui, 2003). There has also been an interest to incorporate forages as an alternative protein source in the feed blocks. In an experiment performed in Mexico, foliage from four different tree species were incorporated into separate feed blocks to see the effect on grazing sheep. The daily feed intake of each separate sheep was recorded. In this region during for example the dry periods, new feeding solutions are being sought after. The results showed that there was a preference for consumption of the blocks with the highest crude protein (CP) content as well as blocks that were palatable. To determine this, the blocks were weighed at the beginning and end of each day, to see how much the sheep in general consumed from the different blocks. One of the four blocks with foliage from *Acacia cochliacantha* was the least consumed block, with a small intake of 12 kg DM<sup>0.75</sup>, which could have been due to a bad taste. The other blocks were relatively equally preferred where the sheep consumed amounts ranging from 19-25 kg DM<sup>0.75</sup>. They also concluded that the sheep consumed more from the blocks in the morning, possibly to store energy for the day. However, no significant difference in weight gain was noted for the sheep fed the blocks (73,5 g<sup>-1</sup>) compared to the sheep without supplementation (71,8 g<sup>-1</sup>) (Martínez-Martínez *et al.*, 2012).

When it comes to the binder, the main use is to provide the feed blocks with a good consistency. They should never be too soft because the sheep may then eat too much, which may lead to consequences such as toxicity. This implies that by adding certain amounts of the binder the hardness can be controlled, which is very important for this feed technology. A feed block usually consists of 10 - 15 % of the chosen binder. Examples of binders that are commonly used are molasses and lime (Makkar *et al.*, 2007).

Salt is the most common preserver used, but sometimes urea is chosen instead. In addition to salt being a beneficial ingredient, it is also said to decrease over consumption of the blocks, which could potentially lead to health issues (Salem and Nefzaoui, 2003).

## 2.3 Different types of feed blocks

### 2.3.1 Urea-molasses multivitamin blocks (UMMB)

Through several attempts of different formulas, the urea-molasses multivitamin blocks (UMMBs) were developed (Makkar *et al.*, 2007). As the name suggest, the two main ingredients in these blocks are molasses and urea. Molasses is a by-product from sugarcanes or sugar beets that is mainly used to provide energy, since it contains up to 60 % sugar (Salem and Nefzaoui, 2003). Therefore, it is very

palatable. It is also an aid in the sheep's digestion as it provides fermentable carbohydrates which are important for the microflora in the intestines. However, due to its palatability, too high percentages of molasses is not to be recommended, as animals may over consume the feed blocks (Baribo *et al.*, 1966). The CP content is, however, low in molasses (Salem *et al.*, 2004). The proportion of molasses in these blocks can range up to 45 % of the product (Makkar *et al.*, 2007).

Urea is usually used to provide non-protein nitrogen (Salem and Nefzaoui, 2003). Due to its rather cheap price, urea is a good choice of ingredient for feed blocks. A percentage of up to 10 % urea is common in UMMBs, as higher percentages may be toxic for the sheep and have negative effects on their health (Makkar *et al.*, 2007). The recommended daily intake for sheep with these blocks is 60 – 125 g per sheep and day (Makkar *et al.*, 2007).

### 2.3.2 Polyethylene glycol (PEG)-containing blocks

Feed blocks are in many cases offered to ruminants to provide nutrients and help with digestion. Certain trees and bushes may contain tannins, which in too high amounts can cause problems with digestion. Many plants in these arid regions contain high amounts of tannins (Makkar *et al.*, 2007). Tannins are secondary compounds who, depending on what form they are in, can cause problems such as toxicity (Salem *et al.*, 2004). Polyethylene glycol (PEG) can form complexes with tannins and therefore aid in inactivating them in order for these tannin-rich feeds to be better utilized by the sheep (Makkar *et al.*, 2007). In Sweden, no PEG-containing blocks are currently on the market.

Salem *et al.*, (2000) conducted an experiment in Tunisia where PEG blocks with different concentrations of PEG (0, 6, 12, 18, 24 %) were given to young as well as older rams. It is common for farmers in Tunisia to have to feed concentrate to fulfil the nutrient requirements, due to the climate. The aim of this study was to investigate if incorporation of PEG blocks in the diet could be a good supplement to the previously fed diet based on acacia. *Acacia cyanophylla* is a tree that contains high amounts of tannins and has low nutritional value, therefore new feeding supplements are sought after. The results showed a linear increase in consumption with higher PEG percentages ( $P < 0.001$ ), since the growth of these sheep increased more than those given the diet without PEG, following better nutrients in the acacia-diet. Furthermore, the feed blocks containing larger amounts of PEG aided the digestion of acacia as well as the nitrogen utilization.

In another experiment carried out in Tunisia adding PEG to both concentrate feed and feed blocks given to slaughter lambs was compared, to determine if there were any differences in carcass composition. The results showed that regardless if PEG

was added to either the feed blocks or the concentrate, the carcass was less fat, which was a desirable trait in this particular study (Atti *et al.*, 2003).

### 2.3.3 Medicated and mineral containing blocks

Some feed blocks may be utilized to include medicines, anthelmintic or other chemical agents. These blocks are particularly used in countries that keep their sheep in extensive systems, where parasites usually are prevailing issues. The blocks are a proactive option to avoid parasites, as well as being easily provided to the grazing sheep (Salem and Nefzaoui, 2003). Anthelmintic agents that can be used are fenbendazole and nematophagous fungi, which can be used against nematodes. Furthermore, herbal drugs are being researched as possible new additives (Makkar *et al.*, 2007). In large parts of China parasites are a main issue and sheep are usually kept on pastures and moved around during different periods. During a few winter months the sheep are kept in stables with outdoor access. One experiment was conducted where medicated feed blocks were compared to regular feed blocks as well as the medicine being orally administered. For these treatments, albendazole (a derivative of fenbendazole) was chosen as the medical component. Both treatments showed positive results in reducing the worm count (up to 100 %). Regarding the feed blocks, even sheep that did not consume sufficient amounts, had a reduction in faecal egg count (Tan *et al.*, 1996).

Apart from medication being added to the blocks, minerals can be added as well. Even though feed blocks usually already contain minerals, depending on what type of deficiency is at the greatest risk in a certain area, additional minerals can be added to the blocks. Many kinds of minerals can be added, but common minerals to add are phosphorus (P), copper (Cu) and zinc (Zn). This can be done in order to reduce health risks and improve the animal welfare. Moreover, these minerals can be added to improve reproduction (Makkar *et al.*, 2007).

## 2.4 Manufacturing

The manufacturing process can differ considerably depending on which type of block that is produced and in how large proportions. Different countries may also apply different techniques as to how the blocks are produced (Makkar *et al.*, 2007). The blocks can either be hand-mixed or made by larger machinery. The aim with any type of block is to achieve the right hardness, which is achieved by pressing the mixed ingredients together (Salem and Nefzaoui, 2003). This is as previously mentioned done in order to avoid consequences such as over- or under consumption of certain ingredients. Further, to succeed with the feed block formulation the blocks should contain a proper balance of ingredients, as well as the ingredients being



mixed in the right order (Donovan and Weigel, 1988). After the ingredients have been mixed together and put into moulds, the blocks need to dry and be put in a preferably dark space with sufficient ventilation (Salem and Nefzaoui, 2003). The moulds can vary in material, shape and size, with materials ranging from cardboard to metal (Makkar *et al.*, 2007).

## 2.5 Feed blocks in the world

### 2.5.1 The United Kingdom

The United Kingdom (UK) is, as previously mentioned, an example where feed blocks have been provided for many decades and have had a positive impact on sheep health and production (Dallas Keith, 2018). There, many sheep are kept grazing in the hills and need extra supplementation to fulfil their needs. Feed blocks have been an attractive option, as they require less labour, since the feed blocks are easily provided and thereafter last a certain period of time (Povey *et al.*, 2006). The blocks can be used for the ewes kept in the hills in early or mid-pregnancy, as the conditions there generally are harsher than the lowlands, with low feed quality (Hyby Cig Cymru, 2018). For the time around lambing, the blocks are recommended to be provided for hill ewes in poorer conditions, as grazing does not cover the requirements necessary for the colostrum production. The feed blocks have shown positive effect as there is a better chance of lamb survival (Hyby Cig Cymru, 2018). For lowland ewes and young ewes in good conditions, the blocks may not be required (Hyby Cig Cymru, 2018). Furthermore, the blocks can be provided during the flushing period, but this is mainly necessary if the pasture quality is low, since the ewes during this time are kept grazing. During the mating period feed blocks are also recommended to be provided if the sheep are kept out on pasture (Country Smallholding, 2006).

### 2.5.2 Sweden

There is no domestic manufacturing of feed blocks in Sweden, meaning that all the blocks are imported from other countries, mostly from the UK. Many users of feed blocks today are smallholders as well as hobby herds. According to the British company “Dallas Keith” (which is one of the exporting companies of feed blocks to Sweden) the popularity in Sweden is increasing and feed blocks are becoming an established feeding method for sheep. Exact numbers of the tonnes imported per year is, however, not registered and there are no official records on how quick the

feed blocks in fact are increasing in popularity. However, given that the sheep population in Sweden is quite small compared to other countries, the tonnes imported will also be relatively small (Dallas Keith, personal communication).

At present in Sweden the blocks can be purchased from a couple of companies. Furthermore, most of these companies also have several resellers in different parts of the country where the blocks can be purchased. According to the resellers, feed blocks are today available for ewes and lambs and can be bought for the different phases of a sheep's life. These phases include early and late pregnancy, lambing, lactation, growth and mating. There are also blocks that fulfil the requirements of organic sheep production. The blocks can be chosen in different sizes according to your herd size and requirements, ranging from around 20 kilograms (kg) to the largest one reaching up to 500 kg. Packaging is available either in plastic containers or degradable well pap. According to the seller's recommendations a standard feed block that weighs 20 kg is calculated to last around eight days for 25 sheep if the consumption is around 100 g per day and sheep (Hunden & Herden, 2018).

### 2.5.3 Other parts of the world

Small ruminants such as sheep and goats are important animals all over the globe as they contribute to a large part of income (Makkar *et al.*, 2007). The total sheep population is estimated to be approximately one billion sheep. Sheep play a huge part in many developing countries. Furthermore, the UK, Australia and New Zealand possess large sheep populations. For the most parts, sheep are kept in extensive systems on pasture (Freer and Dove, 2002). However as previously mentioned, many parts of the world therefore struggle to meet their sheep's daily requirements and feed blocks are often introduced where the grazing conditions are harsh and low in nutrients (Makkar *et al.*, 2007). In particular, countries in Africa and Asia face these challenges (Salem *et al.*, 2004). Compared to for example Sweden where the sheep usually do not graze all year around and are kept in stables over the winter months, it is more difficult to control feed intake of sheep on pasture all year round (Dove, 2010).

In the Mediterranean area, feed blocks are also a source of nutrients used. There, dairy sheep are usually kept in extensive systems (Cabiddu *et al.*, 2014). In one experiment performed in Sardinia, the focus was put on what effect the feed blocks had before and after lambing since during this period pasture may be too low in nutrients compared to the ewe's requirements. Two groups were formed which both were fed forage and concentrate, however, the treated group received a molasses-licking block (Crystalyx<sup>®</sup>) as an extra addition. The ewes were kept inside for a period of 60 days prior to lambing until the lambs were weaned and then they were allowed back out on pasture. The ewes were more prone to using the blocks before

lambing. Furthermore the blocks showed positive results as the ewes maintained a better body condition score (2.54), compared to the control group that was not provided with the blocks (2.46) (Cabiddu *et al.*, 2014).

In Iraq sheep generally have a low productivity, however, feeding the sheep sufficiently remains a common issue. Therefore feed blocks have been tested as an alternative to grains. Salman (1996) concluded through several experiments that ewes gained more weight on the feed blocks compared to grains (47-100 %), which also had positive effects on the conception rate (7-27 %). The blocks mainly consisted of local by-products and could easily be mixed together, which are major advantages for a new feeding method and has major future potential.

## 2.6 Disadvantages

Even though many advantages are reported on feed blocks, as with every feeding method there may be disadvantages as well. Since studies researching this topic have not been performed in Sweden yet, it is hard to estimate how the blocks truly affect our Swedish sheep. However, this is quite a well-researched topic abroad and some disadvantages have been reported.

One factor that may be of concern is how the sheep get accustomed to the feed blocks when they are first introduced. Lobato and Pearce (1980) performed an experiment in Australia where UMMBs were offered to sheep on pasture, to determine the usage of the feed blocks in different flocks. The results showed great variation between the flocks, but after three weeks in general only 50 % of the sheep had eaten from the blocks. However, when the sheep that did not really consume the feed blocks the first time were confined with the feed blocks in a smaller paddock for another three weeks, the percentage rose to 88 %. This could imply that a certain degree of introduction to the feed blocks may be needed in order to achieve all sheep eventually eating from the feed block. Tan *et al.*, (1996) also found that some sheep that were offered medicated feed blocks against parasites did not eat enough from the blocks, which could lead to the disadvantage that these sheep keep on spreading the parasites and also create resistance to the compound against the parasites.

When it comes to the formulation, as previously mentioned agro-industrial by-products are usually used. Unfortunately there have been a few issues connected to these by-products, such as mould growth and anti-nutritional factors (Salem *et al.*, 2004). Additionally, it is often difficult to determine nutritive value of these by-products and many lack sufficient amounts of nutrients necessary for sheep. Their availability at all times of the year is a further issue (Salem and Nefzaoui, 2003).

As feed blocks are meant to be available at all times, it may be hard to observe that all the sheep in the group consume sufficient amounts of the blocks, in

comparison to feeding the sheep a certain amount of concentrate every day. A possible solution to keep track that the ewes do not drop too much in weight, body condition scoring (BCS) can be applied. The main concept of this method is to assess the condition of sheep as well as their degree of fat, using a scale of zero to five, where zero is too emaciated and five is obese. No equipment is needed since the examination is done by eye and hand (Russel, 1984). In very extensive systems however, this may be hard and time consuming to perform, especially if a herd has many ewes.

The growth of lambs fed feed blocks is also a factor of interest, but not a very researched topic, as ewes seem to be the main category of interest when it comes to feed blocks. Atti *et al.*, (2003) found in their experiment that lambs that were fed roughage and concentrate had a higher body weight at slaughter (34.4 kg) than lambs that were fed roughage and feed blocks (30.5 kg), showing a potential negative effect of the blocks for growing lambs.

## 2.7 Marking of feed products

When it comes to how feed products, and therefore also feed blocks, have to be marked and what claims are allowed, there are certain rules presented by the Swedish Board of Agriculture (SJV). These rules apply to the product itself as well as the website and oral presentations. All claims that are made about a feed product have to be clear for customers to understand as well as being backed up by scientifically proven evidence. It is further not allowed to claim that a feed type can prevent any type of diseases. The following information has to be presented on the product: feed type, type of animal the product is intended for, composition, analytical components, batch number and warranty period have to be separate headings. Further examples that have to be present are directions for use and name and address for the person in charge (Jordbruksverket, 2018).

## 2.8 Economy

In order for feed blocks to be an attractive choice for farmers on a larger scale, the prices of the blocks should be kept at an as low level as possible. The financial aspect is yet to be investigated properly. Not only the costs, but also the production and wellbeing of sheep have to be looked at to determine if feed blocks are a profitable option. When at present looking at websites of sellers in Sweden the prices in November 2018 for a 20 kg feed block is around 300-400 SEK, excluding any shipping (Hunden & Herden, 2018; 3 Lammproducenter AB, 2018). For the 20 kg block that costs 400 SEK, this corresponds to approximately 20 SEK per kg. The cost of

the feed block generally varies due to the formulation and the ingredients that are used.

Salem and Znaidi (2008) showed in an experiment performed in Tunisia the differences two ingredients could make. They concluded that concentrate feed sometimes proved too expensive for some Tunisian farmers and therefore feed blocks included in a feed ration may lower the feed costs. When olive cake was a main ingredient in the feed blocks, the concentrate amount could be lowered more (0.75) than when tomato pulp was included in the blocks (0.5). Thus, a conclusion from this experiment was that the choice of olive cake in the feed blocks reduced the feed costs more than tomato pulps, since the concentrate portion can be lowered, and the growth of the lambs will not be affected.

## 2.9 Feeding and nutrient requirements

Knowing what to feed your sheep at certain times of the year is crucial for good production, animal health and farm economy. The feeding strategy will differ between ewes and growing lambs. Generally, when talking about feed, categories such as roughage, concentrate and mineral feed are used. Naturally, pasture in the summer is key in feeding sheep as well. The quality of the feedstuffs determines the amount that should be provided (Sjödin, 2007). Roughage, is the most important feedstuff for sheep (Freer and Dove, 2002). A general rule of thumb is that a ewe can eat approximately 1.5 % neutral detergent fibre (NDF) of her body weight. When talking about dry matter (DM) on the other hand, a sheep can eat 3 % of its body weight. Some examples of roughages are silage, hay and straw. Concentrates are generally nutrient dense and can be high in energy, such as wheat or barley, or protein (FAO). When it comes to the mineral feed, calcium (Ca) and phosphorus are important components that are needed (Sjödin, 2007). For ewes, most part of the year, good roughage can suffice as only feedstuff. However, in late gestation and early lactation, there is generally a need to add concentrate feed (Sjödin, 2007).

Understanding what nutrients, a sheep needs per day is crucial for formulating a feed ration. The nutrient requirements will differ between the different animal categories depending on for example body condition, performance, growth, lactation, sex and gestation. When the requirements are not met, deficiencies may occur and be projected as for example impaired reproduction and growth. Furthermore, the sheep may be more prone to diseases as well as a loss in production, which in turn leads to less profit for the farmer (National Research Council Staff, 1984).

## 3 Materials and method

### 3.1 Type of interview

Qualitative interviews were chosen for the practical part of this study, in order to understand the opinions of farmers and advisors on the usage of feed blocks for sheep. The reasons for the choice of method were that qualitative interviews aim to understand the interviewed person's standpoint on a certain topic. Moreover, these interviews provide questions that for the main part can be answered rather freely. Even though there is usually a pre-planned interview guide (as there was for these interviews), this method is considered quite flexible, as there is room to ask appropriate follow-up questions. The person giving the interview can steer the questions in the direction they find most suitable for the study. Another reason for the choice of method is that qualitative interviews usually are used to acquire detailed and longer answers from the person that is being interviewed (Bryman and Bell, 2011). The aim of the interviews was to get better understanding of how different farmers experienced using feed blocks and what possible advantaged and disadvantages this may lead to.

### 3.2 The advisors

To acquire background information as well as a good basis for the interviews with the farmers, two interviews with advisors specialized in feeding and sheep were conducted prior to the farm interviews. An interview guide was planned in advance and consisted of open questions. The interview guide for the advisors can be found in Appendix 1. Both interviews were held over the phone and were recorded after the consent of the advisors. Each interview took about half an hour. The questions involved topics such as positive and negative aspects on feed blocks as well as their opinions on their utility. Their identities were kept anonymous for this report and their answers were summarized.

### 3.3 The farmers

Included in the study were seven Swedish sheep farmers who currently use feed blocks for their sheep and who agreed to being interviewed. Two of these farmers were resellers of feed blocks who used feed blocks for their sheep. The interview guide was planned in advance and partly had fixed options for answers, as well as open questions where the farmers could answer more freely. This combination of questions aimed for the farmers to be able to better express their opinions on certain

matters regarding feed blocks. The questions were formed after researching articles for the literature review, as well as the discussions with the advisors. The farmers from the different farms were asked the same questions, however, different follow-up questions were sometimes asked depending on the extent of the answers. The questions included topics such as production, health, economy, pros and cons and comparisons to other feeding methods. The complete interview guide can be found in Appendix 2.

All the interviews were after approval from the farmers recorded. This way the focus could be directed towards listening to the farmers during the interviews. Furthermore, the material could be transcribed, summarized and analysed as well as listened to several times in retrospect to avoid misunderstandings or information being left out. It was important that the true opinions of the farmers were portrayed in a truthful way. Their identities were kept anonymous as well.

### **3.4 Selection of the farms**

The recommendations for the farms included came from local societies from “Svenska Fåravelsförbundet” (the Swedish Sheep Society), feed block retailers as well as contacting farmers on a social media forum about sheep. To be selected first and foremost farms in the middle of Sweden were looked after as this was geographically close and farm visits were the goal. However, one farm was located further away in the South of Sweden. Farms of different sizes were included, with the smallest farm having ten ewes and the largest having around 200 ewes. It was preferred that the feed blocks had been used for at least two years in order for the farmers to share their experiences. Two resellers of feed blocks who also use them were part of the study as it was interesting to hear their opinions on why they are content with the blocks.

### **3.5 The farm visits**

The meeting for the interviews was planned in advance. All the farms were visited except for one, which was due to the longer distance, interviewed over the phone. For each visit approximately two to three hours was set aside to have a sufficient amount of time for the interview as well as a short tour of the farm. The actual duration of the visits however varied (1-3 hours). The farms were visited during the period of late October to early December, where most lambs had been sent to slaughter and the ewes had been or were about to be mated. The interviews always started with a short introduction of the project, followed by some general questions

about the farm and the sheep to get a good overview. Thereafter the questions about the feed blocks were asked.

### 3.6 Short presentation of the farms

Table 1. *Short presentation of the farms that took part in the interviews.*

|                              |         |           |       |         |       |
|------------------------------|---------|-----------|-------|---------|-------|
| Farm                         | A       | B         | C     | D       | E     |
| No. of ewes                  | 70      | 25        | 50    | 200     | 10    |
| Breed <sup>1</sup>           | P & Kdp | P & Kdp   | P     | P & Ksu | P     |
| Used fb <sup>2</sup> , years | 7       | 6         | 2     | 5       | 4     |
| Lambs/ewe                    | 2       | 2.2       | 1.8   | 1.7     | 2     |
| Lamb. period                 | April   | April     | April | May     | April |
| Farm                         | F       | G         |       |         |       |
| No. of ewes                  | 25      | 80        |       |         |       |
| Breed                        | X       | Kdp & Kle |       |         |       |
| Used fb, years               | 5       | 6         |       |         |       |
| Lambs/ewe                    | 2       | 1.6       |       |         |       |
| Lamb. period                 | January | March     |       |         |       |

<sup>1</sup> P=Gotland sheep Kdp=Dorper Ksu=Suffolk X=Mixed breed Kle=Leicester <sup>2</sup>fb= feed blocks

### 3.7 Feed rations

To be able to see if or how well a feed block can be introduced to a feed ration, a couple of estimated feed rations were calculated. The feed rations that were calculated for this report were based on the three parameters NDF, energy in MJ and digestible CP. Assumptions made were that the ewes were kept in groups and had free access to roughage, where there was a possibility for over consumption. It was also assumed that the ewes had free access to water and minerals, therefore no mineral requirements were calculated in this feed ration. Further, it was assumed that the ewes at all times ate 1.5 % NDF of their body weight, however in reality, this percentage can vary.

#### 3.7.1 The ewe

These feed rations were calculated for a ewe weighing 70 kg, which is a relatively common weight for ewes in Sweden. The phases chosen were early and late pregnancy as well as lactation, with the ewe carrying two lambs. To be able to get a better understanding of how well the feed blocks cover the nutrients requirements



of ewes, it was important to investigate during these several different phases as the ewe's requirements are changing. For late pregnancy, more than two lambs on average was chosen as this is a predesigned category based on herd level. Unless the ewe has been scanned, the exact numbers of lambs is unknown until parturition. Once the ewe has given birth and it has been established if she has two lambs or more, the corresponding values can be chosen. The nutrient requirements of the ewe during the different phases of her life are taken from table 8 in "Fodertabeller för idisslare" (Spörndly, 2003) and are summarized below in table 2.

Table 2. *Nutrient requirements of a ewe weighing 70 kg (Spörndly, 2003).*

|                                    | ME  | g Dig. CP | Max. consumption of NDF |
|------------------------------------|-----|-----------|-------------------------|
| Early pregnancy                    | 9.6 | 69        | 1050                    |
| 2 w before lambing, > 2 on average | 21  | 209       | 1050                    |
| Lactation, 2 lambs                 | 29  | 269       | 1050                    |

### 3.7.2 Roughages

These feed rations either contained the roughage types silage or hay to see how different roughage types could work with the feed blocks. Values for both roughages were chosen from table 10 from "Fodertabeller för idisslare" (Spörndly, 2003). The values for the hay was taken from Sweden in general, above mean value. The silage values were also from Sweden in general above the mean value, containing less than 25 % legumes. These roughages were chosen as the nutritional values are representative of the quality of feed that many farmers in Sweden have access to. Their values can be found in table 3. The prices chosen for the roughages were 1.05 SEK per kg DM from Länsstyrelsens "Bidragskalkyler 2018" for conventional lamb production with lambing occurring around April.

Table 3. *Dry matter content (g/100 g fresh weight), NDF (g/kg DM), digestible CP (g/kg DM), and metabolisable energy content (MJ/kg DM).*

| Feed                | DM | NDF             | Dig. CP | ME |
|---------------------|----|-----------------|---------|----|
| Hay <sup>1</sup>    | 86 | 652             | 76      | 10 |
| Silage <sup>2</sup> | 46 | 573             | 120     | 11 |
| Concentrate         | 89 | 287             | 165     | 13 |
| Feed block          | 83 | 10 <sup>3</sup> | 77      | 16 |

<sup>1</sup> whole Sweden <sup>2</sup><25 % legumes, whole Sweden <sup>3</sup> g fibre

### 3.7.3 Concentrate

The concentrate values used came from “Lantmännen” and their concentrate “Fårfor tacka”. The price chosen for this concentrate was also taken from Länsstyrelsens “Bidragskalkyler 2018” (like the roughages) where the bulk price for buying concentrate was set to 2.60 SEK per kg. The nutritive values of the concentrate can be found in table 3.

### 3.7.4 The feed blocks

For the feed blocks, an energy block called “Extra Energy” from the reseller “Hunden och Herden” was chosen as a guide. This particular block was commonly used by the interviewed farmers. The feed block manufacturer is “Dallas Keith” from the UK. The energy value of this block is presented by the sellers as 16 MJ/kg DM and was therefore used. This value is basically the only value that for certain can be interpreted from the table of content. The daily intake for calculating these feed rations intake set to 100 g per sheep and day according to the recommendations.

Due to continuous difficulties in completely understanding the other relevant parameters, finally own assumptions were made that were thought to be the most accurate. Since the energy value was presented per kg DM and not per kg fresh weight, an assumption was made that the other nutritional parameters also were presented in this form, since this is common practise in Sweden.

This particular block contains 17 % moisture; therefore, the dry matter percentage of the feed blocks is 83.

Furthermore, assumptions were made for the values of digestible CP and NDF. According to the resellers the blocks contain 9 % protein. It was assumed that the protein was presented as CP. The five main ingredients of this block were as following: molasses from sugarcanes, vegetable oil, rape seed meal, salt and soy bean meal. As salt and vegetable oil do not contain any protein, the CP from these blocks could only come from the remaining three ingredients. First and foremost, it could also be read on the product that the feed block contains 2 % Sodium (Na), meaning 20 g per kg DM. It was assumed that all this Na came from salt and therefore the salt percentage could be estimated. As salt contains 40 % Na and 60 % Chloride (Cl-), it could be calculated that the blocks contain maximum 5 % salt, meaning 50 g. Since there was less soy bean meal than salt, this value will not exceed 50 g and therefor does not contribute massively to the CP content. This leaves molasses and rape seed meal. Their digestibility coefficient is 70 and 85 respectively (Spörndly, 2003). When multiplied with the 9 % protein, molasses will have 63 and rape seed meal 77 g digestible CP/kg DM. The value 77 was chosen for the digestible CP for this feed ration as it appears to be the maximum value.

The resellers further say that the fibre percent is 1 % for the block. This means that these blocks do not contain more than 10 g of fibre per kg. The chosen value for NDF for these feed rations was therefore 10 g.

The price for this 20 kg feed block is 410 SEK without shipping, giving a price of 21 SEK/kg. The values of the feed blocks can be found in table 3.

## 4 Results

### 4.1 Summaries of advisor interviews

#### 4.1.1 Advisor A

Advisor A has no personal experience on using feed blocks for sheep but has several clients who use them.

##### *Farmers*

Customers calling about the blocks generally want to know if they are a good feeding option. Some customers view the blocks as a complement feed to roughage and concentrate. Others aim to fully replace the concentrate and in this advisor's experience this is mainly the case with smallholders.

##### *How they should be used*

Advisor A believes that the best way to use the feed blocks is as an energy complement, where you still provide roughage, concentrate and mineral feed. This is in accordance to how the manufacturers abroad market their use. This advisor stresses the importance of monitoring the consumption pace as well as the individual consumption of the blocks. Advisor A believes that if energy content of feed is lacking, feed blocks can be a good solution to supply energy for both ewes and growing lambs. Especially during periods where the grass is low in carbohydrates. For ewes in poorer condition, during mating for example, the blocks may be a great energy supplementation for the rumen which also may aid in the digestion of feed.

##### *Pros and cons*

The main advantages of feed blocks in this advisor's opinion are that they are easy to buy, easy to distribute and some farmers find it reassuring to know that their sheep have access to feed at all times. This advisor believes that it is a good way to provide molasses and quick energy out on pasture or in the barn.

Advisor A believes that the disadvantages are that the feed blocks are very expensive to purchase. Furthermore, to fulfil their requirements from the blocks a sheep may need to consume 1.5 kg per day, which is not realistic. The feed blocks also do not cover all the mineral requirements in regard to how they are meant to be consumed and rarely contain vitamins. The advisor explains that when looking at the table of content it may read that there is no potassium (K). However, a feed block can contain up to 70 % molasses, which is very rich in potassium. Since the nutritional value of molasses is not accounted for, this may lead to issues in herds using

feed blocks where the roughage already contains a lot of potassium. Unfortunately, too much potassium may contribute to a higher risk for hypocalcaemia and cramps.

#### *Economy*

This advisor believes that the market for feed blocks in Sweden today is rather large and profitable. In comparison to one kg concentrate, advisor A estimates the price for one kg feed blocks to be around four times higher. On a smaller herd level, the higher price may not be an issue. This advisor believes that the blocks may be more beneficial for farmers as it is an easier option, rather than for the sheep.

#### *Future knowledge*

Advisor A wishes for a table of content that is consistent, easier to interpret and suitable for the Swedish legislations. Furthermore, an analytical comparison of the different blocks would be interesting to examine.

#### 4.1.2 Advisor B

As with the previous advisor, the second advisor does not have any personal experience with feed blocks, but occasionally gets contacted by clients who are interested in learning more about them.

#### *Farmers*

The most common questions that are asked are if the blocks are good nutrition wise and if they can be used instead of concentrate feed, especially around lambing. In advisor B's experience, the main reasons as to why farmers start using feed blocks are that they are easy to use as well as less stressful and noisy around feeding.

#### *How they should be used*

When it comes to the usage of feed blocks, this advisor recommends following the manufacturer's instructions. It is however important to be aware of the balance of vitamin and trace elements, as well as making sure that the sheep are fed enough protein and energy. The blocks can be a good option when there is a need for these nutrients. This advisor does not recommend using feed blocks as the only source of concentrate for ewes that carry two or more lambs. Some producers want to stay away from concentrate feed and if nutrients are lacking in the roughage, feed blocks may in this advisor's opinion be a good solution.

#### *Pros and cons*

The fact that the blocks are easy and less stressful to use when feeding the ewes, especially around lambing, are in advisor B's opinion the advantages of feed blocks. The disadvantages that this advisor sees are that you pay a lot of money for a small

energy supply. The advisor is further unsure about the effect of the blocks, as there currently is a lack of research.

#### *Economy*

Advisor B is unsure if the feed blocks are profitable, as usually there is a price of around 20 SEK per kg block. This advisor always gives recommendations after the client's goal for their production. It is important to both look at the money spent and how well the ewes perform to know if you get your money's worth.

#### *Future knowledge*

For the future advisor B would be interested to know if the blocks are profitable in comparison to concentrate. Also, facts on how supply of vitamin and trace elements work and what strategies should be applied if supplementation is needed. Since most feed blocks are imported from the UK and work well there, many clients instantly believe that they will have the same effects here. Important to keep in mind is that the UK has different conditions and production systems than Sweden. Some examples are that they usually do not feed as much concentrate, mainly keep their sheep on pasture and have a lower fertility rate.

## 4.2 Summaries of the farmer interviews

### 4.2.1 How they initially heard of the feed blocks

It appears that feed blocks are increasing as a feeding method in Sweden and therefore it was of interest to hear how the farmers first learned about the blocks. Four out of seven farmers heard about the block from a close friend or contact who used and recommended them. The remaining three farmers did some research online for new feeding strategies and thereafter found resellers on their own.

### 4.2.2 The use of feed blocks

Why they started using feed blocks was an interesting question, where all seven farmers basically answered the same thing. The reason was the chaos that previously occurred when feeding concentrate. Most farmers expressed this environment as loud with a lot of pushing and stress for both themselves and the sheep. They also expressed that the feed blocks provide all individuals of the group access to the blocks when they wish to. Additionally, as a reason, one farmer wanted a supplement for the lambing period and one farmer wanted to minimize the mouse and rat population that used to be an issue around the concentrate.

Five farmers did not have any concerns before starting to use the feed blocks, while two were a bit concerned about how much a ewe can consume and what the nutrient content of the blocks looked like. These two farmers discussed these questions with the resellers to acquire more information before they purchased the blocks. None of these farmers had asked a feed advisor for advice.

There were different opinions on how the blocks should be used among the farmers. Two farmers answered that they thought the blocks can be used as either a complement or replacer depending on your roughage quality. On the other hand, five farmers thought that the feed blocks can replace all concentrate feed and be used on its own.

#### 4.2.3 Adaptation to the blocks

All farmers, once they had purchased the blocks, just put them out on the pasture or in the barn. However, in four of the herds it took a few days up to a couple of weeks before the sheep started eating from the blocks.

#### 4.2.4 Inside or outside

When it comes to where the blocks were kept, two farmers kept them outside at all times, whereas the rest both kept them inside and outside depending on the period. One farmer expressed a problem with keeping the blocks inside, as the blocks sometimes got littered with faeces. When it came to the blocks being kept outside six farmers answered that the top layer of the blocks during rainy period gets dissolved and softens up and therefore the blocks have to be drained. Two farmers replied that at colder temperatures the blocks get too hard for the sheep to be able to sufficiently consume them.

#### 4.2.5 Groups

It quite quickly became clear that the blocks on these farms mainly were used for ewes, but occasionally for growing lambs if they needed to gain weight for slaughter. This was the case at two farms. The rest of the farms used the blocks for both categories, with one of the farms using them for rams as well. Two farms thought that the blocks were most suited for the growing lambs, whereas three farms voted for the ewes, especially around lambing and flushing. For the least suited category, three farmers replied thin, older ewes, as they may have difficulties consuming the blocks due to their teeth. One farmer thought that ewes with more than three lambs were the least suited for feed blocks.

At the farms with the breed Dorper, these farmers expressed that these sheep can be fed low quality roughages and still be in high body condition scores and therefore might not require the blocks. In these farmers opinions, this is in comparison to for example the Gotland sheep that they experienced need better roughages.

#### 4.2.6 Periods

No farmer used the blocks all year round. Flushing and lambing were the most common periods to use the blocks. Five farmers used the blocks around lambing and the other two used the blocks for the flushing period as well. However, all the farmers expressed that the use of the blocks could vary from year to year depending on factors such as the weather.

#### 4.2.7 Production and reproduction

As for if the slaughter weight had improved since starting to use feed blocks only two farmers answered yes, whereas the rest were unsure and had not really reflected over it. Three farmers experienced that the ewes had fewer reproductive issues when fed the blocks and the rest of the farmers were unsure about the effect.

#### 4.2.8 General health

The aspect of the teeth could be negatively affected by consuming the blocks was a further question, where only one farmer answered yes and four answered no. All farmers however had observed that the sheep not only lick, but bite from the blocks. The effect on body condition score (BSC) was an aspect that all farmers except for one were unsure about, with the exception farmer answering that they had seen a positive effect.

#### 4.2.9 Pros and cons

There were a few main advantages mentioned during these interviews. Five farmers thought the main advantages was the calmer environment in the stable, where the sheep can eat from the blocks depending on what they need. Low ranked sheep can eat and are not pushed away and there is no overconsumption. Furthermore, no waste and no vermin as well as easy storage was mentioned. Four farmers expressed that the main disadvantages of feed blocks are that they are expensive. From those four, three farmers also expressed that the blocks are quite heavy and sometimes difficult to handle and carry. Three farmers did not see any disadvantages at all and were so far very content with the blocks.



#### 4.2.10 Feeding

Even though most of the farmers initially thought that the blocks work as a replacer of concentrate, all farmers on certain occasions did provide another type of concentrate. These periods included the lambing period, if the ewe carried more than three lambs, the last period for lambs before slaughter as well as for sick animals. One farmer gave grains and feed block, because to exclusively use feed blocks had proven too expensive for this farmer. To calculate feed rations for their sheep was very common among all the farmers except for one, where sometimes an advisor was consulted. However, only two farmers had tried to incorporate feed blocks into their feed ration calculation, where one farmer was unsure about the nutritional values. All farmers except for two always analysed their roughages.

Since the feed blocks are present at all times, it was interesting to hear how the farmers experience the stress and ranking in the flock around feeding. All farmers agreed on that the blocks provide a more evenly distributed feed intake as the low ranked individuals can feed from the blocks when the higher ranked sheep are finished.

#### 4.2.11 Minerals

One of the claims from companies selling the blocks is that the sheep will reduce their intake of mineral feed when provided access to the feed blocks. However, only three farmers experienced that the sheep consumed less from the mineral blocks when they were fed feed blocks. One farmer on the contrary did not believe that they consumed less at all, and the rest of the farmers were unsure about the mineral consumption pace.

#### 4.2.12 Economy

When talking about if and how the economy had changed since starting to use feed blocks, the answers were very diverse. Two farmers said that their feed costs had increased, while three farmers thought that it had not become more expensive. The remaining farmers did not really have an answer to this question. However, all farmer said that they had to spend less time and labour since starting to use the blocks and this could be seen as a financial advantage.

#### 4.2.13 Marking of the feed blocks

If the recommended feed block intakes were accurate and if the table of content was clear were both questions that five farmers answered yes and two answered no to. All farmers except one thought that it was easy to find information about the feed blocks online.

#### 4.2.14 Future

For the future two farmers wished for a clearer table of content and two wished for more research in general. One farmer wanted more clarity on how the feed blocks can be incorporated in the feed ration calculation. The rest of the farmers could not think of anything in particular that they wished for. Five farmers were convinced that the feed blocks would keep on increasing as a feeding method in Sweden in the future. The one farmer that answered no to this question, thought so due to the belief that a lot of farmers are traditional and use what they always have used. One farmer was unsure if they would increase in popularity. When it came to the question if there were any factors that would lead to them stop using the feed blocks three farmers did not see any reason at all. For the farmers answering yes, the reasons were if they would get more expensive (for example due to Brexit), if they would get harder to acquire and if new research proved any negative effects.

### 4.3 Feed rations

In this section, the calculated feed rations described previously in materials and method are presented. The values for the ewe and the feed can again be found in tables 2 and 3. The values of MJ and digestible CP presented in the feed ration tables are relative numbers compared to the norm. If a ewe would eat in relation to her nutritional needs the value would land at 100. Numbers above or under 100 would in turn mean an over- or an under consumption of nutrients for that individual.

Looking at the tables 4 and 5 it can be seen that during early pregnancy for both hay and silage the nutrient requirements are met when feeding the blocks. For the remaining periods there is always a nutrient deficit. The exception there is that with silage and feed block during late pregnancy the nutrient requirements are met. Overall, the feed rations with silage cover the nutrient requirements of the ewe better when adding feed blocks. With concentrate however, the nutrient requirements can always be reached.

When it comes to the prices in the tables 4 and 5, especially per MJ, it can be interesting to note that these prices during some phases are very high when feed blocks are included, even though the nutrient requirements are far from being covered, in other words below 100. For example, in table 4, when looking at lactation, the feed ration with feed blocks is slightly cheaper, however, since the nutrient requirements are not covered overall this ration will be expensive.

The kg DM used for the different feed stuffs can be found in the tables 6 and 7 in Appendix 3.

Table 4. Example feed rations for an ewe weighing 70 kg with two lambs during early and late pregnancy as well as lactation, when fed either hay and concentrate or hay and feed blocks as well as the prices for the feed rations per day and per MJ.

|   | Feed ration <sup>1</sup> | MJ compared to norm | Dig. CP compared to norm | Price/day | Price/MJ |
|---|--------------------------|---------------------|--------------------------|-----------|----------|
| Early pregnancy                                       | Hay                      | 167                 | 176                      | 1.68      | 0.11     |
| 2 w before lambing, > 2 lambs on average <sup>2</sup> | Hay+C                    | 114                 | 110                      | 3.70      | 0.16     |
| Lactation, 2 lambs                                    | Hay+C                    | 101                 | 107                      | 4.60      | 0.16     |
| Early pregnancy                                       | Hay+FB                   | 142                 | 143                      | 3.79      | 0.28     |
| 2 w before lambing, > 2 lambs on average              | Hay+FB                   | 85                  | 62                       | 4.21      | 0.24     |
| Lactation, 2 lambs                                    | Hay+FB                   | 62                  | 48                       | 4.21      | 0.24     |

<sup>1</sup>Fb=Feed block C=Concentrate <sup>2</sup>Predesignated category on herd level

Table 5. Example feed rations for an ewe weighing 70 kg with two lambs during early and late pregnancy as well as lactation, when fed either silage and concentrate or silage and feed blocks as well as the prices for the feed rations per day and per MJ.

|   | Feed ration <sup>1</sup> | MJ compared to norm | Dig. CP compared to norm | Price/day | Price/MJ |
|---|--------------------------|---------------------|--------------------------|-----------|----------|
| Early pregnancy                                       | S                        | 206                 | 313                      | 1.89      | 0.10     |
| 2 w before lambing, > 2 lambs on average <sup>2</sup> | S+C                      | 103                 | 113                      | 2.37      | 0.11     |
| Lactation, 2 lambs                                    | S+C                      | 93                  | 114                      | 3.71      | 0.14     |
| Early pregnancy                                       | S+FB                     | 211                 | 307                      | 4.32      | 0.21     |
| 2 w before lambing, > 2 lambs on average              | S+FB                     | 104                 | 107                      | 4.42      | 0.21     |
| Lactation, 2 lambs                                    | S+FB                     | 75                  | 83                       | 4.42      | 0.21     |

<sup>1</sup>S=Silage Fb=Feed block C=Concentrate <sup>2</sup>Predesignated category on herd level

## 5 Discussion

### 5.1 Interviews with the advisors

In these interviews, both advisors had similar opinions on many aspects of feed blocks. Customers also generally ask them the same questions, which may be an indication that some information may be difficult to find or interpret. It could however also be that customers who are new to the topic are just curious and directly want the information from an experienced advisor. As advantages and main reasons for the usage of the blocks, both mention the ease of providing the blocks to the herd. On the other hand, they both also estimate feed blocks to be quite an expensive supplement to purchase.

Both advisors also mention the difficulty of importing a product from abroad, as there may not be the same conditions in those countries as here in Sweden. This may result in a table of content that may not be clear to some Swedish farmers since there are different units used for the nutrient components. Products that work in one country may not have the same effect in another. Furthermore, many factors have to be considered such as breed, climate, fertility, feed ration, body condition score, health and production system to determine how well the blocks actually work. As discussed with one of the advisors, the UK generally has breeds with lower fertility in their ewes than here in Sweden. Fewer number of lambs mean less need for nutrients and this may be a reason why the blocks are used in the UK. In England the ewes are also more often fed forages and kept on pasture for longer periods, whereas here in Sweden most sheep are confined to stables during the winter months due to the colder temperatures, where they generally are fed roughage.

When it came to how the feed blocks should be used, both answered to follow the directions of the manufacturer, which equals to using them as a complement feed to the total feed ration, not as a replacer of concentrate feed. This way, the low daily intake recommendations compared to other concentrate feeds make more sense. Although both advisors wish for more research and scientifically proven facts, they think that feed block can be a good option depending on what type of production you have and what you wish to accomplish with your production.

## 5.2 Interviews with the farmers

### 5.2.1 The farmers

The farmers included in the interviews had generally used the blocks for several years, which was one of the prerequisites for being part of the interviews. However, this implies that they overall were happy with the results and therefore mainly named the positive aspects. It was however important that they had used the blocks for at least two years to see a long-term effect. Two interviews that were performed were with resellers of feed blocks, due to them possibly possessing further information about the blocks. It was important to acquire a broad spectrum of opinions from farms of different sizes, with different conditions and breeds. The broad variety of farm size and breed also made it possible to hear how well the feed blocks work under different Swedish conditions.

A difficulty with these types of interviews is that the participation of the farms depended on that they voluntarily wanted to be a part of the study. Therefore, the small number of farms included can make it hard to draw any general conclusions.

### 5.2.2 The use of feed blocks

The main reasons for the farmers to start using the feed blocks in the first place was to be relieved of the stress and themselves being pushed around by the sheep, that can occur when feeding concentrate manually during the stable period. Abroad, however, this reasoning is not really to be found in literature. There, the main use of feed block is in areas where the nutrient content of the feed is uncertain, and the sheep need extra supplementation (Makkar *et al.*, 2007). Due to the colder climate here in Sweden, keeping the sheep in a stable during the winter months is common and concentrate feed during some parts of that time is generally necessary. For the animal keeper, feed blocks seem to present an easy option with less work load and time spent tending to the animals. However, it is important to include the feed blocks when calculating a new feed ration to make sure that the requirements are covered. Otherwise nutrient deficiencies or problems around lambing may occur, and concentrate may need to be added. This can again be seen in the calculated feed rations provided in this report in tables 4 and 5. In turn, this would lead to the struggles such as the stress when feeding concentrate are back and therefore the positive aspect of the blocks is no longer there.

### 5.2.3 Adaptation to the blocks

Some farmers expressed that it took several weeks for their sheep to start eating from the blocks. The longer time for adaptation on some farms coincides with what Lobato and Pearce (1980) found in their experiment. However, the question arises if it further could have anything to do with the personal preference of the individual sheep. Issues that could arise from this is that some individuals consume more from the blocks, which the farmer may not notice since they think the consumption pace means that all the sheep are consuming the blocks. This could lead to deficiencies for some individuals. It is therefore very important to keep track of all the sheep's body conditions scores to see if some individuals drastically increase or decrease in body weight. An experiment showed that only some individuals developed a liking for the feed blocks and therefore consumed more (Bowman and Sowell, 1997). Another explanation could however be that the sheep during that period did not require more nutrients and therefore self-regulated and did not eat from the blocks right away, which is what most manufacturers and reseller claim is one of the advantages of the blocks. However, since the sheep after starting to eat from the blocks continued to eat them even though they still were given the same roughage, the reason of adaptation appears more likely when first introducing the blocks.

### 5.2.4 Effect of weather

Due to the effect of rain on the blocks, as well as the cold when the temperatures drop, it could be argued that the best place for the blocks are under some sort of shelter. This would save even more work time, since the blocks do not have to be drained during a rainy period. A further concern is that the top layer gets dissolved when it rains, which could lead to that the sheep more easily can consume the product, which may lead to overconsumption in a way that was not possible before when the blocks were hard. However, the experience from the interviews was that this dissolved layer was not as palatable to the sheep and therefore they generally do not eat too much if this situation occurs. A possible issue following this could however be that the sheep consume too little of the blocks during these periods if the blocks are not drained properly. Salem and Nefzaoui (2003) however in their review claim that if the blocks are not hard enough and the animals consume more, urea toxicity may occur in blocks containing urea, so therefore the risks of the rain may be a factor that need to be taken into consideration. On the other hand, the problem of the blocks hardening during colder temperatures was another issue mentioned. This may lead to the sheep consuming less of the blocks because they are unable to extract product from the blocks. During colder temperatures it is possible that it is better to keep the blocks inside, if the stable has a warmer temperature.

### 5.2.5 Groups

The opinions from the farmers of for which groups they are most or least suitable made it hard to draw any conclusions, as some thought the ewes while others the growing lambs. One of the advisors further thought that they can work well nutritionally for both groups. The issue of feeding ewes with more than two lambs also came up in the interviews. According to the feed rations calculated in this report, it was even hard covering the requirements of ewes with two lambs. Therefore, these ewes need extra concentrate. Since the feed blocks further are quite expensive, it could be argued that the only use of concentrate may be the best option for herds where triplets are common. During periods like early and mid-pregnancy the blocks generally were not used on these farms. This was likely due to that during these periods, if supplied with good quality roughage, there generally is no need for extra supplementation (Sjödin, 2007). The blocks were generally used before and after lambing due to the high nutrient requirements. According to the in this project, calculated feed rations it was not possible to fit the requirements during these periods. It could potentially work if a better roughage quality was chosen instead of the roughages chosen for these calculations, but since this roughage was not of too poor quality it may be unlikely. However more research would be needed to make further statements.

### 5.2.6 Production and reproduction

These parameters were of great interest in the planning process of this report. However, when it came to the reality, most farmers could not really determine if the effect they saw, had to do with the blocks or other factors such as pasture and roughage quality, the ram or similar factors. More research specified within these topics in Sweden would be required to draw a final conclusion.

### 5.2.7 Effect on general health

All farmers tended to keep track of the health of their sheep by continuously keeping track of their body condition by the hand and eye. Some farms even took it one step further and weighed their sheep up to four times a year. The care and attention that was paid by the farmers was evident, as all the sheep appeared to be in good shape during this period where most ewes had been or were about to be mated. It is however hard to say if this was due to the feed blocks or not. It can be argued that during this period, which at the time of the interviews was around mating, the sheep could have fared well on just roughage which they also did on some farms (Sjödin, 2007). As a flushing alternative feed blocks could be a good solution, however expensive. But if time and comfort is valued over money, it may present a good choice as they according to the farmers reduced stress. What feed blocks do not provide however, is an instant overview over all the animals to make sure that they are eating. When

feeding concentrate in for example feeding trays, you can instantly see if an animal does not want to eat, which may be an indication of sickness or injury. Furthermore, the time at feeding provides a good opportunity for performing BCS, as the animals are busy eating. If you however have fewer sheep who are very tame, BCS probably will be easy to perform at any time.

#### 5.2.8 Effect on teeth

When it comes to how the blocks affect the teeth of the sheep, it became clear that this parameter may be hard to determine. Some possible reasons are that the lambs generally are slaughtered at around the age of six months and the ewes were generally not kept for more than six years in order to maintain a sustainable production on these farms. There is furthermore a lack of research on the topic. It could be argued that younger sheep which have not yet acquired their full set of teeth would struggle to consume the hard blocks by biting. Also, older ewes with poorer teeth quality could struggle. On one farm however, the teeth of two ewes at the age of ten were assessed and there was no sign of broken or overly worn-down teeth. These ewes had been fed feed blocks the majority of their life. However, since most of the farmers shared that the sheep actually bite from the blocks, it is not impossible that in the long run they may have some negative effect on the teeth.

#### 5.2.9 Minerals

It became clearer during these interviews that some farmers when asked about blocks, also started referring to the mineral blocks that they use. This may be a matter of own categorization, as the mineral blocks are still considered hard blocks. However, the word feed and block in the same word indicate that the animals get more out of the blocks than minerals (Salem and Nefzaoui, 2003). Since the hard-mineral blocks are commonly used in Sweden, this could be one explanation as to why most farmers were not worried to introduce the new feed blocks to their flock, as they thought it is the same principal as the mineral blocks. Technically, the style of eating is the same, however, the sheep should consume more of the feed blocks than the minerals. That may, also explain the fact that the feed blocks rarely were calculated into the feed ration. This report explains that content wise mineral and feed blocks should not be confused, and their purposes are very different.

#### 5.2.10 Stress and ranking

It was very interesting to hear that the farmers all experienced that there was a much more even feed intake when using feed blocks, where ranking and stress around



feeding were not issues that had been observed. Even though, some expressed that they rarely see their sheep consuming from the blocks, they believe that it is true since the blocks are always available and since the sheep can eat whenever they want without competition.

#### 5.2.11 Economy

Through the interviews it became clear that the high price of the blocks is one of the main problems and constraining factors for the use of feed blocks, as this was a common answer to the disadvantages among the farmers. The economic aspect of feed blocks and their possible profitability is even a subject abroad that requires more research (Salem and Nefzaoui, 2003).

As previously mentioned, all available feed blocks in Sweden are imported. Therefore, the feed blocks cannot be produced with locally available by-products in Sweden today. In other countries, these by-products are very common ingredients to use (Salem and Nefzaoui, 2003). This may explain why in other countries feed blocks may be considered the cheaper feeding option, instead of grains, which may be harder to obtain. Many farmers that were interviewed desired a feed block produced in Sweden. This would be more likely if the feed blocks keep increasing in popularity. Domestic production could possibly decrease the cost of the blocks as they do not have to be transported too long distances. It is in turn therefore possible that farmers are more open to trying this product as some farmers refuse to give their animals feed that contains foreign ingredients. More resellers spread out over the country could lead to reduction in shipment fees and therefore a cheaper price, since the blocks do not have to be transported long distances. Again, this could be possible if more feed blocks are being sold.

#### 5.2.12 Table of content

It may be argued that a main issue with the feed blocks here in Sweden is that some people have a hard time understanding the table of content on the blocks on their own. Even though a few farmers answered that they could in fact understand the table of content, even the feed advisors were confused. Swedish farmers are generally used to reading a list of dry matter percentage, energy presented in megajoule, NDF, digestible CP and minerals. Usually these values are expressed per kg DM. Since the feed block labels have been translated from their original countries, most parameters are only expressed in percent, such as percent protein, moisture and fibre. It is furthermore not clear if this percentage is per kg DM, kg fresh weight or percentage per 20 kg block. This could be a reason as to why most farmers had not included feed blocks when calculating their feed rations. A further reason may be a

relaxed attitude towards the blocks, where it is worth giving them a try and if they do not work, they can easily be removed. A clearer table of content adapted for our Swedish conditions would be preferable and is highly sought after by both advisors and farmers. This would probably lead to more farmers including the blocks in to their feed rations, which could avoid any feeding related issues.

### 5.2.13 Future

For the future it would be desirable to perform experiments under Swedish conditions, as well as maybe experiments with a Swedish produced feed block. Mainly, since studies performed abroad have used different types of feed blocks, have different climates and breeds and even sometime different goals with their productions. It is therefore hard to implement these studies to Swedish conditions. These experiments could help prove if the feed blocks work as well here as they do abroad. However, planning and performing these experiments could be hard. Experiments over several years would be preferred to see how the feed blocks work over time. It would also be interesting to perform experiments where two groups of sheep are compared, where one is fed a traditional feed ration and the other is fed a feed ration with feed blocks to see the possible differences. Most farmers predicted that feed blocks most likely will increase in popularity in Sweden in the future. If more research and more blocks are presented to the market, this could just be the case.

## 5.3 Miscellaneous

### 5.3.1 Recommendations for daily intake

The recommendations for daily intake of the feed blocks are as previously mentioned set quite low, usually around 100 g/head and day. Compared to other concentrate, which during lactation be around 1,5 kg per head and day (Sjödin, 2007). There has been some confusion about why the recommendation can be set so low. This has also led to the belief that the feed block prices are lower compared to concentrate feed as the sheep do not need to consume as much. When talking to the advisors and reading on the manufacturer's websites, it became clearer that feed blocks are meant to be an addition in places where pasture and roughage quality is not enough, not to replace concentrate. This may be one of the reasons for this low recommendation. For some categories such as ewes expecting twins and triplets, the feed blocks on their own will not cover the requirements, as can be seen again in tables 4 and 5. These ewes therefore need to be supplemented with concentrate such as grains or compound feed. Among the farmers there were mixed responses to if

the feed blocks really last as long as the recommendations say. These recommendations should probably not be taken literally and should only be used as an initial guide.

### 5.3.2 Directions for use

On the block directions it is recommended to provide high quality roughage together with the feed blocks. This may be hard to interpret and also to define what a good quality roughage means. This goes against Salem and Smith (2008), who claim that feed blocks should be used when there is a lower quality of the roughage or when the grazing conditions are not optimal. Furthermore, directions from the UK encourage the use of feed blocks at low quality feed values (Hyby Cig Cymru, 2018). However, this recommendation probably aims towards the idea that with a high-quality roughage the sheep will consume the recommended smaller amounts of the blocks, otherwise they may consume more. And as one of the feed advisors mentioned, maybe caution should be taken with high quality roughages containing too much potassium.

### 5.3.3 Medicated blocks

The use of anthelmintic agents in feed blocks in some foreign countries seem to be a technique that is commonly applied. Even though some studies showed a positive effect on the total worm count, the question is if these low doses of anthelmintic may be a factor in eventually contributing to resistance to these substrates. Caution should be applied in using these types of feed blocks, if they are not deemed totally necessary.

## 5.4 Feed rations

### 5.4.1 Difficulties

As previously mentioned, there were a few difficulties in completely understanding the table of contents. Even after a lot of research and contact with manufacturers, there were still uncertainties. Furthermore, the feed advisors expressed that the table of content were difficult to understand completely. Eventually, decisions had to be made to be able to complete the task during the course of this master's thesis, even though the accurate numbers would have been preferred. The feed rations aim to show an example of what including feed blocks can look like, with as accurate

estimations as possible during the time course of this report. Therefore, the feed rations are representative of the reality. Hopefully in the future, these misunderstandings will be cleared up to provide a clearer view of the table of content.

#### 5.4.2 Choices

The reasons for not choosing a complete feed ration, containing for example minerals and PBV, were that this type of feed ration was an easy option to get a quick overview over the chosen parameters. The intake per day for the blocks was set according to recommendations to get an overview of what the feed rations could look like if the sheep consume the given amount. However, feed rations were also calculated for the doubled intake at 200 g/day (not presented in this report) and even so the nutrient requirements were still not covered. This in turn leads to issues such as even higher feed costs.

Only one type of hay, silage, concentrate and feed block were used to be able to narrow the amount of feed rations. The roughage values were chosen as they most likely are similar to what most farmers in Sweden have access to, as not everyone can acquire top quality feed. "Fårfor tacka" was chosen since this is a commonly used concentrate in Sweden. An energy feed block was used as it is a common choice and generally has high energy content, which is what many farmers look for during periods like lambing. These feed rations were furthermore only calculated for ewes as they were the most interesting category to look at during different phases. Also, this category is the most researched abroad.

Another choice made was the ewes during the different phases all consumed 1.5 % NDF of their body weight. However, if a lower quality feed was chosen the ewes may consume less and the blocks will not compensate for the nutrients lost. In an experiment performed, it showed that ewes fed grass silage during lactation consumed considerably more than 1.5 % and ewes in early and late pregnancy consumed slightly less (Nadeau *et al.*, 2015). In the feed rations chosen for this report however, the 1.5 % was chosen as it is a general model for how much the ewes can consume, even though in reality this clearly can vary.

#### 5.4.3 Conclusions from the feed rations

After looking at the calculated feed rations it proved not possible to compose a feed ration with feed blocks that cover the nutrient requirements of ewes. Furthermore, the price per MJ and day are always higher when using the feed blocks. Important to note is that even though the prices for the blocks are high, this would not be the actual cost. That cost would actually be higher, due to that the nutrients requirements are not being covered. Therefore, the sheep will consume more of the feed leading

to even higher costs, or on the other hand suffer from nutrient deficiencies. The NDF value was not presented in the tables, as it was not set too high and only shows how much a sheep can consume. Therefore, the protein and energy requirements were more interesting to look at. Especially impossible to cover, were the requirements during lactation as well as late pregnancy, even for ewes carrying two lambs.

## 6 Conclusions

Through the calculated feed rations in this report, it proved not possible to compile a feed ration with feed blocks as the sole concentrate that fully covers the nutrient requirements of an average ewe, with twin lambs or more. Therefore, it makes the most sense to follow the manufacturer's instructions and to only use the feed blocks in combination with roughage and concentrate, not as the only concentrate source. Furthermore, feed blocks are expensive to use, especially when taking into consideration that they do not cover all the requirements, sometimes not even half of what is required. Since they however can provide the sheep with energy and protein, the blocks could be used as a complement where these nutrients are lacking. For example, periods such as lambing and flushing, where there is an additional need for nutrient for the ewe. This in case of the ease of the distribution and less stressful work environment is preferred, and if the farm has the means to pay for the blocks.

## 7 Future research

More research, preferably performed under Swedish conditions, would be desirable and necessary to draw further conclusions about the impact of the feed block. Interesting to investigate would for example be to compare two groups of ewes during pregnancy and lambing, where one group is fed roughage and concentrate, and the other group is fed roughage and feed blocks to compare how well the ewes can keep their body conditions scores and how well they can manage their parturition. A similar experiment would also be interesting to perform on growing lambs to see which group grows better and reaches slaughter weight faster. Furthermore, the comparisons of feed prices would be interesting to look at to see which groups prove more expensive. If these experiments would be performed it would then further be interesting to compare different breeds typically used in Sweden to see which breed may perform better or worse when fed the blocks.

## 8 References

- Atti, N., Salem, B.H., Priolo, A., 2003. Effects of polyethylene glycol in concentrate or feed blocks on carcass composition and offal weight of Barbarine lambs fed *Acacia cyanophylla* Lindl. foliage. *Anim. Res.* 52, 363–375. <https://doi.org/10.1051/animres:2003022>
- Baribo, L.E., Porter, M.W., Willard, A., Wright, K.N., 1996. MOLASSES FEED BLOCKS AND METHOD OF PREPARATION AND USE 3.
- Bowman, J.G.P., Sowell, B.F. 1997. Delivery method and supplement consumption by grazing ruminants: a review. *J. Anim. Sci.* 75: 543-550.
- Cabiddu, A., Trevisi, E., Molle, G., Lovotti, G., Manca, C., Epifani, G., Dattena, M., 2014. Effects of cooked molasses licking block supplementation pre- and post-partum on feed intake, suckling lamb performance, milk yield and milk quality in dairy sheep. Part 1. *Anim. Prod. Sci.* 54, 1838. <https://doi.org/10.1071/AN14332>
- Donovan, D., Weigel, G.C., 1988. Animal feed blocks containing dietary supplements. US4735809A.
- Dove, H., 2010. Balancing nutrient supply and nutrient requirements in grazing sheep. *Small Rumin. Res.* 92, 36–40. <https://doi.org/10.1016/j.smallrumres.2010.04.004>
- Lobato, J.F.P., Pearce, G.R., 1980. Responses to molasses-urea blocks of grazing sheep and sheep in yards. *Aust. J. Exp. Agric. Husb.*, 20: 417-421
- Makkar, H.P.S., Sánchez, M., Speedy, A.W. (Ed.), 2007. Feed supplementation blocks: urea-molasses multinutrient blocks ; simple and effective feed supplement technology for ruminant agriculture, FAO animal production and health paper. Food and Agriculture Organization of the United Nations, Rome.
- Martínez-Martínez, R., López-Ortiz, S., Ortega-Cerrilla, M.E., Soriano-Robles, R., Herrera-Haro, J.G., López-Collado, J., Ortega-Jiménez, E., 2012. Preference, consumption and weight gain of sheep supplemented with multinutritional blocks made with fodder tree leaves. *Livest. Sci.* 149, 185–189. <https://doi.org/10.1016/j.livsci.2012.06.032>
- Nadeau, E., Arnesson, A., Helander, C. 2015. Effects on grass silage feed value on feed intake and performance of pregnant lactating ewes and their lambs. *Grass and Forage Science.* 71, 448-457.
- Povey G., Stubbings L., Phillips, K., 2016. Feeding the ewe. AHDB Beef and Lamb
- Russel, A., 1984. Farm Practice Body condition scoring of sheep.
- Salem, H.B., Nefzaoui, A., Salem, L.B., Tisserand, J.L., 2000. Deactivation of condensed tannins in *Acacia cyanophylla* Lindl. foliage by polyethylene glycol in feed blocks Effect on feed intake, diet digestibility, nitrogen balance, microbial synthesis and growth by sheep. *Livest. Prod. Sci.* 10.



- Salem, H.B., Nefzaoui, A., 2003. Feed blocks as alternative supplements for sheep and goats. *Small Rumin. Res.* 49, 275–288. [https://doi.org/10.1016/S0921-4488\(03\)00144-5](https://doi.org/10.1016/S0921-4488(03)00144-5)
- Salem, H.B., Makkar, H.P.S., Nefzaoui, A., 2004. Towards better utilisation of non-conventional feed sources by sheep and goats in some African and Asian countries 12.
- Salem, H.B., Smith, T. 2008. Feeding strategies to increase small ruminant production in dry environments. *Small Rumin. Res.* 77, 174-194.
- Salem, H.B., Znaidi, I.-A., 2008. Partial replacement of concentrate with tomato pulp and olive cake-based feed blocks as supplements for lambs fed wheat straw. *Anim. Feed Sci. Technol.* 147, 206–222. <https://doi.org/10.1016/j.anifeedsci.2007.09.019>
- Salman, A.D., 1996. The Role of Multinutrient Blocks for Sheep Production in an Integrated Cereal-livestock Farming System in Iraq 11.
- Tan, L.X., Gong, X.H., Tan, R.F., Ni, Y.L., Wang, J.C., Guo, Z.M., Vanselow, B.A., 1996. The efficacy of an albendazole-medicated block in controlling sheep nematodes in Xinjiang Province, north-west China. *Vet. Res. Commun.* 20, 427–435. <https://doi.org/10.1007/BF00419180>

### **Books**

- Bryman, A., & Bell, E., 2015. *Business Research Methods*, 4th ed. Oxford Univ. Press.
- Freer, M., Dove, H., 2002. *Sheep Nutrition*. CABI.
- National Research Council Staff, 1984. *Nutrient Requirements of Sheep: Sixth Revised Edition*, 1985. National Academies Press, Washington, UNITED STATES.
- Sjödin, E., 2007. *Får*. Stockholm, Natur & Kultur.
- Spörndly, R., 2003. *Fodertabeller för idisslare*. Uppsala: SLU

### **Internet**

- Country Smallholding, 2006. *Fit for the mating season*. Available: <https://www.countrysmallholding.com/livestock/fit-for-the-mating-season-1-f3493369> [2018-12-13]
- FAO. *The use of concentrate feeds in livestock production systems*. Available: <http://www.fao.org/wairdocs/lead/x6123e/x6123e04.htm#TopOfPage> [2019-01-25]
- Hunden och Herden, 2018. Available: <https://www.hundenochherden.se/product/foderblock-sheep-energy> [2018-11-10]
- Hyby Cig Cymru, 2018. *Feeding the ewe*. Available: [https://hccmpw.org.uk/images/resources/Feeding\\_the\\_Ewe.pdf](https://hccmpw.org.uk/images/resources/Feeding_the_Ewe.pdf) [2018-12-12]
- Jordbruksverket, 2018. *Obligatoriska märkningsuppgifter för foder*. Available: <http://www.jordbruksverket.se/amnesomraden/djur/foder/markningavfoder/obligatoriskamarkning-suppgifter.4.32b12c7f12940112a7c800019883.html> [2018-11-22]
- Länsstyrelsen, 2018. *Bidragkalkyler - konventionell produktion 2018*. Available: <https://www.lansstyrelsen.se/vastra-gotaland/lantbruk-och-landsbygd/utveckling-av-landsbygder/kompetensutveckling-och-radgivning/ekologisk-produktion.html> [2018-11-08]
- National Sheep Association, 2018. *Know your sheep*. Available: <https://www.nationalsheep.org.uk/know-your-sheep/sheep-facts/> [2018-12-13]
- Tre Lammproducenter AB, 2018. Available: <https://trelammproducenter.se/foder-tillskott/foder-mineral-hinkar/sweetcorn-foderblock/> [2018-11-10]

### **Personal message**

- Dallas Keith, 2018. E-mail conversation.

## Appendix

### Appendix 1 - Interview guide with the advisors in Swedish and English

1. Berätta lite allmänt om dig själv och din erfarenhet av foderblock./ *Tell me a little bit about yourself and your experience on using feed blocks.*
2. Vilka frågor får du oftast av färgare när det gäller foderblock?/ *Which questions do you usually receive from sheep owners when it comes to the feed blocks?*
3. Vilka brukar ringa och fråga om foderblock? Vilka är mest intresserade?/ *Who usually calls to ask about the feed blocks? Who is the most interested?*
4. Vad tror du huvudanledningarna är till att färgare väljer att börja använda foderblock?/ *In your opinion, which are the main reasons why sheep owners start using feed blocks?*
5. Hur ser marknaden ut för foderblock?/ *What does the market look like?*
6. Vad ser du för fördelar?/ *Which are in your opinion the advantages?*
7. Vad ser du för nackdelar?/ *Which are in your opinion the disadvantages?*
8. Hur tycker du foderblock bör användas?/ *How, in your opinion, should the feed blocks be used?*
9. Vilka kategorier tror du gynnas mest/minst av att utfodras med foderblock? (tackor/lamm, dräktig/laktation etc.)/ *Which categories benefit the most/least to be fed with feed blocks?(ewes/lambs, pregnancy/lactation etc.)*
10. I vilka perioder eller sammanhang kan foderblock vara mest lönsamt att ge?/ *Which periods may feed blocks be most beneficial to provide?*
11. När det kommer till den ekonomiska aspekten, hur lönsamt är det att ge foderblock jämfört med annan utfodring?/ *When it comes to the financial*

*aspect, how profitable is it to feed with feed blocks compared to other types of feeding?*

12. *Rekommendationerna för dagligt intag av foderblock är satta rätt lågt till skillnad från andra kraftfodertyper. Vad beror det på?/ The recommendations for daily intake are set relatively low compared to other concentrates. What is the reason for that?*
13. *Vilken aspekt av foderblock tycker du det behövs mer kunskap om?/ Which aspect on feed blocks do you think requires more knowledge?*
14. *Har du något mer du vill tillägga?/ Do you have anything else to add?*

## **Appendix 2 – Interview guide with the farmers in Swedish and English**

### *Allmänt/ General information*

- *Gård/ Farm*
- *Adress/ Address*
- *Brukare/ Farmer*
- *Allmänt om gården (areal åker, beten etc.)/ General information about the farm (land, pasture, etc.)*
- *Ras/ Breed*
- *Antal tackor/ Number of ewes*
- *Lamm födda/tacka i snitt/ On average how many lambs are born per ewe*
- *Hobby/typ av produktion/ Hobby/type of production*
- *Hur länge de haft får/ How long they have had sheep*

### *Inledande frågor/ Introductory questions*

1. *Hur hörde du talas om foderblock första gången?/ How did you initially hear about feed blocks?*
2. *Varför valde du att börja använda dig av foderblock?/ Why did you decide to start using feed blocks?*
3. *Hur länge har du använt foderblock till din besättning?/ How long have you used feed blocks for your herd?*
4. *Hade du några funderingar inför att börja använda foderblock?/ Did you have any concerns about using feed blocks?*  
*JA/NEJ/VET INTE / YES/NO/NOT SURE*  
*Om ja, vilka? / If yes, which ones?*
5. *Tyckte du att det svårt att hitta information om foderblocken innan du började använda de? /Did you find it difficult to acquire information on the feed blocks before you started using them?*

6. Med den information du tog del av, hur uppfattade du att foderblocken ska användas? (komplement till foderstat, ersättning för kraftfoder etc.) / *With the information you acquired, what was your perception of how the feed blocks should be used? (complement, replacer etc.)*
7. Hur introducerade du foderblocken till din flock? Fanns det utmaningar? / *How did you introduce the feed blocks to your herd? Where there any challenges?*
8. Hur går du tillväga inför byte av foderblocken? (väntar du tills de är helt slut eller byter du innan/efter att de tagit slut? etc.) / *What is your strategy when it comes to changing the blocks? (Do you wait until they are empty or do you change before/after they are finished?)*
9. Var har du foderblocken? / *Where do you keep your feed blocks?*  
 INNE/UTE / *INSIDE/OUTSIDE*  
 Om inne, finns det någon positiv/negativ påverkan på foderblocken? / *If they are inside, are there any positive/negative effects on the feed blocks?*  
 Om ute, finns det någon positiv/negativ påverkan på foderblocken? (väder exempelvis regn?) / *If they are outside, are there any positive/negative effects on the feed blocks? (Weather, for example rain)*

#### Grupper/ Groups

10. Till vilka grupper använder du foderblock? / *For which categories do you use the feed blocks?*  
 TACKOR/BAGGAR/SLAKTLAMM / *EWES/RAMS/LAMBS*
11. Vilka perioder under året utfodrar du med foderblock? / *Which periodes do you provide the feed blocks?*  
 HELA ÅRET/VISSA PERIODER / *ALL YEAR ROUND/CERTAIN PERIODS*  
 Om vissa perioder, vilka? / *If certain periods, which ones?*
12. a) Hur många foderblock köpte du in förra året? / *How many feed blocks did you purchase last year?*  
 b) Hur stora är grupperna som du ger foderblocken till? / *How large are the groups which are provided with the blocks?*  
 c) Vilka kategorier är grupperna indelade efter? (storlek, ålder, hull, kön etc.) / *Which categories are the groups divided after? (Size, age, body condition score, sex, etc.)*  
 d) Hur länge räknar du att ett foderblock räcker per grupp? / *How long do you estimate that one block lasts per group?*  
 e) Tycker du att rekommendationerna som ges på hemsidorna stämmer överens med hur snabbt foderblocken går åt hos dig? / *In your opinion, do the feeding recommendations on the websites consort with how long they last for your herd?*
13. a) Varifrån köper du dina foderblock? / *Where do you purchase your feed blocks?*

HUNDEN & HERDEN/TRE LAMMPRODUCENTER/ANNAN SÄLJARE /  
HUNDEN & HERDEN/TRE LAMMPRODUCENTER/ ANOTHER SELLER

*Om annan säljare, vilken?/ If another seller, which?*

b) Varför valde du just denna säljare? (pris, innehåll, etc.)/ *Why did you chose this seller? (Price, content, etc.)*

14. a) Vilken typ av foderblock använder du dig av? (för respektive grupp)/ *Which type of feed block do you use? (for each group)*

b) Har du alltid använt denna typ av foderblock? Varför/ Varför inte. Utveckla./ *Have you always used this type of feed block? Why/why not. Elaborate.*

15. a) Har du märkt skillnader på resultat mellan de olika grupperna? (om foderblocken används till olika grupper) /*Have you noticed differences in results between the different groups? (if they are used for different groups?)*

b) Vilken grupp tycker du är mest respektive minst lämpad att få foderblock och varför? (tackor, baggar, lamm)/ *Which group, in your opinion, is the most as well as the least suited to be fed the blocks and why? (Ewes, rams, lambs)*

c) Vilken kategori du tycker är mest respektive minst lämpad för att använda foderblock och varför?(magra/feta/yngre/äldre etc.)/ *Which category, in your opinion, is the most as well as the least suited to be fed the blocks and why? (Thin/fat/younger/older etc.)*

#### Utfodring/ Feeding

16. Ger du enbart foderblock som kraftfoder? Varför/varför inte? Vad ger du annars för kraftfoder? Utveckla./ *Are feed blocks the only source of concentrate feed that you provide? Why/why not? What other type of concentrate do you provide? Elaborate.*

17. Hur ser foderstaten i övrigt ut för dina får? (hur utfodras de, hur ofta utfodras de, ges extra mineraler, vad får de för grovfoder - om du har analys på grovfodret – kvalitet.)/ *How is the feed ration designed for your sheep? (How are they fed, how often, extra minerals, roughage – analysis – quality)*

18. Hur utfodrade du med kraftfoder innan du började använda foderblock? (Om det var så att du utfodrade med kraftfoder då)/ *How did you feed with concentrate before you started using feed blocks? (If you in fact did provide concentrate)*

19. a) Vad ger du dina får för mineralfoder? /*What type of mineral feed do you provide?*

b) Upplever du att fåren slickar mindre på mineralbaljorna/mineralfodret sen du börjat med foderblock?/ *Do you think that the sheep consume less of these minerals since you started using feed blocks?*

JA/NEJ/VET INTE / YES/NO/NOT SURE

20. Tycker du innehållsförteckningen är tydlig och lätt att förstå?/ *Do you find the table of content clear and easy to understand?*

21. Har du räknat på foderstat med foderblock?/ *Have you calculated a feed ration with feed blocks?*

För-och nackdelar/ *Pros and cons*

22. Vilka är, enligt dig, fördelar med att använda foderblock?/ *Which are in your opinion, the advantages of using feed blocks?*

23. Vilka är, enligt dig, nackdelar med att använda foderblock? (om det finns några) / *Which are in your opinion, the disadvantages of using feed blocks? (If there are any)*

Skillnader/ *Differences*

24. Tycker du att det blir ett mer jämnfördelat foderintag hos alla individer i gruppen?/ *Do you believe that there is a more even feed intake for all individuals now?*

JA/NEJ/VET INTE / *YES/NO/NOT SURE*

25. Upplever du några skillnader för din egen skull sen du börjat använda foderblocken? (arbetskraft, tid etc.)/ *Are there any differences for yourself since you started using the blocks? (Labour, time, etc.)*

JA/NEJ/VET INTE / *YES/NO/NOT SURE*

*Om ja, hur? / If yes, how?*

26. Om foderblocken ges till lamm:/ *If the feed blocks are given to lambs:*  
När det kommer till slaktdata, har foderblock ändrat utfallet? (slaktad vikt, fett och konformation)/ *When it comes to slaughter statistics, have the feed blocks changed the outcome? (Slaughter weight, fat and conformation)*

JA/NEJ/VET INTE / *YES/NO/NOT SURE*

*Om ja, hur? / If yes, how?*

27. Om foderblocken ges till tackor:/ *If the feed blocks are given to ewes:*  
a) Upplever du att reproduktionen har förändrats? (fellägen, kalkbrister, fler lamm, etc.)/ *Do you think there has been a change in reproduction? (Problems at birth, hypocalcaemia, more lambs etc.)*

JA/NEJ/VET INTE / *YES/NO/NOT SURE*

*Om ja, hur? / If yes, how?*

b) Har du märkt någon skillnad på mjölkavkastningen?/ *Have you noticed any difference in milk yield?*

JA/NEJ/VET INTE / *YES/NO/NOT SURE*

*Om ja, hur? / If yes, how?*

28. Har det skett någon ekonomisk förändring sen du började använda foderblock? (foderkostnad, bättre betalt vid slakt, etc.)/ *Has there been a financial change*

since you started using the feed blocks? (feed costs, better payment at the slaughter house etc.)

JA/NEJ/VET INTE / YES/NO/NOT SURE

Om ja, vilken?/ If yes, which ones?

29. Har du upplevt några skillnader i fårens beteende när det kommer till stress och rangordning?/ Have you noticed any differences in the behaviour of the sheep when it comes to stress and ranking?

JA/NEJ/VET INTE / YES/NO/NOT SURE

Om ja, hur?/ If yes, how?

30. Har du märkt några skillnader på fårens allmänna hälsa? (ex. hullbedömning)/ Have you noticed any differences on the general health of the sheep? (For example BCS)

JA/NEJ/VET INTE / YES/NO/NOT SURE

Om ja, hur?/ If yes, how?

31. Tror du att foderblocken kan påverka fårens tänder?/ Do you think the feed blocks can affect the teeth of the sheep?

#### Avslutande frågor/ Finishing questions

32. Vilken aspekt av foderblock önskar du mer fakta/information om för framtiden?/ On which aspect of feed blocks do you wish for more information in the future?

33. Finns det något som skulle få dig att sluta använda foderblock?/ Is there any reasons that would make you stop using feed blocks?

JA/NEJ/VET INTE / YES/NO/NOT SURE

Om ja, vad?/ If yes, which ones?

34. Tror du att flera kommer börja använda sig av foderblock i framtiden i Sverige?/ Do you think more farmers in Sweden will start using feed blocks in the future?

JA/NEJ/VET INTE / YES/NO/NOT SURE

35. Finns det något mer du vill tillägga eller berätta om?/ Is there anything else you would like to add?

### Appendix 3 – Amount of feed for the feed rations

Table 6. Amount of hay, concentrate and feed block used in the feed rations in kg DM.

|  | Hay | Concentrate | Feed block |
|--|-----|-------------|------------|
| Early pregnancy                          | 1.6 | -           | -          |
| 2 w before lambing, > 2 lambs on average | 1.3 | 0.8         | -          |

|  | Hay | Concentrate | Feed block |
|--|-----|-------------|------------|
| Lactation, 2 lambs                       | 1.6 | 1           | -          |
| Early pregnancy                          | 1.2 | -           | 0.1        |
| 2 w before lambing, > 2 lambs on average | 1.6 | -           | 0.1        |
| Lactation, 2 lambs                       | 1.6 | -           | 0.1        |

Table 7. Amount of silage, concentrate and feed block used in the feed rations in kg DM.

|  | Silage | Concentrate | Feed block |
|--|--------|-------------|------------|
| Early pregnancy                          | 1.8    | -           | -          |
| 2 w before lambing, > 2 lambs on average | 1.7    | 0.2         | -          |
| Lactation, 2 lambs                       | 1.6    | 0.7         | -          |
| Early pregnancy                          | 1.7    | -           | 0.1        |
| 2 w before lambing, > 2 lambs on average | 1.8    | -           | 0.1        |
| Lactation, 2 lambs                       | 1.8    | -           | 0.1        |