Wool loss in sheep

Ulltapp hos får

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Swedish University of Agricultural Sciences	Master's thesis
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Abstract

The idea behind this project came from a feed study executed two years during the lambing season. Both years wool loss was experienced. Low temperature in combination with shearing was believed to cause the wool loss the first year, while protein deficiency was believed to be the cause the second year. In the literature many causes of wool loss are described; mechanical wear, telogen effluvium, bacterial dermatitis, external parasites, wool break, scrapie, genetic causes and nutritional deficiencies are some examples. The aim of this thesis was to study causes for wool loss and how common wool loss is in Swedish sheep herds. A questionnaire was sent to 294 sheep owners in Sweden and complemented with an electronic questionnaire online, open for interested sheep owners. Five sheep owners answered further questions and five veterinarians have replied to questions about frequency of contacts regarding wool loss. The paper questionnaire (PQ) received 114 answers while the electronic questionnaire (EQ) received 56 answers. Of these, 42 % of the PQ group had experienced wool loss while the corresponding number in the EQ group was 89 %. The EQ group had larger herds, more crossbreeds and lambing during the winter months was more common. These farms experienced more wool loss during pregnancies and the wool loss was more commonly following a cold period. The primary causes for wool loss in the herds in this study are believed to be nutritional deficiencies and telogen effluvium. Telogen effluvium can develop after longer periods with high cortisol levels, which could be caused by cold stress due to shearing at low temperatures. To avoid wool loss it is important to have a well balanced feeding regime and to avoid causes for stress. Further research on other causes that potentially could cause telogen effluvium is advocated.

Sammanfattning

Idén till detta arbete kom efter en utfodringsstudie som utfördes under två lamningssäsonger. Båda åren uppstod ulltapp trots att utfodringen väl tillgodosåg behovet hos tackorna det första året. Det antogs därför att kyla i samband med klippning orsakade ulltappet år ett medan proteinbrist var en trolig orsak år två. Litteraturen anger många olika orsaker till ulltapp, såsom mekanisk nötning, telogen effluvium, bakteriell dermatit, utvärtes parasiter, ullbrott (när ullfibern bryts av), scrapie, genetiska orsaker samt näringsbrist. För att undersöka utbredning och orsaker till ulltapp i svenska fårbesättningar skickades ett frågeformulär till 294 fårägare i Sverige och ett elektroniskt formulär, öppet för alla, kunde fyllas i via Fåravelsförbundets hemsida. Fem fårägare har svarat på mera utförliga frågor och fem fårhälsoveterinärer har svarat på frågor rörande förfrågningar angående ulltapp. Sammanlagt svarade 114 fårägare på frågeformuläret brevledes (BF) och 56 elektroniskt (EF). Av dessa svarade 42 % i BF-gruppen att de upplevt ulltapp medan andelen var 89 % i EF-gruppen. De senare hade större besättningar, mera korsningsfår, hade en högre andel lamningar under vintermånaderna, upplevde mera ulltapp under dräktigheten och ulltappet följde oftare efter en köldperiod. De främsta orsakerna till ulltapp hos de som har besvarat enkäterna tros vara näringsbrist eller telogen effluvium. Telogen effluvium orskas av förhöjda kortisolhalter under en längre tid, vilket kan orsakas av bland annat köldstress efter klippning vid låga temperaturer. För att undvika ulltapp är det viktigt med en balanserad foderstat samt att minimera orsaker till stress. Vidare forskning på bidragande orsaker till telogen effluvium är önskvärt.

Contents

1

Introduction

Alopecia, or hair loss, affects up to 50 % of the human population at some stage during their life [Price 1999]. In humans this is usually of cosmetic and psychological concern. It also is a phenomenon found in many animal species. Sheep is one of few domestic animals bred for the wool and this could potentially be an important question for both the sheep-owner and the wool production. If wool loss is as frequent in the sheep population as hair loss is in the human population the phenomenon should be brought into light. Is there any research done regarding alopecia in sheep? What are the causes and can they be prevented? Is this an animal welfare problem or is it mainly a cosmetic issue, and is it of economical importance?

The original idea of this project came from a feed study with sheep. Ewes were divided into two groups where one group was fed only silage while the other group received both silage and concentrate. The project started in January and lasted over the lambing seasons for two years, with lambing from the end of February to the beginning of April. Both years the study was finished in May. Wool loss was experienced both years and mainly seen on ewes with more than one lamb (figure 1.1 and 1.2). Both years most ewes with wool loss were found in the group fed only silage. Wool loss was seen mainly after lambing, but also during pregnancy the first year of the study. Parameters recorded in the study included weight and body condition, feed intake, beta-hydroxybutyrate and non-esterified fatty acids in blood. According to these data, a lack of protein in the diet was not likely the first year, but could be a possible cause the second year. The cause of the wool loss the first year was believed to be cold stress, since the temperature dropped the weeks after shearing the wool [Bernes et al. 2010].

Figure 1.1: One of the sheep suffering from wool loss during a feed study. This picture is taken year one, before lambing [Bernes et al. 2010].

Figure 1.2: One of the sheep suffering from wool loss during the feed study, year two. This was the thinnest sheep in the study [Bernes et al. 2010].

In our domesticated, sheared sheep, wool loss is mostly seen as a negative sign. The general health of the animal is reflected by the status and quality of its fibre. Stress in the form of malnutrition, reproduction, or disease will cause a thinning of the fibres and even reduction of wool growth that could lead to wool loss. Apart from it being a cosmetic concern, a disease affecting the fleece will reduce the value of the wool and could also increase the maintenance cost of the sheep in terms of heat loss that needs to be compensated by increased feeding in colder climates.

According to the International Wool Textile Organisation the greatest wool producer today is Australia with 244,958 tonnes of clean raw wool produced in 2011. Fleece, wool, and skin wool from abattoirs are included in the numbers. China comes in at second place with 165,090 tonnes followed by New Zeeland with 130,870 tonnes. In Europe the biggest producer is the UK with 22,016 tonnes. In total, the worldwide production was 1,102,064 tonnes in 2011 [IWTO 2012]. Large outbreaks of wool loss and damaged fleece could lead to economical losses for the individual farmer. Even though Sweden is a small country on the wool market, the wool and especially the sheepskin, can be of a large economic value and practical interest for the farmer. Another aspect is the animal welfare which could include stress, disease, lack of nutrients and exposure to hazards.

The aim of this study was to study how common wool loss is in sheep herds in Sweden. Also, background information about the sheep herds was collected to give an idea about possible causes of wool loss. A further aim was to evaluate whether wool loss is a problem in Swedish sheep herds or not, and if it is considered a problem by the farmers.

2

Materials and methods

An introductory literature review was made to get an overview of causes for wool loss in sheep worldwide.

A questionnaire was sent out to 294 sheep farmers in Sweden in the spring 2011. The addresses were received from the Swedish Board of Agriculture and were sorted according to county. A letter was sent to the last farmer on each page of the list. During March and the beginning of April a questionnaire was also posted on the homepage of the Swedish sheep breeders organisation, Svenska fåravelsförbundet http://www.faravelsforbundet.se, where interested farmers could answer the same questions. Farmers who were willing to answer further questions were asked to take personal contact. These interview answers were collected by e-mail and phone.

The answers from the paper questionnaire (PQ) were put together separately from the answers from the electronic questionnaire (EQ). The final results from the two questionnaires were compared. More than one answer has been possible for several questions. The questions and options for answering are found in appendix A.

The questions for the interview were sent out at two occasions, first the same questions as the rest of the participants answered (appendix A) and later the follow up questions (appendix B). The results from the first questions are included in the EQ, except from two farms where answers were received solely by phone.

Eight veterinarians from Swedish Animal Health Service were asked, by e-mail, the questions found in appendix C.

3

Literature review

3.1 The wool fibre and natural shedding

The wool fibre grows from hair follicles that are formed during three different stages of the development of the foetus. The central primary follicles are the first follicles to develop and spread in the skin of the foetus at 70 days. At day 85 the lateral primary follicles develop on the sides of the central primary follicles, in groups of three, together with the secondary follicles. At day 105, the secondary-derived follicles develop in-between the earlier formed follicles, branching out from the secondary follicles [Mecklenburg et al. 2009].

One month after birth all follicles are usually producing wool fibres. The primary follicles are usually larger than the secondary follicles, especially in long-wool breeds, and the hairs have a greater diameter and grow faster and longer. They form the guard hair. The secondary follicles form thinner fibres that grow slower and make up the underfur or fleece of the wool. In sheep, the normal number of hairs per cm^2 is 5000-7000 [Meyer 2009]. The number of secondary-derived follicles varies between different breeds of sheep, from two secondary follicles to every primary follicle to a tenfold of secondary-derived follicles to every primary follicle [Rogers 2006]. In extreme wool-producing breeds, such as the merino, the secondary follicles may branch and form up to 60 secondary fibres per primary fibre. As the amount of secondary follicles increase, they spread out from the primary follicles and form a more homogenous hair coat where the fleece wool is the dominating feature [Meyer 2009].

During the lifetime of a sheep the wool follicles goes through several

cycles, each leading to shedding of the wool. Several reasons for this cyclicity has been suggested; to enable the animal to grow, to control the length of hairs, to clean the body by shedding old hairs, to suit different weather conditions and to protect against diseases that could arise in the follicles. The cyclicity differs between breeds of sheep and even on different parts of an animal, but all hairs will go through the same phases, even though the length of the phases may vary. Exactly how a cycle is initiated is still not fully understood [Stenn & Paus 2001].

Anagen is the first phase of the cycle of a hair follicle. This is the phase when the hair grows (see picture 3.1). The length of the anagen phase will therefore determine the length of the hair. During anagen the cells of the hair follicle proliferate and differentiate so that the right type of shaft is produced at the right place of the body. It has been shown that trauma can initiate the anagen phase, but it is believed that the stimulus has to reach a threshold value to initiate growth [Stenn & Paus 2001]. In a study on mice performed by Chase and Eaton (1959) at least 1000 hairs had to be picked away to initiate hair growth in that area [cited in Stenn & Paus 2001 p. 457]. Anagen is prevented by glucocorticoids [Ogoshi et al. 1998], but will resume when the glucocorticoids are no longer present.

Catagen, the regressing phase, begins when the follicle growth is completed. Pigmentation and cell growth cease, the papilla is released from the bulb (the base of the hair follicle) and the follicle partly shrinks due to apoptosis, a programmed cell death [Stenn & Paus 2001]. The signal inducing catagen is unknown but stress can trigger the catagen phase, along with trauma and different chemicals [Paus et al. 1994 and Johnson 1965, cited in Stenn & Paus 2001 p. 468].

Telogen is the resting phase where the hair or wool is no longer growing but stays in place. The last phase is exogen where the hair or wool is shed. Normally, new wool will have grown out before the old is shed and several shafts can be present in the follicle at the same time. The anagen and the exogen phases does not have to be related events [Stenn & Paus 2001].

The domesticated sheep has been bred towards a fine wool-coat with more fleece wool than in wild sheep. Compared to the muflon, the domesticated sheep often have a white fleece-wool coat whereas the muflon has guard hairs covering their brown fleece. Another important difference is the continuous growth of the wool in most domesticated sheep while the muflon sheds the wool [Van Vuren & Bakker 2009]. Shedding has been defined as "the absolute loss of fleece, as observed macroscopically, over the whole or a significant part

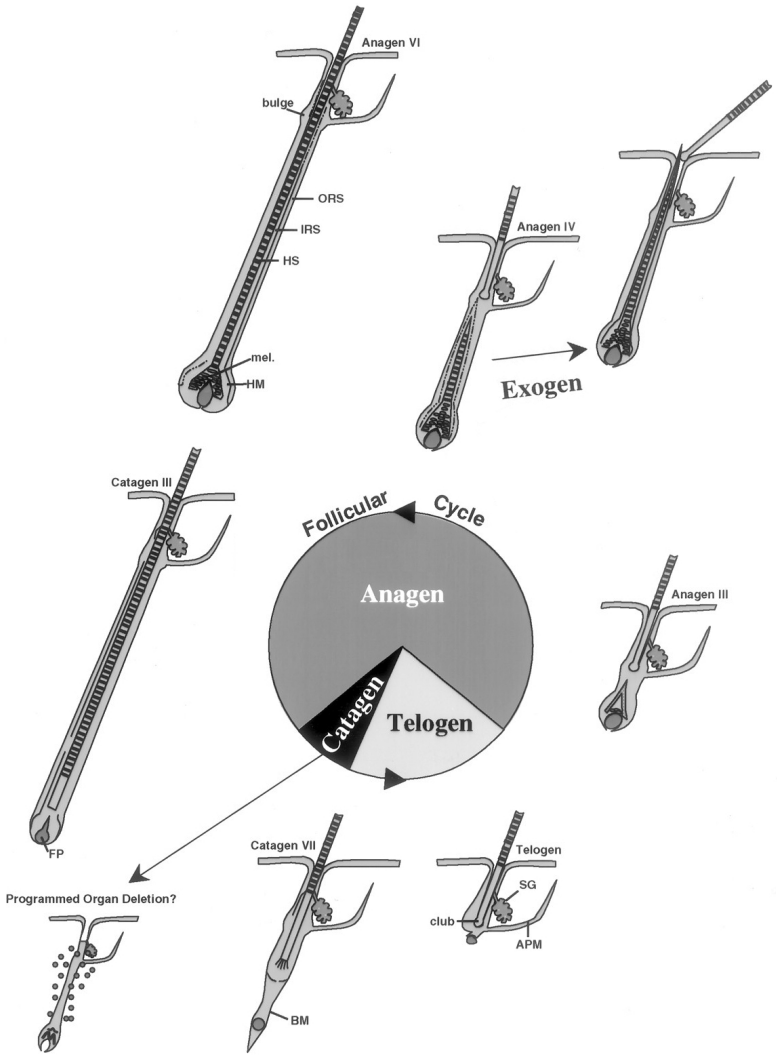

Figure 3.1: The different phases of the cycle of the wool follicle; anagen, catagen, telogen and exogen. In anagen the hair grows and fills the whole hair follicle. In catagen the hair is detached from the bottom of the hair follicle, but the hair is still remaining in place. During telogen the hair is resting and in exogen the hair is expelled by the new hair growing up from underneath. DP, follicular papilla; SG, sebaceous gland; AMP, arrector pili muscle; HS, hair shaft; mel, melanin; BM, basement membrane; POD, programmed organ deletion; HF, hair follice; ORS, outer root shaft; IRS, internal root sheath [Stenn & Paus 2001 pp. 452-453].

of the body area" [Slee 1959]. There are however domesticated breeds that show annual shedding of the wool and thus have a circannual rhythm of the wool follicle cycle [Stenn & Paus 2001]. Temperature, nutrition, and genetic factors have been suggested to influence this rhythm, but the main factor is believed to be the annual change in daylight [Slee & Carter 1962]. The long hair follicle cycles found in domesticated sheep (without annual shedding), also found for example in humans and horse manes, are not triggered by the same factors as shedding, and the influence of this is not yet fully known [Stenn & Paus 2001]. Shedding of individual fibres should be differentiated from annual shedding because shedding of individual fibres "may or may not be sufficiently co-ordinated and extensive as to cause the loss of parts of the fleece" [Slee 1959].

Shedding the wool is beneficial from several aspects; it decreases the body temperature, which in ewes can increase fertility [Clarke & Tilbrook 1992], it reduces the risk of contamination of the wool by faeces and insect infestations [Levot 1995] and makes mating more accessible [Rudge 1986]. Pollott (2011) tried in a study to find out the genetics of the annual shedding of the wool by crossing rams from naturally shedding breeds (Easycare, Wiltshire Horn, Katahdin and Dorper) with non-shedding ewes (Friesland, Lleyn, Suffolk and Texel). Mendelian ratios were tested as well as autosomal and sex-linked recessive and autosomal and sex-linked dominant inheritance modes. The mode of inheritance was found to be autosomal dominant and the heritability of shedding scores (a measure of the difference in shedding in the population that is due to genetic differences) 0.54 in lambs and 0.26 in animals of all ages.

In one study, feral sheep were found to shed the wool on their head, belly or tail in 96.4% of the cases and ewes seemed to be more likely to lose wool than rams were. When comparing with old photos of feral herds, no wool loss was seen in 1930s or before. The authors estimate that shedding arose about 60 years after shearing of the sheep in that population had ceased [Van Vuren & Bakker 2009]. This is supported by findings on other islands with feral sheep where shedding has increased largely from nonexistent to common in 40-70 years [Rudge 1986]. The higher frequency of wool loss in ewes could be explained with the stress of gestation and lactation, but the patterns of wool loss could also indicate thermoregulation and be beneficial to the health [Rudge 1986]. The increased shedding and increased fertility of shedding feral sheep indicate a health benefit for the sheep, according to Rudge [1986). It also indicates a genetic basis, even though other reasons

are likely to be causing the sex difference [Van Vuren & Bakker 2009].

3.2 Differential diagnosis

Alopecia is described as "absence of hair from areas where it normally grows" in the Oxford concise colour Medical Dictionary [Martin 2007]. The first step in diagnosing hair loss is to determine whether the hairs are getting thinner, and therefore easily break, or if the hairs fall off due to shedding. Hair loss is often divided into localized or general hair loss. Generalized alopecia includes telogen effluvium, hair loss caused by drugs, stress and severe illness. Localized alopecia can be caused by alopecia areata, infections and injuries [Jackson 2000]. Alopecia areata has been reported for many different animals and humans, but sheep are not among them [Mecklenburg et al. 2009].

3.3 Mechanical causes

Before suspecting a disease, mechanical causes for wool loss should always be considered. Lambs playing and sleeping on the backs of ewes may cause wear of the wool in those areas. The interior of the stable, especially the construction of the feeding areas, could cause a wear of the wool mainly around the neck.

3.4 Ovine telogen effluvium - wool slip

Ovine telogen effluvium, commonly called wool slip, is identified by the moth-eaten look of the patches and the surrounding wool. The scientific name refers to the "loss of telogen hair in disease states of the follicle" [Harrison & Sinclair 2002]. In telogen effluvium, the normal cyclicity of the wool is disturbed [Harrison & Sinclair 2002]. Skin biopsies taken from sheep with telogen effluvium showed that the wool follicles were in the anagen phase, compared to the telogen phase in unaffected animals [Morgan et al. 1986]. These findings support that the cyclicity has been disrupted and the wool has been shed prematurely and that the wool follicles already are in the anagen phase again.
In a study of 420 crossbreed ewes (North Country x Welsh mules, Welsh half-breeds x Suffolk or Texel cross) housed and sheared in December, 42.4%

of the flock was affected by telogen effluvium [Morgan et al. 1986]. There was no difference between breeds and only 9% of the flock had reoccurring telogen effluvium. The whole herd had a similar body score, independent of if the sheep suffered from telogen effluvium or not, and the number of offspring did not seem to affect the prevalence. Other nutritional factors studied were blood plasma levels of copper and zinc, which were in the normal range in both groups although the copper-levels were noticeably lower in the unaffected group. The authors therefore ruled out nutritional factors and unsynchronised growth cycles of the wool as causes of the telogen effluvium. Ovine telogen effluvium is mainly seen during housing in the winter, especially in connection to shearing, but it has also been reported in the summer. The patches of alopecia commonly appear 3-4 weeks after shearing and are usually found on the back and neck. The cause is believed to be elevated levels of corticosteroids due to the stress of housing and shearing [Morgan et al. 1986].

Cortisol and glucocorticoid analogues have been shown to decrease wool growth. In a study by Chapman and Bassett (1970) plasma cortisol levels above 3 μg/100 ml caused inactivation of the wool follicle and fibre-growth ceased. The study included ewes in three different feeding regimes and the group with the most restricted diet reacted with decreased wool growth at the lowest plasma cortisol levels. Panaretto et al. (1975) found similar results in their study where three different glucocorticoid analogues were found to make the wool more fragile and prone to break at different degrees from complete wool loss to reduced wool growth without signs of wool loss. Some sheep in this study did not show any reaction at all. Combined with the results of Fulkerson and Jamieson (1982) showing that shearing is a considerable cause for stress compared to other handling, Morgan et al. (1986) concluded that wool slip caused by elevated cortisol levels was a probable diagnosis for the wool loss in the study mentioned above. Because wool slip is not common after summer shearing and a long period of cortisol administration is needed to create wool loss [Panaretto et al. 1975], the authors further suggested that there also must be other causes involved in wool slip. Cold stress was suggested as a cause since hypothermia has been shown to increase the cortisol levels sufficiently to induce wool loss. There are cases where shearing in combination with cold-stress has caused the sheep to lose all its wool [Hammarberg & SvDHV 2008]. In the study of Morgan et al. (1986), however, no great difference in temperature was found between win-

ter and summer shearing.

In a study by Dabiri et al. (1995) eight pairs of 2-year-old ewes were used to study the resistance to cold stress. One of the ewes in each pair was sheared with a standard comb and one with a cover comb, leaving more of the fleece behind than the standard comb. The pair was then subjected to different weather conditions such as 'cold plus wind' and 'cold plus wind plus rain'. Instantly after shearing the heat production of the ewes shorn by the standard comb was 22% higher than the heat production of the ewes shorn by the cover comb in 'cold plus wind' and 38% higher in 'cold plus wind plus rain'. During the 10 day experiment the ewes shorn with the standard comb lost 1.4 kg more in weight compared to the sheep shared with the cover comb. The authors concluded that the use of a cover comb will significantly lower the risk of death of hypothermia.

French et al. (1990) reported of a herd of Wiltshire horn ewes suffering from telogen effluvium during the summer months. Histological findings supported the diagnosis. The ewes were reported to mostly be in a good condition and no immediate cause of stress was found as the triggering cause. It was therefore believed that the telogen effluvium was caused by the lambing and lactation period. In humans this could be referred to as telogen gravidarum, a form of acute telogen effluvium that occurs 2-3 months after childbirth [Harrison & Sinclair 2002]. Acute telogen effluvium usually has a spontaneous recovery and does not require thorough investigation or medication in humans [Harrison & Sinclair 2002]. Similarly in sheep, where the condition is considered to be mainly cosmetic and the wool growth will resume after a while [Winter 1995].

3.5 Bacterial dermatitis

The bacterium *Dermatophilus congolensis* causes mycotic dermatitis or 'lumpy wool' [Winter 1995]. It is more common in damp areas where rain or high humidity keeps the wool from drying [Lloyd 1986]. Breeds with fine down-type fleece are more prone to the infection. If the bacteria invade the skin the result is an exudative dermatitis, which dries and forms scabs at the base of the fibres [Winter 1995]. The infection increases the risk of fly strike [Gherardi et al. 1983]. After healing, new wool will grow underneath the

scabs that form a hard layer in the fleece. The back is most commonly affected, but lesions can also appear in the ears and on the head. Wool loss is present in severe cases, where itching and secondary infections are common [Winter 1995]. During the lesion stage, the skin is pain-sensitive and this may restrict the movements of the sheep. A form of this disease is called 'Strawberry foot-rot' with strawberry-like non-exudative dermatitis and scabs localized above the hoof [Hammarberg & SvDHV 2008].

A case report from Greece refers to a flock of 290 Chios sheep where 20 ewes developed facial dermatitis. The dermatitis presented with alopecia or hypotrichosis, redness of the skin, hyperpigmentation, superficial ulcers with crusting and exudation, thickening of the skin but no itching. *Staphylococcus aureus* was found in the exudates and in skin biopsies. Swarming sucking flies were often found feeding in the ulcers. The problem was recurring during spring and early summer. One causative factor seemed to be competition by the feeding troughs which lead to small lesions in the head area of the sheep. The infected sheep had a better body condition than sheep without the dermatitis, indicating that the infected sheep fought harder to get food and were thus more likely to get injured [Koutinas et al. 2007]. The time of the year, skin trauma from competing for feed and the contagiousness are all typical for staphylococcal dermatitis. Other names for facial or staphylococcal dermatitis are peri-orbital eczema or dermatitis, facial eczema, necrotic ulcerative dermatitis and eye scab [Martin 2000]. A similar outbreak was reported from South Africa where lesions on wool-free areas were found on 39% of the sheep in the herd. Except for lip lesions, leg and vulvar lesions were found. Microbiological examinations revealed infection by *Staphylococcus aureus*. Together with the clinical signs the sheep were believed to suffer from staphylococcal necrotic dermatitis. Most of the sheep recovered completely, only in the most severe cases there was permanent scarring [Bath et al. 2011].

Pseudomonas aeruginosa causes unnatural staining of the wool, with a yellow colour as the most common symptom. The pigmentation is permanent and causes downgrading of the pigmented fleece. In severe cases the bacteria can cause a necrotic dermatitis that extends into the deeper layers of the dermis. The wool in the affected area comes loose, usually over the back. The animals can be severely ill and even die. Poor handling during dipping and contamination of the dipping solution could be part of the cause of the disease [Winter 1995].

3.6 Pelodera dermatitis

Pelodera dermatitis causes wool loss and thickening of skin in sheep. It is a rare infection caused by the larvae of *Pelodera (Rhabditis) strongyloides*, a free-living saprophytic nematode. The larvae invade the hair follicles and cause an inflammatory response. They thrive in humid, decaying organic matter, such as dirty beddings. This disease has been described in a flock of crossbreed Rasa Aragonesa ewes. The symptoms were found on areas in contact with the bedding material when the ewes where lying down. The clinical examination showed large areas of thick and leathery exfoliating skin with lesions in 74% of the ewes. After a complete removal of the bedding, cleaning and disinfection of the stable the problems disappeared [Ramos et al. 1996].

3.7 Wool break

Wool break is when the wool fibres are thinned and eventually breaks, causing parts of the wool fleece to loosen. This could be secondary effects caused by malnutrition or diseases such as mastitis [Winter 1995]. Wool break can also have infectious causes such as in Johne's disease caused by *Mycobacterium avium ss. Paratuberculosi*. Ringworm, *Trichophyton verrucosum*, can cause wool loss if the animal is scratching the area because of the itch [Winter 1995].

3.8 External parasites

The sheep scab mite, *Psoroptes ovis*, cause symptoms such as restlessness and irritation. Scratching and biting the wool leads to wool loss and yellow pustules and crusts are seen at the edges of the lesions. In heavily infected sheep the mites can be seen with bare eyes around the lesions. The mites multiply rapidly and only a few mites that infect a sheep can in 8-12 weeks lead to a severe infection [Winter 1995]. This mite is not found in Sweden [Hammarberg & SvDHV 2008].

Chorioptes ovis, foot scab, can be found in Sweden and mainly affects the distal parts of the hind legs and the scrotum. It can cause wool loss and it is common to get a secondary infection with allergic dermatitis in the area after treatment, making it difficult to evaluate if the treatment of the scab is effective or not [Hammarberg & SvDHV 2008].

Demodex ovis, demodectic mite, is rarely found in sheep but can cause wool loss and itching when it infects the hair follicles and sebaceous follicles. This makes the wool oily and nodules may form in the skin. The eyelid is a common site for infection [Hammarberg & SvDHV 2008].

Damalina ovis, the biting louse, is 1-2 mm long and visible for the naked eye [Hammarberg & SvDHV 2008]. The symptoms of an infection are similar to those of a scab infection [Winter 1995]. The lice affect the woolly areas, mainly the neck, back and above the tail. They live off dandruff, hair, and skin secretions. The eggs are visible in the wool and the lice may survive up to one month without a host animal [Hammarberg & SvDHV 2008]. *Linognathus ovillus* and *Linognathus pedalis* are sucking lice that mainly affect the hairy areas, which include the head and legs. They cause irritation and itching [Winter 1995] which can lead to wool loss. Both eggs and lice are visible to the naked eye and can be distinguished from the biting louse by crushing a louse on a white sheet of paper. If the louse contains blood, it is a sucking louse [Hammarberg & SvDHV 2008].

Heavy infections of the sheep ked, *Melophagus ovinus*, can cause wool loss from scratching [Winter 1995]. The flies are large, up to 8 mm, without wings and suck blood of the sheep. They lay larvae in the wool that form pupae, which are resistant to chemical treatments otherwise effective on the adult keds. The main sites of infection are neck, shoulders and underbelly and it causes irritation, wool loss and sometimes a green discolouration of the wool. Secondary infections are seen. The adult fly can survive more than one week separated from the host.

3.9 Scrapie

Scrapie is a transmissible spongiform encephalitis. The symptoms include severe itching, which leads to self-inflicted damages all over the body, wool loss and a decline in overall health. Neurological signs are present in some cases, for example changed behaviour (fear, aggressiveness), fine tremor, oversensitivity for light, sound, and touch, and unsteadiness. Death occurs two to six weeks after infection. Scrapie is probably caused by prions and the diagnosis is confirmed by autopsy [Hammarberg & SvDHV 2008]. Scrapie is not found in Sweden at the moment.

3.10 Feed-related causes

Mineral deficiency and protein deficiency are commonly stated as causes for wool loss in sheep. Deficiencies of copper, zinc, cobalt, calcium, phosphorus, sodium chloride and manganese are all connected to wool plucking [Chiezey 2010]. Wool plucking or pulling is partner-directed in sheep and the behaviour is mostly performed by ewes [Chiezey 2010]. The most commonly affected area is the back.

Schwan et al. (1987) studied 49 lambs from three different flocks on Gotland that suffered from poor growth and appetite, eye secretions, anaemia, ataxia and were generally in a poor condition. Wool loss was also included as a symptom. The flocks were dewormed according to recommendations and were kept on good quality pastures. Based on clinical findings and chemical analysis of organ samples, more than 50% of the lambs were diagnosed with copper deficiency and almost 90% of the lambs were diagnosed with cobalt deficiency. Because cobalt is an important part of vitamin B12, a deficiency for this was also suspected and confirmed via serum analyses. The symptoms decreased and normal growth was obtained after treatment with a B12 supplement and a mineral supplement containing cobalt and copper.

Symptoms of zinc-deficiency has been described by Al-Saad et al. (2010) to be loss of appetite, alopecia, lesions of the skin, including both parakeratosis and hyperkeratosis, and a decreased body weight. Alopecia was found in 62.4% of the sheep that were zinc-deficient. Poor wool growth was also noted. In total 681 sheep were investigated in their study, of these 125 suffered from hypozincemia.

Excess selenium can cause wool loss according to a study by Panter et al. (1995), where ewes were fed seleniforous pellets by adding sodium selenate, equal to 24 ppm selenium, or *Astragalus bisulcatus* (two-grooved milkvetch or silver-leafed milkvetch), equal to 29 ppm selenium. By the 10th week some ewes showed minor wool loss on necks and sides. The selenium levels in the blood were 0.45 ppm in the control group and 1.3 and 2.4 ppm respectively in the test groups. No adverse effects on the reproduction of the ewes were found, which was the focus of the study.

In a study of malnutrition in sheep, Fattet et al. (1984) studied the effects of protein supplements on protein accretion. They found that wool production continued during malnutrition and was more related to energy intake than protein intake. This is opposed to other studies where protein has been positively related to wool growth. This could be due to differences

in breed and wool-growth potential, which has been shown to be a factor affecting the response to methionine and cystine [Williams et al. 1972].

Rcheulishvili (1980) studied alopecia in Georgian semifinewooled fat-tailed sheep. More than 70% of the lactating ewes suffered from alopecia. He suggested that it was not a metabolic disorder in the hair follicles, but a lack of nutrients when the need of the ewe was at the highest during gestation and lactation that caused the alopecia.

In a case report from Ahmadou Bello University in Zaria, Nigeria, 60 Yankansa rams were fed a finely ground concentrate along with hay. After 30 days, wool loss and wool plucking was seen in the flock and four animals suffered from diarrhoea and loss of appetite. In two cases the symptoms worsened and the rams eventually died. No external or internal parasites where found that could explain the symptoms, nor did a post mortem examination result in a diagnosis. Consequently, a nutritional problem was suspected. After adjusting the diet to a more coarse concentrate and hay ad libitum the problem was reduced and after two months the wool was back to normal. This suggests that particle size may have an effect on the wool [Chiezey 2010].

3.11 Genetic causes

Rcheulishvili (1980) suggested in his studies of Georgian semifinewooled fat-tailed sheep that some breeds are more disposed to suffer from alopecia than other due to a hereditary increase in metabolism. The Georgian semifinewooled fat-tailed sheep show strong shedding in the spring, but wool loss appears earlier in winter and spring when feed is at its scarcest. No strong evidence of genetic links to wool loss, other than natural shedding, has however been found in the literature.

4

Results

4.1 Questionnaire answers

From the 294 questionnaires sent out, 114 replies were received. This gives an answering rate of 39%. Of these, 12 herds had problems with wool loss, in 36 herds the phenomenon had occurred and 66 herds had no experience of the phenomenon. In total, 42% of the herds had experienced sheep with wool loss. The questionnaire used is found in appendix A.

The electronic questionnaire (EQ) received an answer from 56 farms. Of these, 37 farms had a problem with wool loss and 52 farms all together had experienced wool loss (Figure 4.1).

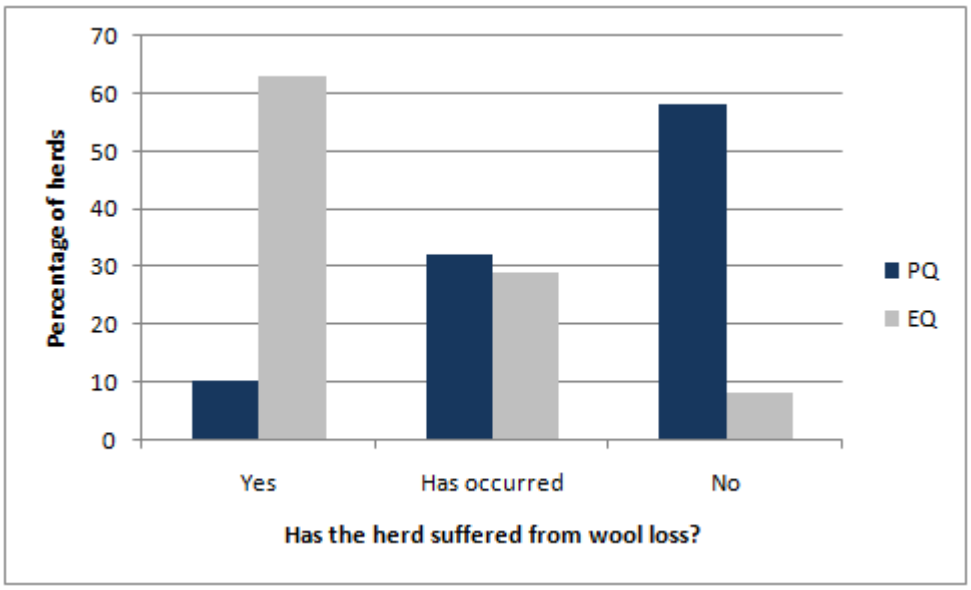

Figure 4.1: Percentage of herds where wool loss has been a problem, where wool loss has occurred and herds that has not experienced wool loss.

4.2 Numbers, breed and production status

All-in-all, 7849 sheep were included in the study. Of these, Gotland sheep were the most common pure breed with 22% in the PQ and 18% in the EQ. Other common pure breeds were Texel with 15% and 8%, respectively and Swedish fine wool with 7% and 6%, respectively. In the PQ the crossbreeds constituted 42% of the total amount with 1281 individuals. In the EQ the percentage was even higher with 60% and 2603 individuals (Figure 4.2). The average herd size was 27 sheep in the PQ and 77 in the EQ.

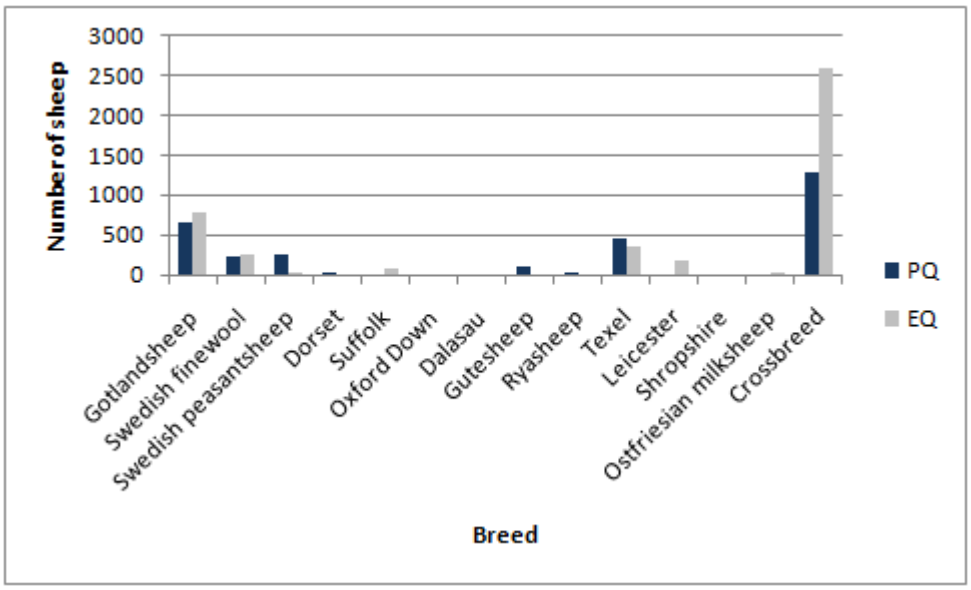

Figure 4.2: Number of sheep per breed on the farms.

Most of the herds had their lambing period in March to May. The rest had lambing in December to February and only a small percentage in June to August. No herd reported lambing between September and November in the questionnaire, but it is found in one of the herds in the case study. Winter lambing was more common in the group answering the EQ than in the other group.

4.3 Housing and feeding

Loose housing with outdoor access the whole time or parts of the day was the most common option for housing sheep in this study (68% in the PQ and 52% in the EQ). Un-insulated loose housing was the second most common option (25% in the PQ and 46% in the EQ) and insulated loose housing was not so frequently used. Some of the herds had two different housing systems. Most of the herds used straw as a bedding material, more than 90% in both questionnaires. Woodchips, feed wastage and peat was also used in a few cases, single or in combination with straw.

Concentrate was fed mostly from cribs, followed by feeding on feeding tables in the PQ. In the EQ feeding tables was most commonly used. Roughage

was mostly fed from racks and feeding tables. Feeding the roughage directly on the floor or ground or feeding round bales directly to the animals by putting the round bale into the pen was also practiced in some herds. In addition to these feeding systems, 10% among those answering the PQ and 17% in the EQ used some kind of front gate. Five percent in the PQ and nine percent in the EQ specifically mentioned that the feeding equipment caused wear on the wool.

4.4 Feeds and body condition

Most of the forage given to the sheep was not analysed for energy and protein content. In the PQ 6% of the herds had analysed their forage, while 23% had analysed the forage in the EQ. Regarding body condition, most sheep in both questionnaires were considered to have an average body score. A few herds were considered to have ewes with a body condition lower than average and about 35% herds in both questionnaires were considered to have ewes above the average in body condition score. Only a few of the herds considered their ewes to be fat (2% in the PQ and 5% in the EQ). No herd was considered to be thin.

4.5 Shearing

The wool was cut two times per year or more in 50% of the herds in both questionnaires, with the percentage being a bit higher in the EQ. The distribution of wool cutting over the year had its top in spring (March to May) in the PQ but in the winter (December to February) in the EQ. The wool was cut in the autumn in 50% of the herds, according to both questionnaires (figure 4.3).

4.6 Deworming

Regular deworming once or more often every year was performed in about 50% of the herds in both questionnaires. Most of the herds dewormed their sheep sometime between March and May.

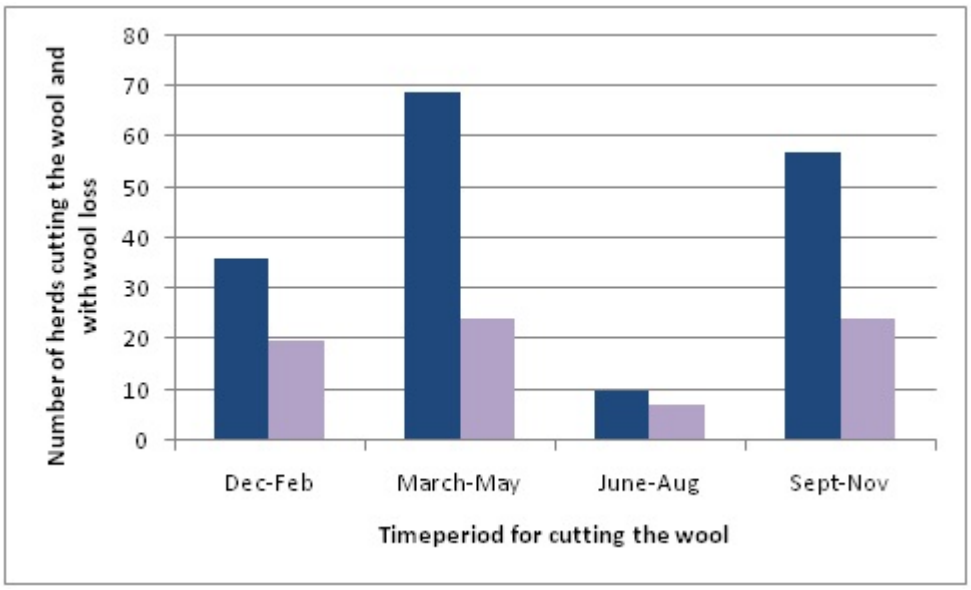

Figure 4.3: Number of the herds, including both questionnaires, shearing at different time periods (blue) with the number of herds experiencing wool loss (lilac).

4.7 Wool loss

The percentage of herds with wool loss is seen in figure 4.1. In herds where no wool loss was seen the participant did not answer further questions concerning that matter. Ewes were the most affected category of animals but in both questionnaires there were reports of both lambs and rams suffering from wool loss as well. In 63% of the herds with wool loss the problem had recurred several years according to the PQ. The corresponding number was 66% in the EQ. In 30% and 27% of the herds, respectively, the problem had not returned and in the rest of the herds the answer is unknown, either due to no answer or because this was the first year in the herd with wool loss. Three of the herds in the PQ where wool loss had returned did not state if it is the same individuals that are affected each year or not. For herds that replied that the wool loss did not return, but still answered that the same individuals or partly the same individuals were repeatedly affected, the second answer was not included in the statistics since it is conflicting with the first one. In the PQ a few herds failed to answer the second question. Of those that answered

that the problem with wool loss returned, 43% of the cases were on the same individual in the PQ and 46% in the EQ, 37% and 41% respectively were partly the same individuals and in 13% of the herds it was not the same individuals. Wool loss was reported to mainly occur in winter and spring. In 44% of the herds wool loss occurred in December to February and in 52% it occurred in March to May. In the EQ the same figures were 69% and 44%, respectively. Since some herds had wool loss occurring at several time-periods (6 herds in the PQ and 14 herds in the EQ), the total percentage exceeds 100.

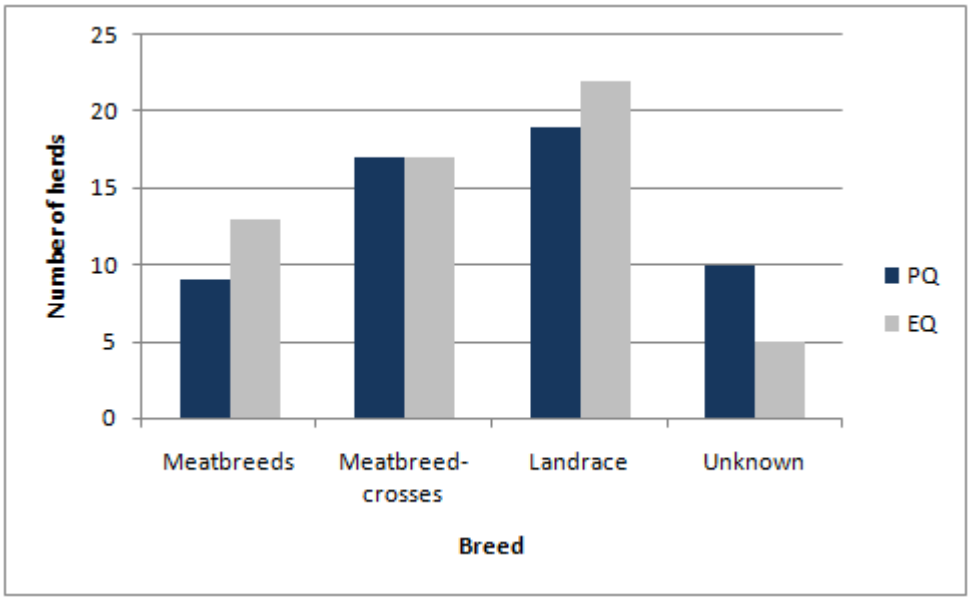

Figure 4.4: Breed categories suffering from wool loss.

Consistently in both questionnaires the breeds most affected of wool loss were the landraces (Figure 4.4). Crosses between landrace and meatbreeds were the second most affected group while meatbreeds, according to this question, were least affected. Some herds (10 in the PQ and 5 in the EQ) reported the breed as unknown. Breeds such as Gotland sheep, Swedish finewool, Swedish peasantsheep, Gutesheep and Ryasheep are considered as landraces while Dorset, Texel, Oxford down and Leicester are considered as meatbreeds. Herds that had reported several different breeds were in this question counted as different herds, giving a total of 55 herds in the PQ and 57 in the EQ.

The most common production stages when wool loss occurred were pregnancy and lactation. In some herds wool loss occurred in different production stages. According to the PQ, 35% of the herds had wool loss during pregnancy. In the EQ the corresponding figure was 67%. For lactation the figures were 31% and 27%, respectively. Wool loss was, however, reported for all production stages.

Figure 4.5: A sheep with wool loss in one of the herds that participated in the study.

In most cases there was no scratching among the sheep related to the wool loss. The part of the sheep that was most commonly affected by wool loss was the back. In 71% of the herds in the PQ and 56% of the herds in the EQ where wool loss had occurred, the backs of the animals were affected. In 44% and 38% of those herds, respectively, the sides were affected and in 23% of the herds in both questionnaires the hind quarters were affected. In half of the herds with wool loss, only a small part of the wool fleece was affected in each sheep, according to both questionnaires. In about a quarter of the herds a quarter of the wool was lost and in about 10% half of the wool was lost. In only a few herds (3 herds in the PQ and 1 herd in the EQ) it was reported that most of the wool was lost. Some herds gave several answers to this question, making it difficult to interpret. Figure 4.6 shows the percentage of herds where a cold period is reported to have preceded the wool loss or not. In the PQ no difference was found but in the EQ more than half of the herds reported a cold period preceding the wool loss.

In 25% of the herds in the PQ, the wool cut preceding the wool loss occurred during a cold period. In 42% of the herds no cold period was occurring during the wool cut preceding the wool loss and in the rest the

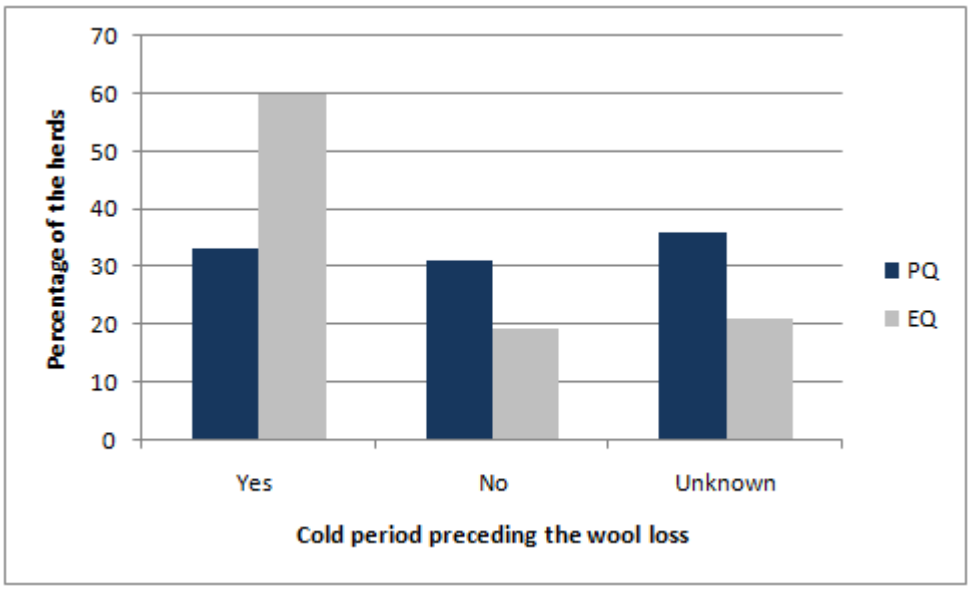

Figure 4.6: Percentage of the herds that did have, did not have or it is unknown if they had a cold period preceding the wool loss.

weather conditions were not reported. In the EQ equally many had a cold period occurring at the time of cutting before wool loss as the ones that had no cold period. In 20% of the answers the weather condition was unknown.

4.8 Reasons

In 44% (PQ) and 38% (EQ) of the herds, the reason for wool loss was believed to be lack of nutrients or that the sheep was worn out. In 13% of the herds in the PQ some kind of mineral deficiency was believed to be a part of the problem. In the EQ a genetic cause was suggested in 13% of the cases. Other reasons suggested for wool loss were internal or external parasites, photosensitization, hormone disturbances, pregnancy, lambing, old age, wear and tear, wounds or eczema, cold weather when cutting the wool or a bad cutting, the environment or fatness.

4.9 Diagnosis

Forty-four responders to the PQ provided an answer to if they had consulted a veterinarian regarding the problem with wool loss or not. Out of the herds with wool loss, 19% had consulted a veterinarian. Of these, four herds had got a working diagnosis; in one herd the sheep were believed to suffer from photosensitization and the other three were believed to suffer from indistinct deficiencies, protein deficiency mentioned in one case. In 73% of the herds a veterinarian had not been consulted. In the EQ 14 herds had consulted a veterinarian. Of these, four cases were believed to be caused by external parasites, two cases got the diagnosis degenerated hair follicles (unknown cause); one case was believed to be protein deficiency and one vitamin deficiency.

4.10 Is wool loss a problem in the Swedish herds?

Of all the participants in the study, 66% had no comment about if wool loss is a problem in the Swedish sheep-herds. About thirty percent in the whole study did not consider wool loss to be a problem in the Swedish sheep-herds while 5% meant that it is a problem. In the EQ 9% considered wool loss to be a problem.

4.11 Contacts and case reports

Nine participants reported interest in follow up questions. In the end five farmers replied.

Farm 1

Farm 1 consists of 340 crossbred sheep with about 50% meat-breed (Dorset, Texel and Suffolk). Lambing is taking place during one period in March to April and one period in July. The sheep are fed silage ad libitum. The silage is analyzed for nutrient contents. In addition, ewes with triplets and ewes in their first pregnancy are fed a concentrate mix including minerals; the rest of the sheep have free access to minerals. Ewes that are lambing in July and

rams are fed silage with lower nutritional quality. All sheep are sheared in December. The ewes lambing in spring are also sheared in August and the ewes lambing in summer are sheared in May.

The shearing in December was followed by a cold period. The wool loss was easy to notice, it started suddenly three weeks after shearing on one ewe and during the following weeks it was noticed on several others. The wool came loose and fell off from large or small areas. Either the wool around the area was normal, or it also came loose if pulled.

The wool loss appeared mainly on the back and high on the hindquarters. The amount of wool loss differed between the animals, some lost only a little on the back while some lost more. The wool started to grow again after some weeks and by the time of lambing, in the end of March and April, the areas with wool loss had new, short wool. Only older animals were affected, no young ewes or rams has ever been affected in this herd. The animals were kept in un-insulated stables and some of the groups had outdoor access. There was no difference in wool loss found between the groups.

Nothing seemed to aggravate the wool loss, but keeping the sheep warmer after cutting the wool seemed to reduce the risk. No other symptoms associated with the wool loss were found. The animals were considered to be in good condition and some of the ewes were even a bit fat. No change in weight was noticed at the time. The sheep did not seem affected by the wool loss. A few got "pink and naked" at the area with wool loss, but have not appeared to be colder or behaved any different compared to the other ewes.

The relation between the affected animals has not been examined. Several rams of different breeds and crosses have been used. The meat-breeds seemed to be more commonly affected, but this could be due to an overrepresentation in the herd.

Farm 2

The farm is small with only three crossbred ewes. The sheep are sheared in May and October.

Wool loss first appeared in November 2010. In 2010 the winter started early with a snow cover already in November and with the coldest December for years in large parts of Sweden [SMHI 2011]. The onset of wool loss was sudden, with tufts of wool falling off from the back and sides of the sheep. The wool loss was going on for 1-2 weeks and then it ceased completely. In the most severely affected ewe, half of the wool was lost. The wool around

Figure 4.7: A sheep with wool loss in one of the herds that participated in the study.

the affected area was found to be shorter than the normal wool. Nothing was distinguished as reducing or increasing the wool loss. The hoofs were more fragile during the wool loss but no other associated symptoms were noticed.

The sheep are kept in a loose-housing system with outdoor access. The stable is un-insulated with permanent bedding. At the time of wool loss, the sheep were fed roughage and minerals. The ewes were considered to be fat. No weight-change was noticed in association with the wool loss. The sheep were treated once against external parasites without any effect on the wool loss. Sheep related to each other has suffered from wool loss at this farm preceding years, but not at another farm.

A post-mortem examination was performed on one of the ewes and degeneration of the wool follicles was found which according to the results indicated an endocrine malfunction. A specific test for fungi was conducted but was negative.

Farm 3

The farm has 30 Swedish fine-wool sheep with lambing season in May-June. The sheep are sheared in January and during the winter the ewes are kept in an uninsulated loose-housing system without outdoor access. The wool loss appeared gradually around the tail and under the belly and then on the neck. The amount of wool loss varied from no wool loss at all to about half of the wool. One ewe lost almost all her wool. The remaining

wool was found to be of lower quality, wispy and dull, compared to the wool of the sheep without wool loss. The skin in the affected area seemed unchanged. Generally, the sheep seemed unaffected by the wool loss. Wool loss affected ewes in late gestation and early lactation. Ewes with fewer lambs were less affected. The only associated symptom noticed was hypocalcaemia and weight loss in the ewe loosing almost all wool. The ewe was carrying six lambs. The ewes were 3-4 years and had previously got 3-4 lambs. Lameness among the sheep due to the hoofs growing too fast and white-line separation had also been present. No treatment had been given. During the time when wool loss appeared, the sheep were kept outside on pasture. The pasture was described as a clean, fertilized mixed pasture with a high nutrient content. The sheep also had free access to minerals. No cold-period was associated with the wool loss, but during the last shearing the weather had been cold.

Farm 4

The farm has 300 Gotland sheep and 140 Swedish fine-wool. The lambing is divided into three periods, in January, March/April and in September. The sheep are kept in un-insulated loose-housing stables. The winter 2010-2011 about half of the ewes lambing in September suffered from wool loss. The group consisted of 80 Swedish fine-wool ewes, all older ewes that had been through at least three pregnancies. The ewes were separated from their lambs in the middle of December and sheared in January. The wool loss appeared in the end of December and January and was noticed before shearing. The wool fell off gradually in tufts, with a rapid progress until it stopped. After shearing they were completely bare at the places of wool loss. The wool loss initially appeared on the back and progressed down the sides and thighs. About 30% of the wool was affected and the wool might have been of a lower quality than the rest of the wool. No related health problems were noticed. In August, when the ewes were sheared again, no signs of wool loss could be seen and it was not possible to tell the ewes that had lost wool from the ones that had not. The sheep at the farm are fed analyzed silage of good nutritional quality and concentrate when needed. Since the ewes experiencing wool loss were not lactating any more, they were fed only silage ad libitum and minerals. In general the ewes on the farm are considered to be a bit over good body condition, but the sheep suffering from wool loss were considered to be a bit thinner, but not thin. A veterinarian was consulted but no apparent reason for the wool loss was found. The ewes were treated

for lice after the wool loss appeared even though no signs of lice were seen. No other ewes sheared at the same time suffered from wool loss. The other ewes were lambing in spring. The extent of the problem that appeared in the group of ewes has not happened before and was not repeated the following winter. Then only one ewe suffered from wool loss, likely due to a very high production and the fact that the ewe was not able to eat enough. The pattern of wool loss was not the same even though it also appeared on the back, but this time closer to the head.

Farm 5

Farm 5 consists of 85 sheep; 40 Gotland sheep and the rest Texel-crosses. Lambing occurs in December - February and in April. The sheep are kept in an uninsulated loose housing system, with or without outdoor access. The air is reported to be fresh and good and not moist. It can sometimes get a bit dark with only artificial light. Straw is used as a bedding material. A feed rack combined with a feeding table is used for both silage and concentrate. The diet for a ewe with two lambs is estimated to be silage ad lib, approximately 1 kg hay and 0.5 kg crushed barley mixed with protein concentrate. The silage is analyzed. The sheep are sheared in November-December and June. They are dewormed according to needs; the last time was summer 2011. During the winter 2010-2011 there were 10 ewes suffering from wool loss. All of them had gone through 5-8 pregnancies. The winter 2011-2012 fewer animals were affected but two ewes lost about half of the wool; one was also suffering from mastitis and another had three lambs. The wool loss appeared gradually, starting on the back and moving on to the trunk. Nothing extraordinary was noticed on the skin or the wool surrounding the wool loss. Some of the older ewes suffering from wool loss also lost some weight in connection to the wool loss, but in general the herd was considered to have a good body condition score. No cold period was associated to the wool loss or the shearing before the wool loss. No more scratching than usual has been observed in combination with wool loss. The problem has been reoccurring, mainly during the lactation period and mainly on the same individuals. Mostly crosses are affected.

The wool loss was believed to be caused by a nutrient (especially protein) deficiency due to the age of the sheep; they were not able to assimilate enough of the nutrients in the feed. A change in the diet with a higher amount of concentrate was used to treat the wool loss. The sheep did not seem affected

by the wool loss and the underlying cause was perceived as the problem.

Figure 4.8: A sheep with wool loss in one of the herds that participated in the study.

4.12 Replies from veterinarians

Five sheep veterinarians from the Swedish Animal Health Service replied to questions about wool loss. According these veterinarians, the most common season for contacts regarding wool loss was the winter. The frequency of contacts is from every second week during the winter to around ten times during a year. A diagnosis has been possible to make in a few, at most in 50% of the cases. Mostly it is hard to find a cause unless there have been obvious signs of external parasites, such as excessive itching among the sheep. Other suggested causes have been protein deficiency and stress related causes. No difference was noticed between the cold winter 2010-2011 and the much warmer winter 2011-2012 regarding contacts about wool loss.

5

Discussion

After experiencing wool loss in a study regarding feeding of pregnant and lactating ewes with silage *ad lib.* versus feeding silage and concentrates, the question about wool loss in the Swedish sheep population was brought into light. Differences in nutritional status of the ewes as well as in temperature at shearing between the two study years indicated that there is not one single cause for wool loss.

The aim of this study was to get an overview of wool loss in Sweden, frequency, causes and if it is a problem or not. As the answering rate of the PQ was only 39%, the answers cannot be said to show a statistically accurate picture of Swedish sheep production. Together with the internet answers and the personal contacts, they may however give an indication regarding the frequency and a probable picture of the causes.

The number of adult sheep in Sweden is increasing and was 2010 reaching 273 126 [SCB 2011a]. Three percent of these were included in this study. In 2010 the numbers of farms with sheep in Sweden were 8628, which gives an average of 29 sheep per herd [SCB 2011b]. In this study the average number was 27 sheep in the PQ and 77 sheep in the EQ. This makes it likely that there are a higher percentage of professional farms in the EQ, while more farms in the PQ have sheep more as a hobby.

Problems with both questionnaires have been noted. Open questions are hard to summarize and some questions have not been clear enough. Some responders have had problems with the EQ, as in some cases it was not possible to choose more than one option, but luckily many corrected the weakness by writing the answer under Comments that was the last heading in the questionnaire.

This study reports loose housing with outdoor access as the most common way of keeping sheep. This could be questioned since it is mainly common on organic farms. One way this question could be misunderstood is if the summer pasture is considered as outdoor access and not with outdoor access during the winter as well. There is however no way to tell which is true, but it shows that some questions have several possibilities for interpretation.

The EQ group reports mostly crosses as breed (Figure 4.2). This could indicate that a larger part of that selection group has intensive winter lambing with meat breed crosses, since the EQ also reports more lambing during the winter. Gotland sheep are underrepresented in this study compared to statistics of breeds in Sweden [Elitlamm 2012], with a lower percentage in the EQ group than in the PQ group. This could indicate either a breed effect or a less intensive production with fewer lambs per ewe or simply caused by the selection of the groups.

The reasons for wool loss are many and varying, and a single main reason is hardly possible to distinguish. Looking over the year, wool loss is mainly occurring during winter and spring, when the strain and stress on the sheep is the greatest with cold-stress, gestation and lactation.

Figure 5.1: A sheep with wool loss in one of the herds that participated in the study.

The literature suggests many possible nutritional causes for wool loss and in the case study of farm 3 a nutritional deficiency (hypocalcaemia) was associated with the wool loss. Also the farmers suggested that nutritional deficiency could be part of the answer. To be able to draw any conclusions about possible mineral or protein deficiencies a more accurate material would

be needed. Most farmers do not analyse their forage and concentrate was fed in varying ways. The total intake also is unknown. However, the fact that most of the wool loss occurs during the times when the ewes have the highest nutritional demand supports the theory. In the case study of farm 3 the sheep were kept on pasture without any additional concentrate fed. Even though the pasture was of high nutritional quality it is unlikely to be enough for a ewe in early lactation with four lambs or more. Because ewes with fewer lambs were less affected by wool loss, it strongly supports the theory of a nutritional deficiency. Further support to the theory is that the ewe losing all of her wool was carrying six lambs.

Chiezey (2010) suggests too finely grinded feed as a cause for wool loss. The wool loss in the study could however have other causes, such as nutritional deficiencies caused by the diarrhoea mentioned as one of the symptoms. The wool plucking seen in the study could be a sign of the lack of fibres in the diet. The study however confirms that diet is important when considering wool loss, and not only what is fed but also how it is fed.

The case history from farm 1 shows an interesting comparison between similar groups. The progression of the wool loss, time of onset and especially the relieving factors strongly suggest that the sheep on the farm were suffering from telogen effluvium. To reduce the frequency of wool loss caused by telogen effluvium, prolonged stress with cortisol release needs to be diminished. The farmer has found that keeping the sheep warm by adding an extra roof after cutting the wool reduces the wool loss, indicating that cold stress is a factor in that case.

A higher percentage of the herds in the questionnaires where the wool was cut during winter experienced wool loss, compared to herds cutting the wool in spring and autumn (Figure 4.3). The percentage was also high in summer, but the total amount of herds cutting the wool in summer is low, which could influence the result. Looking at the number of herds experiencing a cold period preceding the wool loss the percentage is especially high in the EQ group with more than 50% (Figure 4.6). This could be related to that the top of shearing is in December to February in the EQ group and during March to May in the PQ group. The EQ group report that 69% of the wool loss was experienced during winter, compared to 44% in the PQ group. As the EQ analyze the forage to a greater degree, there should be less risk of nutrient insufficiency; therefore it is likely that the wool loss in this group is caused by telogen effluvium to a greater degree than in the PQ group. The fact that most wool loss according to the PQ is experienced during spring,

along with most shearing, and maybe a less accurate feeding regime indicate that a nutrient insufficiency could be the dominating factor causing wool loss in the PQ group.

Another difference between the groups is seen in the percentage of herds experiencing wool loss during pregnancy. The EQ has a higher number with 67% compared to 35% in the PQ. For wool loss during lactation the numbers are more similar between the groups. In both groups most of the lambing was between March and May, but a higher percentage of lambing between December and February is found in the EQ with 40% compared to 23% in the PQ. A higher frequency of wool loss during pregnancy in the EQ group can be related to a higher percentage of earlier lambing and a higher percentage of shearing in the winter.

Landraces seem to be most affected by wool loss. This could be due to more lambs per ewe than in the meat breeds. It could also be that some of the sheep show shedding of the wool reported as wool loss. This is however purely a genetic cause and should not cause any worries. Natural shedding has even been brought forward as an economical benefit since it reduces labour costs when shearing is reduced [Pollott 2011]. Since shearing is a great contributor to the stress levels of sheep, unexpected wool loss could possibly be reduced by using breeds that shed the wool naturally.

According to the PQ in only 19% of the cases with wool loss a veterinarian was consulted. A minimum of ten questions about wool loss a year was received by the veterinarians involved in this project. If that number is compared to the percentage of herds with wool loss that has consulted a veterinarian in the PQ, there are about 50 herds in the district of every veterinarian where the owners are not asking for help or advice regarding possible cases of wool loss.

By most farmers, in both questionnaires, wool loss was not considered to be a problem, or no opinion about the matter was stated. It is hard to see an economical disadvantage from a small area of lost wool and many farmers reported that the sheep suffering from wool loss did not seem affected. But when the areas become larger, disadvantages can be suspected. Sheep sheared with a standard comb lost 1.4 kg of weight during 10 days when exposed to cold and wet weather. Sheep sheared with a cover comb gained 0.4 kg during the same experiment [Dabiri et al. 1995]. A difference in 1.8 kg over 10 days with the same amount of feed clearly shows one of the negative effects that could arise from a widespread wool loss, which was found in more than 10% of both questionnaires (half of the wool lost or more). Four herds in

total mentioned that the sheep lost almost all their wool. When the difference in weight can be so large it will also have an economical effect, on top of the welfare aspect. When the wool loss gets this extreme, the consequences are great. To prevent this, even small patches of wool loss should be noted and cared for to prevent the problem from escalating.

Figure 5.2: A sheep with wool loss in one of the herds that participated in the study.

6

Conclusion

In conclusion, wool loss is an existing phenomenon in Sweden. It may be underestimated in frequency by farmers since it mostly is not considered as a big problem. The economical effects are hard to estimate. The best strategy to avoid wool loss would be to make sure that the ewes are receiving, and eating, enough during late gestation and early lactation. An analysis of the forage will aid in calculating a suitable diet according to the needs of the ewe. When shearing in the winter the weather and housing conditions need to be taken into consideration to avoid cold-stress in addition to the stress caused by shearing. Suitable cover and cutting equipment which leaves a bit more wool than normal may be considered. Other causes for stress should also be minimized, especially in combination with cold weather. Further research about contributing factors to wool loss is needed to fully understand the whole picture of the phenomenon.

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Appendix A

Questionnaire - Frågeformulär

Frågeformulär - Ulltapp hos får

1. **Antal, ras och produktionsstadium**
   a) Hur många tackor av respektive ras ingår i din besättning?
   Ange antal tackor per ras i kolumnerna för ”Antal”. Om rasen inte finns som alternativ, vänligen ange rasen i de tomma raderna längst ner. Om du har korsningar, vänligen ange de raser som ingår i korsningen på raden under ”Korsning”.

	Antal		Antal
Gotlandsfår		Gutefår	
Svensk finull		Ryafår	
Svenska allmogefår		Texel	
Dorset		Leicester	
Suffolk		Shropshire	
Oxford Down		Ostfrisiskt mjölkfår	
Dalasau		Korsning	

   b) När brukar den beräknade lamningsperioden vara?

   _____

2. **Uppstallning**
   a) Hur är fåren uppstallade?
   - ☐ Lösdrift med möjlighet till utevistelse hela eller delar av dygnet.
   - ☐ Lösdrift, fåren är inomhus i oisolerat stall hela dygnet.
   - ☐ Lösdrift, fåren är inomhus i isolerat stall hela dygnet.
   - ☐ Annan inhysningsform, ange vilken:

   _____

   _____

   _____

   b) Vilket strömaterial används?

   _____

   _____

   _____

c) Hur ser fårens utfodringsplats/foderbord ut? Ang särskilt om det finns detaljer i inredningen eller utfodringsrutiner som kan påverka ullen.

Var och hur utfodras kraftfoder?

Var och hur utfodras grovfoder?

3. **Foderstat**
   a) Hur ser en foderstat ut per dag för en tacka med två lamm genast efter lamning? Inkludera även eventuella mineralfoder/tillskottsfoder.

Fodermedel	**Mängd**

b) Är grovfodret analyserat? ☐ Ja ☐ Nej

c) Om grovfodret är analyserat, ange innehållet i det grovfodret som används till tackorna i foderstaten ovan (fråga a). Alternativt bifoga en grovfoderanalys.

	Innehåll
Torrsubstans (ts)	
Energi MJ/kg ts	
Smältbart råprotein g/kg ts, AAT/PBV (ange vilket mått som används)	
NDF g/kg ts	
Koppar µg/kg ts	
Kobolt µg/kg ts	
Zink µg/kg ts	

d) Vilket hull anser du vara representativt för tackorna i din besättning vid lamning?

- ☐ 2 – mager
- ☐ 2,5 – något smal
- ☐ 3 – god kondition
- ☐ 3,5 – något tjock
- ☐ 4 – fet

4. **Klippning**
   När klipps fåren?

_____

_____

_____

5. **Avmaskning**
   a) Hur många gånger per år avmaskas fåren?

_____

_____

b) När sker avmaskningen?

_____

_____

_____

c) Vilket avmaskningsmedel användes vid senaste avmaskning?

6. **Ulltapp**

a) Har du haft problem med får som tappat sin ull i din besättning?

- ☐ Ja.
- ☐ Det har förekommit, men inte i stor omfattning.
- ☐ Nej. Gå direkt till fråga 9.

b) Hur många individer i besättningen har drabbats av ulltapp?

c) Vilken/vilka djurkategori har huvudsakligen drabbats?

- ☐ Tackor
- ☐ Baggar
- ☐ Lamm

d) Har problemet återkommit flera år?

☐ Ja ☐ Nej

e) När under året uppkommer problemet?

f) Är det samma individer som drabbas flera gånger i rad?

- ☐ Ja, till största del.
- ☐ Delvis.
- ☐ Nej, inte alls.

g) Vilken ras är det på fåren som tappar ull?

h) I vilket produktionsstadium är fåren som tappar ullen?

_____

_____

_____

i) Har fåren kliat ovanligt mycket innan ulltappet?

- ☐ Ja.
- ☐ Fåren har kliat sig lite mer än vanligt.
- ☐ Nej.
- ☐ Kan inte säga.

j) Var är ulltappet lokaliserat? Kryssa i de alternativ som bäst överensstämmer med lokaliseringen.

- ☐ Huvud
- ☐ Hals
- ☐ Bog och bringa
- ☐ Längs ryggen
- ☐ Sidor
- ☐ Buk
- ☐ Bakdel
- ☐ Ben

k) Hur stor del av ullen har tappats? Välj det alternativ som bäst stämmer överens med situationen i hela besättningen.

- ☐ Enbart lite
- ☐ En fjärdedel av ullen
- ☐ Hälften av ullen
- ☐ Största delen av ullen.

l) Har det varit köldperioder i samband med ulltappet?

- ☐ Ja
- ☐ Nej
- ☐ Vet ej

m) Har det varit köldperiod i samband med senaste klippningen innan ulltappet?

- ☐ Ja
- ☐ Nej
- ☐ Vet ej

7. **Orsak**

Vad tror du att ullavfallet beror på?

_____

_____

_____

_____

8. **Diagnos**
   Har du sökt veterinärhjälp till dina får på grund av detta? Har du fått en diagnos?

9. **Problem i de svenska besättningarna?**
   Anser du ulltapp hos får är ett problem i de svenska fårbesättningarna? Varför, varför inte?

Returnera ditt svar innan den 21a mars.

Tack för ditt deltagande!

Appendix B

Questions used for the interviews - Fördjupade frågor

1. När uppkom ulltappet?
2. Hur upptäcktes ulltappet?
3. Hur uppkom ulltappet? (Gradvis, plötsligt...)
4. Var uppkom problemet på djuret?
5. Hur har ulltappet utvecklats? (Blivit större, spridit sig till andra delar av djuret, återkommit flera gånger på samma ställe..)
6. Har ni märkt om något gör ulltappet värre?
7. Har ni märkt om något minskar ulltappet, det vill säga gör det bättre?
8. Har ni upptäckt andra symptom i samband med ulltappet? (Aptitlöshet, hosta, diarré...)
9. Hur stor del av ullen är påverkad?
10. Hur skulle ni beskriva ulltappet? (Ullen som tappats, ullen runt omkring, huden...)
11. Har fåret något annat problem med ullen, huden eller klövar?
12. Har fåret något annat problem med hälsan?

13. Hur skulle du beskriva miljön fåret vistades i när ulltappet uppkom?
14. Noterade ni någon viktförändring hos fåret i samband med att ulltappet uppkom?
15. Beskriv fårets foderstat när ulltappet uppkom, inkludera även eventuella tillskottsfoder och mediciner.
16. Påverkas ulltappet av solljus?
17. Ser fåret ut att påverkas av ulltappet?
18. Har ulltappet behandlats på något vis?
19. Hur gammalt är fåret?
20. Hur många lamm/dräktigheter har fåret fått/haft?
21. Har släkt till fåret drabbats av ulltapp?

Appendix C

Questions for veterinarians - Frågor till veterinärer

1. Hur ofta blir du kontaktad angående ulltapp per år?
2. Hur ofta det går att få fram en orsak och vilken/vilka i så fall?
3. När på året det är vanligast att du får förfrågningar angående ulltapp?
4. Har det märkts någon skillnad på antalet förfrågningar denna vinter jämfört med fjolårets?

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