WELFARE OF GOATS ON ORGANIC GOAT SYSTEMS IN THE NETHERLANDS; TESTING A PROTOCOL.

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ABSTRACT

There is a need for an easy to use protocol to assess the welfare of goats since more attention is paid to welfare in animal production systems from the European Union as well as from the consumer site. For goats there was not such a protocol yet in the Netherlands and Belgium. In this study a protocol 1.0 based on the Muri protocol for goats (Muri et al, 2011) and developed in a previous study is improved to a summary protocol 2.0 which is tested on 10 organic goat farms in the Netherlands. The protocol 2.0 exists of animal-based indicators, farmer-animal indicators, management indicators, resource based indicators and environment indicators. Indicators are reliable and valid proven in previous research (Muri et al., 2001; AWIN, 2015; Welfare Quality®, 2009). The protocol can be done in 3 hours by a single person. The most prevalent health issues observed are claw conformation, vaccination bulbs, regrowth of disbudded horns and pinnae pathologies. Human-animal interactions are a key factor in the welfare. Also the difference of welfare on farms with horned goats and farms with dehorned goats was assessed. Results should be taken with care since there is an influence of farm size, farms with horned goats were smaller and farm size is correlated with negative emotions from the Qualitative Behavior Assessment. Health issues were lower on farm with horned goats (P=0.008). Overall it seems that housing conditions, group stability, feeding management and farmer-animal relationship, rather than presence of horns had an influence on social stress and injuries. The conclusion is that the protocol provides a provisional and practical tool for on-farm assessment of organic goat farms.

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1. INTRODUCTION

1.1 DAIRY GOAT SECTOR IN THE NETHERLANDS

The dairy goat sector in the Netherlands developed and professionalized the last century. The image of the goat changed from a poor man's cow into a milk production animal (Cornelissen et al., 2013). Since the start of the milk quota in 1984 some dairy farmers replaced their cows for goats. But not only dairy farmers also pig and chicken production farms changed to goats. It is a sector easy to access and the market is not yet satisfied. For the same reason new starters of agricultural business choose for goats. The last 10 years the number of goats spectacularly increased (from 98.077 in 2000 to 295.539 in 2014) (CBS, 2016) although the number of farms decreased (from 838 in 2000 to 495 in 2014) (CBS, 2016). One of the reasons for this growing goat sector is the outbreak of foot and mouth disease in 2001. Dairy farmers who had their cows culled had to decide a new strategy and saw that the goat milk price was higher than cow milk. At the moment it is the pig sector that is facing difficulties being economical viable which forces farmers to switch (Bremmer et al., 2012). While the goat sector is still attractive due to a high demand of goat milk in china, giving a high milk price (Dubeuf et al., 2004).

From the 495 goat farms around in the Netherlands around 60 farms are organic (SKAL) part of them process the milk into products on farm (CBS, 2016).

Although the goat sector increased it is still a minor production in terms of economic value. That's one of the reasons not a lot of research is done on goats compared to cows (Martini et al., 2015) The goat sector has a positive image (Cornelissen et al., 2013). It is a small sector and most goats are housed on straw bedding where they can walk freely. Also the high amount of organic farms (~12%) adds to the good image for the consumer (Morand-Fehr et al., 2004). However since the outbreak of Q-fever in 2011 more attention is paid on the goat sector and the image is affected (Swinkels & Karstens, 2015). From the European Union more focus is now on animal welfare and diseases (Veissier et al., 2008). A good monitor tool to check and improve goat welfare is urgent to create trust and the support of society.

1.2 WHAT IS ANIMAL WELFARE?

The first initiative from the EU to protect animals was in the '70s. The main motive was the competition between countries that could become unfair with the different national laws on animal welfare (Veissier et al., 2008). A first attempt to make clear what the basics of animal welfare are is done with the five freedoms (Farm Animal Welfare Council, 1993). The Five Freedoms (Figure 1) address both physical fitness and mental suffering. That does not mean animals should be always free from any exposure to any stress. The aim is to prevent suffering, something that occurs when an animal fails to cope with the stress factor because the factor is too severe or the animal is prevented to take any action against the stress factor (Webster, 2001).

Welfare is defined in many different ways with each a different point of view. In the paper of Wiepkema and Koolhaas, 1993 is stated: "welfare is present when an individual can reliably predict or control relevant events". Spruijt et al., 2001 states that "welfare is the balance between positive and negative experiences". Animal welfare refers to the state of the animal and how it is coping with the environment it lives in (World Organisation for Animal Health). Animal health is only one part of welfare. Poor welfare does not always imply

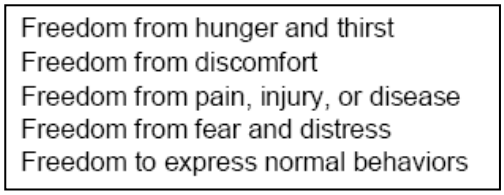


FIGURE 1 THE FIVE FREEDOMS (FARM ANIMAL WELFARE COUNCIL, 1993)

that the animal's health is poor (Dawkins, 2008). One important aspect of animal welfare is the degree to which animals are capable of fulfilling their behavioral needs (WelfareQuality®, 2009a).

For an improvement of animal welfare a scientific understanding of the factors that are related to animal welfare is needed, next to an understanding of the ethical and economic incentives to improve animal welfare (Webster, 2001). The monitoring of animal welfare could be used by researchers, certification bodies and veterinarians. It also could be used as an advisory tool and a management tool by farmers (Caroprese et al., 2009).With the Amsterdam treaty in 1997 a legally binding protocol on animal welfare was made by the European Union but the protocol leaves the countries free to introduce national legislation (Veissier et al., 2008).

The welfare requirements in the conventional goat husbandry in the Netherlands are limited to the space in the stable. In most farms the animals are kept inside all year round. Giving the animals the possibility to graze on pasture is obligatory for organic farms. Access to pasture gives the animals the opportunity to express natural behavior (Ruis, 2010).

Scientific welfare studies are still at the beginning so the state of animal welfare on-farm depends partly on the reference to other farms. The indicators that show the level of welfare of goats need to be developed further since animals cannot tell how they feel. The hypothesis is that welfare is more than endangered health level or affected stress levels (Duncan, 2005). The expression of natural behavior seems to be important in welfare quality but it is difficult to know exactly what the natural behavior of the goat is since goats are domesticated 10.000 year BC (Veissier et al., 2008). The question is to what extend farmers can provide a natural environment for the goats since they are production animals, since the milk price is really low and farmers have to take into account the cost price. But it might turn out that if the animal has more possibilities to behave naturally, it has a positive effect on the animal's health in the long term and with that economical benefit for the farmer (Lusk & Norwood, 2011).

The domestic dairy goat is a sociable, inquisitive, and intelligent species. During domestication, many of the behavioral traits of the wild types were replaced by those found in existing domesticated populations (Miranda-de la Lama & Mattiello, 2010). Captivity and management practices, especially in intensive production systems, can limit the opportunity to express these behaviors (Miranda-de la Lama & Mattiello, 2010; Andersen and Bøe 2007, Jørgensen et al 2007). The social structure of the group can become unstable due to stress. Goats are sensible to group hierarchy (Barroso et al., 2000), groups should be kept stable. Whenever it is possible, individual animals should not be isolated. The dominance order in the herd is influenced by age, size, breed, sex, aggressiveness, experience, the presence of horns, horn length (Barroso et al., 2000), and individual differences (Miranda-de la Lama & Mattiello, 2010). Males are often dominant over females, but a female with horns can dominate a male without horns. In general, horned goats are dominant over the others and they occupy more space at the feed trough than do hornless goats (Aschwanden et al., 2008).

1.3 AIM OF THIS PROJECT

From the European Union as well as from the consumer site more attention is paid to welfare in animal production systems. Especially in organic systems the EU put high norms on welfare and natural behavior of the animals which should be implemented in the national law (EFSA, 2016). Another reason for the interest to develop a welfare protocol next to ethical reasons is the fact that welfare issues can be linked to economic performance. Research has shown there is a direct link to milk yield, milk composition, conception and growth rate (Battini et al., 2015). The outcome of a welfare assessment can be used to find concrete factors for welfare improvement

on farm level which may consequently improve the economic performance. For production systems of cattle, pigs and poultry well tested protocols are set up to evaluate the welfare of the animals. Now also for small ruminants protocols are being developed and tested in different countries.

The protocol that is developed for the Netherlands and Belgium is based on a Norwegian protocol for dairy goats (Muri et al, 2013). The Muri protocol is developed with a review of the literature on goat health and some animal-based parameters were included based on extrapolation from other species. The Welfare Quality® project 2009 was used as a guide to design the first drafts. After a test on 30 goat farms in Norway modifications were made to the protocol based on these experiences. The Muri protocol for goats has proven to be valid, reliable and to have some common criteria with consumer perception of animal welfare (Muri et al, 2013).

According to the Muri protocol indicators to assess animal welfare can be split in five view points: animal based indicators, farmer-animal indicators, management indicators, resource based indicators and environment indicators. With the first indicator included are factors as behavior and condition. This can be assessed with a Qualitative Behavior Assessment, body condition score and an overall health check: diseases, hair coat, udder health, ears, eyes, nose, lips, hooves, and lameness. Farmer-animal indicators are the farmer's approach to the animal and the reaction of the animal on the farmer. Included in management indicators can be feeding, hygiene in the stable and the milking. Resource based indicators are for example access to pasture, possibilities to climb, queuing during feeding, number of drinkers. Environment indicators are climate in the stable, for example temperature, draught, humidity and lux are measured.

In 2014 Jo Vicca, a Dr. in Veterinary Medicine and teacher and researcher at the KU Leuven, adapted the welfare protocol for dairy goats described by Muri et al. (2013) for the use on goat herds in Belgium and The Netherlands. The main difference with goat systems in Norway is the housing and the climate. In Norway the floor types of the building can be deep litter, wooden slats, plastic/composite slats or expanded metal grating. In Belgium and the Netherlands all goats are housed on straw bedding. Regarding the climate it is more important in Norway to have insulated and light buildings since the climate is colder and light intensity lower for a larger part of the year. The protocol (called from now on protocol 1.0) is usable to assess welfare issues on goat farms in either conventional systems as organic systems but since consumers expect higher welfare norms in organic systems the focus is on organic. The complete work-out of this protocol 1.0 took 10 h on the herd which is too time-consuming to be used on a regular basis. The protocol need to be short and easy to use so that it can serve as a tool for veterinaries, researchers and hopefully farmers to do a welfare analysis themselves. The aim of this study is to shorten the protocol 1.0 and test if this summary protocol (called from now on protocol 2.0) is still able to predict the general welfare status on a goat herd and is able to point out welfare working points.

Since there is a question from the sector about the difference in welfare on farms with horned goats and farms with dehorned goats this factor is analyzed while testing the protocol 2.0. Disbudding of goat kids is a common procedure in dairy goats and is done by thermal cauterisation. But the risk of complications and severe traumata (cerebral hemorrhage) is relatively high due to the thin skull and the relative large size of the horn buds (Alvarez, 2009; Thompson et al., 2005). It is justified by a possible higher risk of injuries and higher stress levels when keeping horned goats as compared with hornless ones (Pugh & Baird, 2012; Al-Sobayil, 2007; Szabó, 2011).

Research questions:
- How can the extended protocol 1.0 for the analysis of welfare of goats on farm level be adjusted to a shorter and easy to use protocol 2.0?
- What can be improved in this summary protocol 2.0?
    - related to indicators on animal conditions and behavior
    - related to indicators on farm facilities and management
- What is the influence of the presence of horned animals on the overall welfare in the herd?
- What are the main welfare improvement factors in organic goat systems in the Netherlands?

2. MATERIAL AND METHODS

In 2014 Jo Vicca tested the extended protocol 1.0 on 10 different goat farms in Belgium and the Netherlands. The summary protocol 2.0 is developed together with Jo Vicca, based on the data of the testing of the extended protocol 1.0. A further comparison of protocol 2.0 with The Welfare Quality® protocol and the meanwhile published AWIN protocol (2015) did result in a further optimization of this protocol 2.0 (for the comparison see Appendix 1). The final protocol 2.0 is included in Appendix 6: Protocol 'Welfare score of dairy goats').

To come to a summary protocol changes were made in the indicators. For the animal based indicators the most important one was that the number of individually observed goats is brought back from 30 to 12 goats. Ella Roelant, a statistician in the KU Leuven, calculated that this is the minimal number of individually observed goats needed for a statistic analysis. 6 goats are marked by the farmer to observe the farmer-animal interaction. Also some indicators are taken out. In the individual goat observations the indicator lice is taken out since it is very time consuming to assess. The indicator skin changes on knees and hocks is taken out since it does not necessarily lead to welfare problems. Instead cleanliness of the sternum is added; this tells something about the time lying down and can be related to lameness. Body condition score is measured by the lumbar score; sternum scoring and other scoring variations are taken out. Furthermore subcategories of some indicators are minimized. For the indicator claws one claw is observed instead of 4. The coat condition is reduced from 4 sub-categories to normal coat condition or abnormal coat condition. For the resource based indicators queuing during feeding is added as an indicator instead of number of spaces at feed rack and the feed space in cm. For drinking there were no problems observed with queuing so the number of drinkers is counted. The indicator leftover roughage at 1 hour after feeding is taken out because it does not say anything about the welfare of the herd. The indicator space per goat is taken out since the law states the minimal amount of space per animal required and in the test all farms had enough space per goat. Since Belgium and Dutch goats are always housed on straw the indicator floor type taken out. Instead bedding quality and cleanliness are used. The indicator number of sharp protrusions in the pen is taken out since it is really difficult to find them all and skin lesions can tell more on this factor. For environmental indicators the indicator CO2 is taken out since no problems were found in the test with high levels of CO2.

The summary protocol 2.0 is tested on 10 different organic goat farms in the Netherlands in April and May 2016 in order to test the scoring systems and assess the feasibility and relevance of the used indicators and methods. Goat farms that are registered in SKAL (the organic certification body in the Netherlands) or 'de Groene Geit' (an association for organic goat farmers in the Netherlands) are contacted and asked to participate in a welfare assessment on their farm. Selection criteria were the farm size and the presence of horned or hornless goats. Different farm sizes were wanted as well as farms with and without horned goats. The farm

visits started at morning feeding. Only one farm per day is visited with at least one day in between two visits to minimize disease transmission.

The number of adult dairy goats on each farm ranged from 98 to 1750 with a mean (± SD) of 568 (± 544). The average milk production had a range of 700l to 1100l with a mean (± SD) of 933 (± 141). The main breed is White Dutch milk goats, a Dutch version of Saanen, but crossbreeds with Toggenburger are often seen. Three of the ten farms had horned goats. For analyzing the farms are numbered, the farms with horned goats are number 2, 9 and 10.

On farm, group observations and individual observations are done. 12 goats are selected for individual assessment. 6 goats that represent the farm are selected by the farmer, 6 goats are ad random selected by the researcher. Goats need to be housed during the observations and the farmer needs to be around to answer a questionnaire. A stopwatch, a centimeter, a collar to hold the goat, a thermometer, hygrometer, lux meter and draught meter are taken. Next to that the protocol sheets are taken to fill in. Observations are done by one trained person, but an assistant can be useful to catch the goats.

The order of the protocol is shown in Figure 2. When arrived on the farm an appointment was made with farmer for the questionnaire later in the morning. The farmer was asked to give a short explanation about the structure of the stable (how many pens are there, where are the lactating goats, where is the milk parlor, etc.). A sketch of the building was made. The farmer was asked if it was allowed to enter the pens and catch the goats and if the farmer could mark 6 goats that represent the farm. The test human-animal interaction could be done. Then resource based indicator tests started with the test: queuing for the feeding rack and the number of kneeling goats if there was already feed provided.

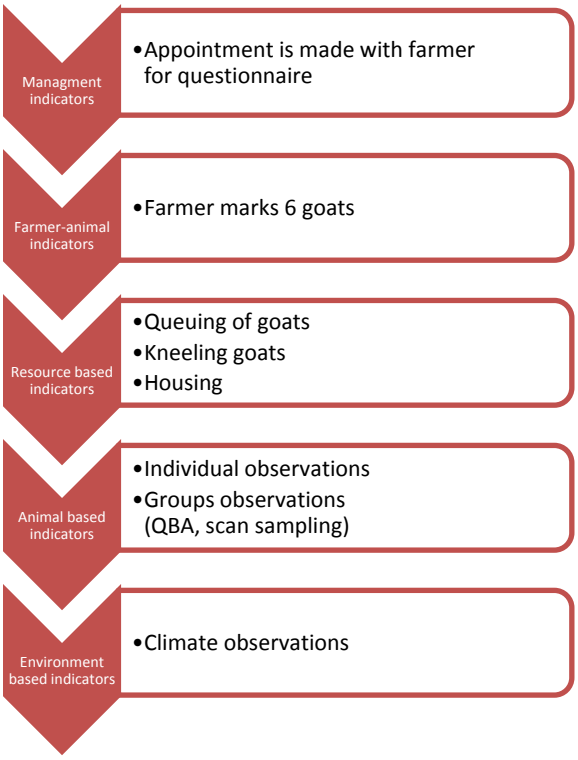


FIGURE 2 ORDER OF OBSERVATIONS

After this the 12 selected goats were caught one by one for individual observations. First the goats' fear of unfamiliar humans was assessed (chin contact test) by lifting the hand with the palm pointing upwards toward the goat's chin. Then the rest of the health check was done including nasal discharge, ocular discharge, pinnae pathologies, lips/mouth, hornes, skin lesions, vaccination bulbs, enlarged lymph nodes, coat condition, swollen joints, body condition score, chest girth, claw conformation, cleanliness of sternum, cleanliness of hind quarters, diarrhea, lameness, udder asymmetry, udder conformation, clinical mastitis, udder nodules, teat lesions, udder hygiene and skin lesion on udder and teats.

After the individual goat observations, around 1 hour after the morning feeding, the group observations were done as the Qualitative Behavior Assessment and the scan samplings. A pre-fixed list of descriptors was used for the QBA and scan sampling. The descriptors used in the QBA included 19 fixed terms: resting, aggressive, inquisitive/interested, fearful, calm/indifferent, active, apathetic, relaxed, agitated, frustrated, friendly, irritated, positive behavior, playful, bored, uncomfortable, social, tense and lively. A rough indication on a scale bar was given for each descriptor during the test; these results are transformed into percentages

afterwards. In the scan sampling the following behavior is used: laying, walking, standing, running, drinking, eating, ruminating, browsing, sleeping, crabbing, playing, licking, aggressiveness and scratching. Two segments of the stable with around 25 goats each were taken; each segment was observed for two times 5 minutes. For each behavior, every 30 seconds the number of goats in the segment that showed this behavior was noted down.

Around 11h environment indicators were measured outside and inside on different spots in the stable on the height level of the goats. The optimal temperature in the stable is between 10 and 15 °C. Temperatures below 6 °C or above 27 °C can have negative effects on the production and gestation (Vicca, 2016). A dry stable is really important for goats since they don't like rain. Strong draught must be avoided but ventilation is important to regulate temperature, humidity and noxious gases (Sevi et al., 2009). Optimal humidity is between 60% and 80%. Higher or lower percentages can cause lung problems. Light intensity should be above 200 lux. Lower light levels have an influence on hormone levels and with that production loss (Vicca, 2016). Ammoniac levels should be below 10 ppm. In this research there was not the possibility to take a Ammoniac level meter so this indicator is not measured.

Resources based indicators, apart from queuing and kneeling at the feedlot, are looked at in between other observations. These indicators are type of housing (insulated/non-insulated), hygiene of the building, enrichment, possibility to climb, enrichment outside, automatic feeder, signs of gnawing on interior, type of drinkers, functioning and cleanliness of drinkers, bedding amount and cleanliness. When the farmer had time, for example during coffee break, the questionnaire was done.

The data were entered into Microsoft Office Excel and SPSS. With the data, a descriptive analysis was made. Means between goats selected by the farmer and goats selected ad random are compared with a t-test to see if there is a difference in the samples.
In SPSS a Principal component analysis (PCA, correlation matrix, rotation) was made out of the Qualitative Behavior Assessment (QBA) to see if the results could be clustered. The hypothesis was that the goats on farms with horned goats show more calm emotions since this was noticed during the farm visits. A Principal component analysis (PCA) is a statistical procedure that converts a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components (setosa.io).
A spearman's rho test is used to find correlations between different welfare factors (for data see Appendix 2). In the correlation test emotions of the QBA are grouped as positive and negative emotion with as positive the mean of resting, inquisitive, calm, relaxed, friendly, playful, positive behavior, social and lively. Negative emotions are the mean of aggressive, agitated, frustrated, irritated, bored, uncomfortable and tense. Behavior in the scan sampling is also grouped as positive and negative behavior with as positive the mean of laying, eating, drinking, ruminating sleeping and playing and negative behavior is taken as aggression. A Kruskal Wallis test is used to show a significant difference between the data of the scan sampling; the difference in behavior between farms.

Special attention is paid in the analysis to the difference in farms with horned and farms with dehorned goats. The hypothesis is that herds with horned goats have more skin and udder lesions since they can hurt each other with the horns. A chi square test is used to compare means between the health results of horned goats and dehorned goats.

Part of the results is reported back to the farmers. Remarkable outcomes were discussed with the farmer at the end of the visit. Later by e-mail an excel file is send where they could anonymously compare their farm results with the other farms. In the meeting 'de groene geit' meeting other results will be presented for the farmers.

3. RESULTS

THE PROTOCOL

The total assessment took around 3 hours per visit. This is mainly due to the individual goat observations which take time to catch the goats.

3.1 FARMERS PERCEPTION OF MOST IMPORTANT WELFARE FACTORS – OUTCOME OF THE QUESTIONNAIRE

According to the average opinion of the farmers goats are sensible to group size and fixed groups are needed to keep the hierarchy stabilized. Ill goats should be given a quiet corner but should not be separated from the group since that gives more stress. If a farmer knows the animals he can know the needs of the goats and observe welfare issues by observing the behavior of the group. Most farmers would place brushes and climbing objects in the stable if they would have no economic limiting factors and if it would fit in the stable without being in the way while cleaning the stable. Other ideas to improve the welfare are trees in the stable, better ventilation and a fodder hedge in the pasture. Most farmers enjoyed the work with the goats. They agree with the statements that the way of the farmer handling the goats has a big influence on behaviour and performance of the goats and with this an influence on welfare. Goats are sensitive to changes in routine, it can deliver them stress and since stress is lowering the milk production this should be avoided. Noting the health and the welfare of goats can be done just by observing the goats, but farmers don't have always time for this. Farmers that are milking themselves stated that this was a good moment to observe the behaviour of the goats. For dehorning and claw trimming most of the time somebody is hired to do this. Figure 3 illustrates the behavioral attitudes, work motivation and general beliefs of the farmers about their work.

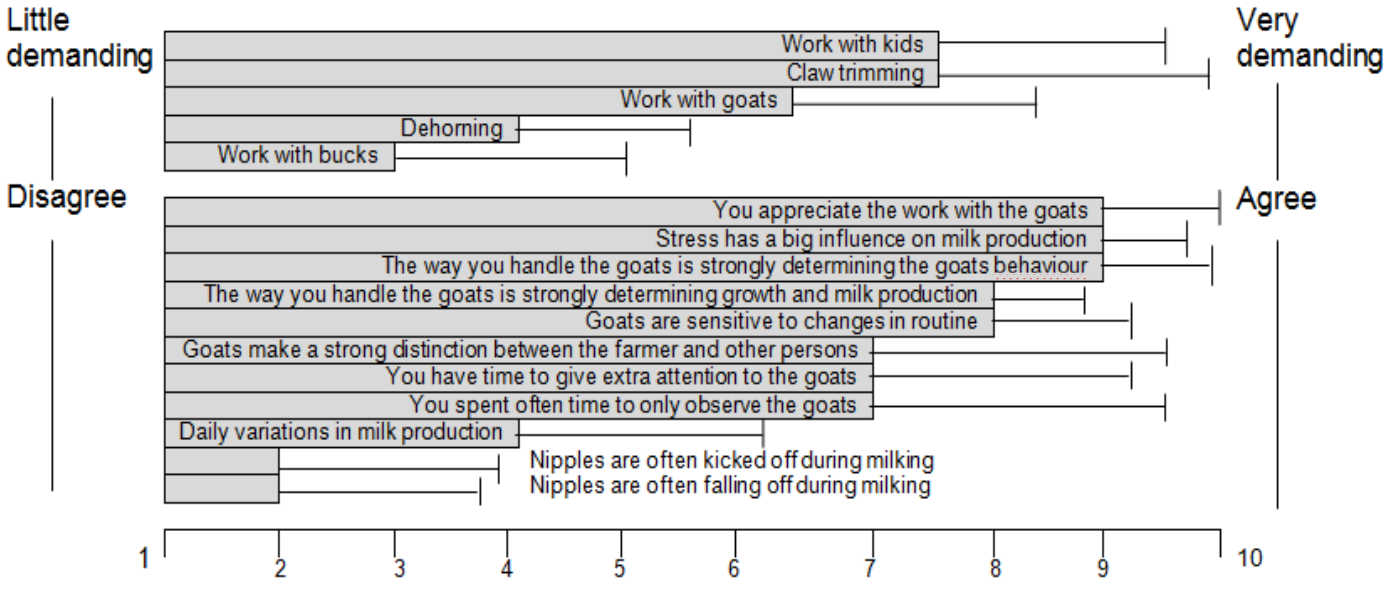
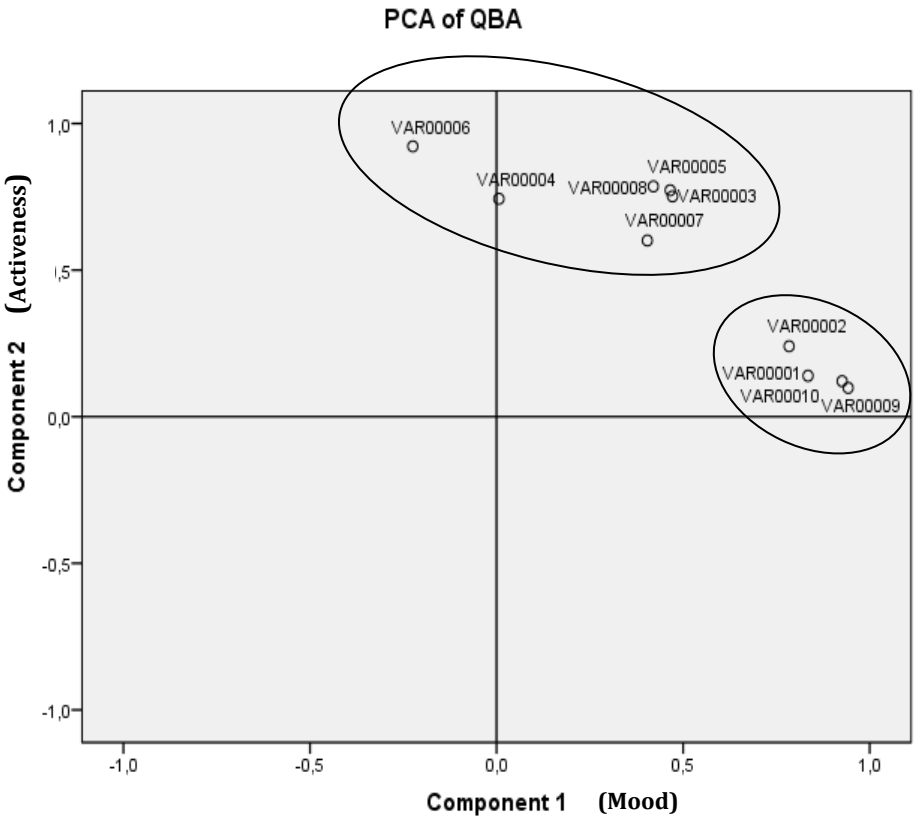


FIGURE 3 MEAN RESPONSES OF FARMERS TO QUESTIONNAIRE IN GREY BAR (+ STD IN BLACK LINE)

3.2. BEHAVIOR OBSERVATIONS

The PCA (Figure 4) of the Qualitative Behavior Assessment (QBA) scores for the 10 goat farms identified two main factors with eigenvalues greater than 1 (5.364, 2.166 for PC1 and PC2 respectively). The first two components together explained 75.2% of the variation between farms (53.6, 21.6 for PC1 and PC2 respectively). The suitability for factor analysis was assessed with the Kaiser–Meyer–Olkin. The value was 0.611, exceeding the recommended value of 0.6. Figure 4 shows the distribution of the descriptors along the first two PCA factors. The first Principal Component appears to distinguish generally between positive and negative mood. PC2 seems related to the level of activeness of the animals.



Rotated Component Matrix[a]

	Component	
	1	2
VAR00009	,942	
VAR00010	,926	,121
VAR00001	,835	,140
VAR00002	,784	,240
VAR00006	-,224	,922
VAR00008	,420	,786
VAR00005	,465	,773
VAR00003	,472	,752
VAR00004		,743
VAR00007	,404	,601

Extraction Method: PCA.

Rotation Method: Varimax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

FIGURE 4 PRINCIPLE COMPONENT ANALYSES OF THE QBA WITH TWO CLUSTERS. COMPONENT 1 CAN BE DESCRIBED AS MOOD, COMPONENT 2 AS ACTIVENESS.

There is a clear clustering of farm 3,4,5,7 and 8 and of farm 1,2,9 and 10. Farms 2,9 and 10 had horned goats and therefore an adjusted farm management meaning a smaller farm, more space for the goats and more attention for the goats by the farmer. Also all three farms had cheese production on-farm. Farm 1 is included in this cluster of unexplainable reasons. There is a difference in means (P=0.11) of emotion between the clusters made by the PCA (Table 1). Goats on farm 1,2,9 and 10 are overall more calm and relaxed while on farm 3,4,5,6,7 and 8 the goats are more active.

The correlation test showed that on horned goat farms the goats showed less negative emotions (cor=-0,71). All horned farms are small goat farms (98-160 goats) and farm size is correlated with negative emotions (cor=0.68); so the bigger the farm the more goats showed negative emotions. It is not clear what factor has a bigger influence on the state of emotions: horns or farm size.

Other outcomes of the PCA and the correlation test are presented in discussion.

TABLE 1 THE MEAN (%) OF EMOTIONS DIVIDED BY THE CLUSTERS MADE IN THE PCA

Emotions	Farms 1,2,9,10	Farms 3,4,5,6,7,8
Resting	74	34
Agressive	18	27
Inquisitive/interested	38	77
Fearfull	5	28
Calm/indifferent	63	28
Active	20	68
Apathetic	7	7
Relaxed	88	49
Agitated	11	50
Frustrated	10	23
Friendly	72	72
Irritated	12	21
Positive behaviour	77	70
Playful	25	55
Bored	23	18
Uncomfortable	4	39
Social	75	75
Tense	6	43
Lively	34	67

Scan sampling results are presented in Figure 5A,B. The Kruskal Wallis test (See Appendix 3) showed there is a significant difference in behavior between the farms (P=0.00, P=0.003 for aggressiveness). In general there is not much locomotion, most of the goats are or laying or standing. Farm 6 stand out in the eating behavior and activity is high. This is the farm with the feed machine, every time the machine past by the goats stand up to eat. In Figure 6 the difference in activity per farm is showed. This is the number of goats standing v.s. laying. The difference between farms with horned goats and dehorned goats (P=0.01) can be seen very clearly in this. On the farms with horned goats the goats are less active. In the correlation test positive behavior is correlated to horned goats (cor=0.8).

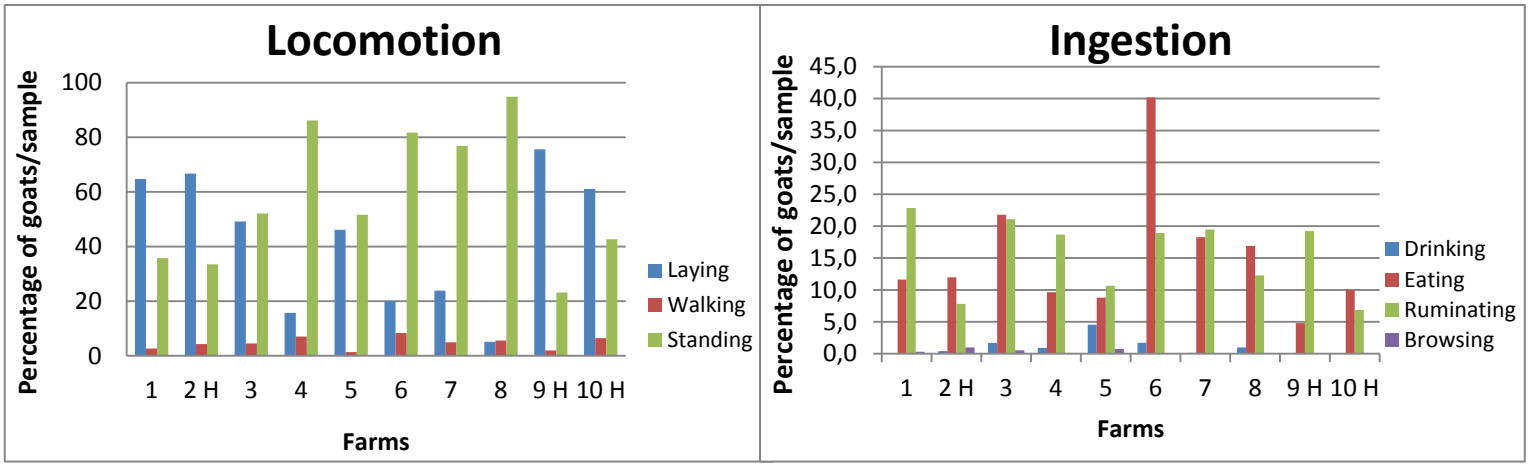


FIGURE 5A RESULTS OF SCAN SAMPLING: LOCOMOTION, INGESTION (PERCENTAGE OF GOATS/ SAMPLE). H MEANS FARM WITH HORNED GOATS

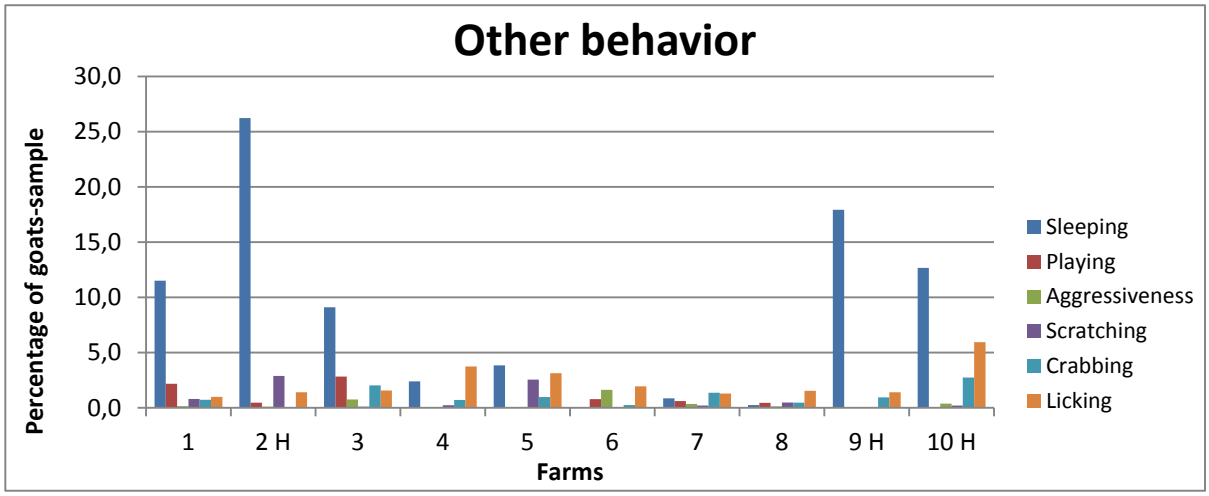


FIGURE 5B RESULTS OF SCAN SAMPLING: OTHER BEHAVIOR (PERCENTAGE OF GOATS/ SAMPLE). H MEANS FARM WITH HORNED GOATS.

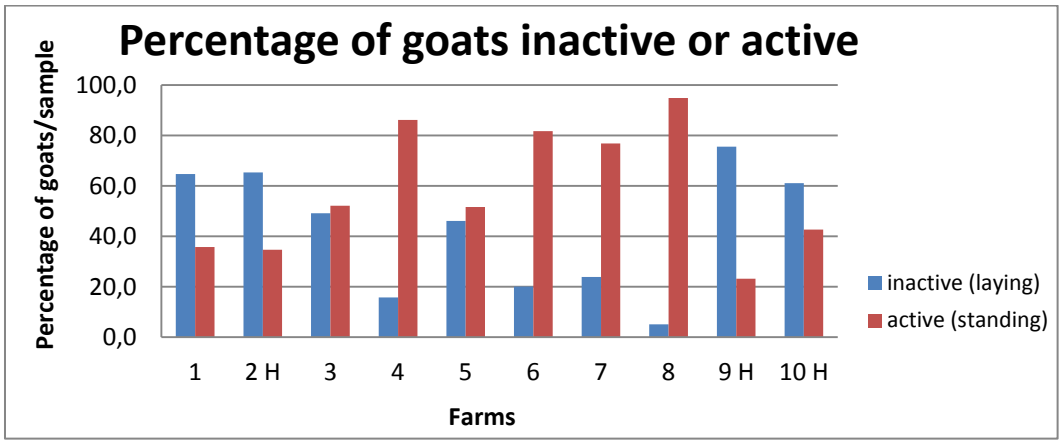


FIGURE 6 GOATS INACTIVE OR ACTIVE PER FARM (IN PERCENTAGE) H MEANS FARM WITH HORNED GOATS

3.3 INDIVIDUAL GOAT OBSERVATIONS

The overall prevalence of the health indicators recorded during the individual goat observations of 12 animals on each farm are presented in Table 2. There was no statistic significant difference between the results of health indicators of goats selected by the farmer or by the observer (P=0.97). The observations are grouped for horned and dehorned goats.

Main health problems are found in the claw conformation (58% of observed goats)(scores 2 to 4 are taken as problematic), vaccination bulbs (36%), horn regrowth after disbudding (23%), pinnae pathologies (20%). There were no major health problems found. In the chin contact test 42% of the goats pulled their head back (score 1 and 2 in the test). Chest girth measures ranged from 80 to 122 cm, with a mean (± SD) of 100 (± 8.12) cm. Mean (± SD) body condition score was 2.5 (± 0.7), and ranged from 1.25 to 4.0. BCS has a significant correlation with chest size (P=0.00). The recommendations for BCS of dairy goats under intensive conditions are >2.0 and <3.5 at dry-off; >2.5 and ≤3.5 at parturition; and >2 at peak lactation (Smith and Sherman, 2009; Vieira et al., 2015). 16.7% of the individual observed goats were too thin (BCS<2.0). 7.5% were too fat (BCS>3.5%). The main diseases occurring on the visited farms are Mastitis *(Staphylococcus aureus)* and Enterotoxemias *(Clostridium perfringens)*. All farms are obligatory vaccinating for Q-fever, most farms are also vaccinating for para-tbc and clostridium.

In the comparison of the health status of horned and dehorned goats we can see that horned goats have overall less health issues (P=0.008). Only the Body Condition score is on average lower on farms with horned goats. The reason for this is not clear. The hypothesis that herds with horned goats have more skin and udder lesions is not confirmed (See appendix 4 and 5).

TABLE 2: SUMMARIZED OUTCOME OF THE INDIVIDUAL ANIMAL OBSERVATIONS OF THE 10 VISITED FARMS. IN YELLOW THE % OF GOATS ABOVE 15%

		Total goats N=120	%	Dehorned goats N=84	%	Horned goats N=36	%	Farms in total N=10	%
Observations in front of the goat	**Chin contact test**	50	42	41	49	9	25	9	90
	Nasal discharge	15	13	14	17	1	3	8	80
	Ocular discharge	10	8	7	8	3	8	5	50
	Pinnae pathologies	24	20	23	27	1	3	6	60
	Lips/mouth	4	3	3	4	1	3	3	30
	Not well disbudded horns	27	23	27	32	-	-	9	90
	Skin lesions head/neck	17	14	16	19	1	3	6	60
	Severe skin lesions	7	6	7	8	0	0	5	50
	Vaccination bulbs	43	36	33	39	10	28	10	100
	Abscessed/enlarged lymph nodes	9	8	8	10	1	3	5	50
	Rib fracture	8	7	6	7	2	6	4	40
Observations behind the goat	**Skin lesions hindquarters**	3	3	2	2	1	3	3	30
	Severe lesions	0	0	0	0	0	0	0	0
	Vaccination bulbs	3	3	3	4	0	0	2	20
	Lymph nods	2	1,7	1	1	1	3	2	20
	Lower coat condition	14	11,7	10	12	4	11	6	60
	BCS <2.00	20	16,7	12	14	8	22	8	80
	>3.5	9	7,5	9	11	3	8	5	50
Limbs and joints	**Lameness**	0	0	0	0	0	0	0	0
	Swollen joints	0	0	0	0	0	0	0	0
Claws and cleanliness	**Poor claw conformation**	70	58	59	70	11	31	9	0 90
	Dirt on sternum	16	13	16	19	7	19	3	30
	Dirt on hind quarters	9	8	9	11	5	14	6	60
	Diarrhoea	1	1	1	1	0	0	1	10
Udder	**Asymmetry**	3	3	3	4	1	3	3	30
	Poor conformation	10	8	10	12	3	8	5	50
	Clinical mastitis	0	0	0	0	0	0	0	0
	Nodules	8	7	8	10	1	3	5	50
	Teat lesions	3	3	3	4	0	0	2	20
	Skin lesions or impetigo on udder and teats	5	4	5	6	4	11	3	30
	Hygiene	1	1	1	1	0	0	1	10

3.4. RESOURCE BASED AND CLIMATE INDICATORS

The goats had access to pasture on all farms since it is obligatory in organic goat farming. The time they can go on the pastures is around 6 month/year. On 30% of the farms the goats had year round access to an outside space. The number of times feedings per day by the farmer were varying from 2 times to 8 times, 1 farm had an automatic feeder. Four farms had enrichment in the stable. Only one farm had build in laying platforms. Three farms provided browsing material in the form of straw/hay racks in the stable. Two farms had brushes for the goats to scratch. The observations during feeding time showed that on 4 farms there were no goats queuing at the feed rack, this means that there is enough space for feeding. The others farms had an average of 3.2 goats queuing (0.3% of the goats). Only on 1 farm the goats were kneeling at the feed rack.

Table 3 shows the climate factors measured in the stable and outside at 11am and the recommended values.

TABLE 3 CLIMATE FACTORS LIKE TEMPERATURE, DRAUGHT, HUMIDITY AND LIGHT INTENSITY

	Indicators	Mean	Range	Recommended (Vicca, 2016)	% farms with a value outside the recommended range
Outside	Temperature (°C)	12,2	9,2-16,2		
	Wind speed (m/s)	1,0	0,1-2,14		
	Humidity (%)	62,5	52,5-73		
	Light intensity (Lux)	1899	850-3050		
Inside	Temperature (°C)	14,3	10-17	10 -18 °C	0 %
	Draugth (m/s)	0,2	0,08-0,32	<0,2 m/s	40 %
	Humidity (%)	61,4	39,2-75,7	60%-80%	30 %
	Light intensity (Lux)	810	100-1727	> 200	10 %

4. DISCUSSION

4.1. PROTOCOL

Welfare indicators to be included in a protocol for on-farm assessment should be easy to apply and to interpret (Farm Animal Welfare Council, 2005). In addition, the indicators must be valid, which means that they should be important in respect of animal welfare, and reliable, which indicates the tendency to give the same results by two or more observers (Napolitano et al., 2009). Most of the tests used in this protocol are well known and validated in other research. Also the reliability is tested in previous research.

Using the new developed protocol it can be concluded that on organic goat farms in the Netherlands there is an overall satisfactory level of welfare; there were no shocking welfare problems found although there are always improvements. Results per farms can be linked and explained to give an on-farm advice for improvements. The assessments of the protocol could be performed during a morning (3h), by a single observer. However it is easier when it is done by two (one assistant). On the one hand, the fact that the prototype protocol can be done in one morning is an advantage. On the other hand, however, doubts may arise if an assessment of the welfare in such a short-term is meaningful for welfare over longer-periods of time (Lawrence

and Conington, 2008). But since the protocol is used as a practical tool for researchers and veterinarians it has to be a short protocol. It could be interesting to assess the welfare on 1 farm at different times of the year to see if there is a difference.

4.2. HUMAN-ANIMAL INTERACTION INDICATORS

Human-animal interactions play a principal role in sustaining the welfare and production of domestic animals (Jackson and Hackett, 2007; Muri et al., 2012). Goats can suffer if handling is inappropriate but also when it is excessive since there is still an ancestral predatory fear. Therefore goats can suffer when rearing practices change suddenly, in terms of time, place and stockmen involved in milking or when regrouping and relocation occur suddenly or frequently (Sevi et al., 2009). The quality of the relationship between the animals and their handler is a key factor affecting animal welfare (Napolitano et al., 2011). However the handling test in this protocol, where the relation between farmer and animal is tested, is proved difficult to assess. The farmer is asked to select 6 of his animals and should walk in between his animals. This gives the researcher good insight in the farmer-animal relationship. However, some farmers refuse to go inside the pen because it can disturb the animals and some marked the animals during milking or from outside the pen. This makes the test useless and unfortunately as researcher it is not possible to oblige the farmer to go into the pen.

Also the reaction of the goats on humans is difficult to assess. The chin contact test is not ideal because the goat is restrained from moving. There are other tests like the avoidance distance (Welfare Quality®, 2009a). In this test the observer walks in a straight line towards the animal with his hand stretched out, the moment the animal turns away the distance between the nose of the animal and the hand is estimated. However when you walk in a straight line towards the goat most goats sense there is something wrong and will panic. Another test is the latency to the first contact test (AWIN, 2015). The observer stands motionless with the back against the wall or the feed rack and measures the time until the first goat comes to nuzzle at the observer. Critic for this test can be that in every herd there are some goats with no fear so this test will not give a good indicator of the overall fear for humans of the herd. The best way to test the animal fear for humans is probably by observing the goat's behaviour when the goat is strained during the individual observation. The goat will either accept being strained or struggle all the time.

4.3. ANIMAL BASED INDICATORS

Behavior studies can tell a lot about animal welfare. Normally goats have an alert, attentive, and inquisitive mental attitude (Miranda-de la Lama & Mattiello, 2010). In these observations no use is made of video cameras so the influence of the observer could have an impact. Also it is a moment observation which may be influenced by the time of the day or unusual disturbing factors (Dawkins, 2004). A Qualitative Behavior Assessment (QBA) is giving an idea about the emotional state of the animals. The animals are observed as a group and emotions as active, friendly, irritated are noted down on a scale bar. This method is sometimes described as anthropocentric and subjective (Wemelsfelder and Farish, 2004). But it depends on the skill of the observer to integrate large amounts of input into meaningful descriptive terminologies without being subjective. QBA describes the behavior with terms that have positive or negative emotional components. These should be interpreted carefully since for example alert and active behaviour of the animals may not necessarily be a positive indicator of their welfare. That is why a whole list of indicators is used during the QBA; together they can give a picture of the emotional state of the herd.

Scan sampling is a method used to record all the animal's activities at pre-selected moments (e.g., every 30 seconds). It is used to study the percent of time spent in a certain activity. This

provides data on the distribution of behavioral states in the herd (Lehner, 1992). A scan sampling protocol was developed to include in the welfare protocol (Vicca et al., 2014). Using this protocol on the farms starting 1 hour after morning feeding we see clear difference in behavior between farms. The behaviour on each farm can be related to factors on the farm and explained individually. For example on the farm with an automatic feeding system the scan sampling showed that the activity of the goats is much higher because goats don't eat in a group at fixed moments but separate and continuously during the day, they spent more time eating. From the correlation study we see that positive behaviour is negatively correlated to farm size (cor=-0.67). This could be explained that on large farms the group size is also larger resulting in a less stable group hierarchy but this could be researched further.
As goats are quite sturdy animals they may not express pain or distress obviously. Goats are originally animals of prey which makes it possible that in the evolution goats that show signs of pain had a disadvantage (Miranda-de la Lama and Mattiello, 2008). Therefore, methods to assess welfare and pain in farm animals objectively are required. To get a good inside of the animal's health not only group observations are done but also individual animal observations. With palpation and a close look at the goat health issues can be possibly found (Table 2). Main health problems in the farms visited are found in the claw conformation (58% of observed goats), vaccination bulbs (36%), regrowth of disbudded horns (23%) and pinnae pathologies (20%).

In Dutch and Belgium goat systems claw trimming is essential since goats walk on straw in the stable and on grassland outside, which are all soft surfaces. Untrimmed claws grow into a variety of shapes, putting unusual pressures on leg ligaments and tendons, causing pain and distorting their normal shape. This can cause difficulties in walking and eventually goats go down on their knees. This posture can become permanent. Claw conformation can be improved by cutting the claws more than two times a year (Ajuda et al., 2014). All farm visits were performed just before the next claw cutting. But nevertheless the claws were often overgrown in a way it could not be improved by one time cutting. Regrowth of disbudded horns were likely to have resulted from incomplete disbudding of goat kids. The regrowth may harm the animal they belong to by growing at an angle that injures the head and the partial horns may injure other animals in the group (Azuino et al., 2005). Pinnae pathologies were mostly due to torn out ear tags. Ear tags are often placed when the goats are very small, the ear tags can then be too heavy for the small ears, the ear tag is hanging down and makes the hole bigger than necessary. This results in a reduced welfare and impairs the goat's integrity and increases the risk of ear tag losses (Verkaik, 2001). Swelling of knees or other joints did not occur on the farms visited while in similar Norwegian research this is one of the main health problems (Muri et al., 2013). Swelling of knees is mainly caused by infection of the small ruminant lentivirus, causing caprine arthritis and encephalitis (CAE). This disease is actively eradicated in most commercial goat herds in the Netherlands (GD, 2016). Also lameness did not occur; maybe it could not be seen very well due to the deep litter stables or because the goats were not showing it out of distress. Therefore, we assume that the true prevalence of mild lameness was somewhat higher than observed. In similar research in Norway and England the prevalence of lameness was respectively 1,7% of 1520 goats observed and 19% of 596 goats (Muri et al., 2013; Anzuino et al., 2005). Lameness could maybe not individually be observed but on herd scale by walking slowly through the stable.

Body condition score (BCS) is performed to estimate the nutritional and health status of the goats. The frame size of an individual adult is constant, but deposition of fat and muscle (body condition) varies with nutritional and physiologic status. Critical times for scoring goats might include at the beginning of the dry season, dry-off, the last two weeks of gestation, six weeks into lactation, at turn-out onto pasture and at the beginning of the breeding season (Morand-Fehr et al. 1989). Goats with a low BCS have a higher chance of getting ill while goats with a high BCS are at risk to develop pregnancy toxemia. Too low or too high BCS also will lower fertility and productivity (Vieira et al., 2015).

4.4. RESOURCE BASED AND CLIMATE INDICATORS

The use of enrichment in the stable was very limited on the visited farms. Enrichment to create a more natural habitat, e.g. by adding additional spatial structure, has according to literature the potential to improve the welfare of animals (Andersen &Bøe, 2007; Jørgensen & Bøe, 2009; Aschwanden et al., 2009a, Aschwanden et al., 2009b; Ehrlenbruch et al., 2010). Farmers gave the reason that enrichment in the stable gives problems with using machinery in the stable.

Regarding climate measures most of the farms were in the recommended range of climate factors since springtime is not the most problematic time of the year. Only light intensity was on two farms a problem (Table 3). But on farms with a low light intensity in spring it would be interesting to measure again in winter when it can occur to be a problem.

4.5. COMPARISON FARMS WITH HORNED AND FARMS WITH DEHORNED GOATS

Results from the comparison of farms with horned and farms with dehorned goats should be taken with care since in this study the visited farms with horned goats were all small farms (98-160 goats) while all dehorned goat farms had a range from 200-1750 goats. Another factor that can influence the results is the fact that on the farms with horned goat young goats had been reared by their mothers. This could give the opportunity to form long term social bonds to their mothers. With the protocol we can conclude that horned goats behave more calm and show less negative behavior and emotions. Also skin lesions are less in horned goat herds. This can mainly be explained by the farm management on the farms with horned goats. The farmers implemented factors that can retain harmony within a group leading to a low level of competition and high level of social stability. These factors are grouping animals at an early age, keeping groups stable (Aschwanden et al., 2008, 2009a, b), ensuring that all resources are easily accessible by all the goats in the group (Barroso et al., 2000) and a high intensity of farmer-animal contact (Waiblinger et al., 2011; Szabó, 2011). Further support for this comes from the evidence that horned goats tend to either avoid each other or threaten each other without physical contact, and are avoided by hornless goats (Andersen & Bøe, 2007; Loretz, 2004). The behavior of horned goats contrasts with that of hornless goats, which frequently head butt, and might sustain injuries as a result (Aschwanden and others 2008). Other research showed a stricter dominance hierarchy in horned herds compared to hornless ones resulting in lower stress levels (Szabó, 2011).

4.6. PROTOCOL IMPROVEMENTS

The protocol can be developed further in the future by making a more easy way to assess the results. An importance score can be given to each factor of the protocol to make the possibility to come to an end score of each farm. Although this is risky since an end score on welfare does not give an explanation of the different factors and is not linking outcomes. But it can give a quick inside in the welfare of the farm. The buildup dataset of assessed farms can be used as a reference population to compare new assessed farms.

It would be interesting to test if group observations regarding health will have the same results as the 12 individual observations. These observations could be eventually replaced by group observations saving a lot of time and stress of capturing.

In follow-up research a link between welfare and economic factors can be made. This is already tried in past research but did not have a clear outcome yet since it is difficult to get access to all the economic data of the farms. But it can be interesting and useful for the farmers. When welfare factors are clearly linked to economic factors the farmers will be easier tempted to improve the welfare on their farm.

5. CONCLUSION

The present monitoring protocol 2.0 is tested on 10 farms in the Netherlands and is proved to provide a provisional and practical tool for on-farm assessment of organic goat farms. The list of indicators is giving a comprehensive image of the state of welfare on each farm and the indicators can be combined to get correlations. The protocol can still be improved by giving an importance score to each indicator to come to an end result and by linking the results to economic farm performance.

Specific health issues found on the farms are claw conformation, vaccination bulbs, regrowth of disbudded horns, and pinnae pathologies. Human-animal interactions are a key factor in the welfare of domestic animals like goats. There is still a need to find a good assessment tool for this indicator. Behavior studies like the QBA and the scan sampling are proved to give a good insight in the state of being of the herd and can be linked to other factors in the protocol. The use of enrichment in the stable was very limited but has according to literature the potential to improve the welfare of animals.

The results of the comparison between horned goat farms and dehorned goat farms should be taken with care since the factor of farm size is influencing. The farms with horned goats were smaller in amount of goats than on farms with dehorned goats (98-160 goats to 200-1750 goats respectively). The results show less health problems on farms with horned goats and more positive behavior. Farm size is correlated with negative emotions from the QBA (cor=0.68). The bigger the farm the more goats showed negative emotions. Overall it seems that housing conditions, group stability, feeding management and farmer-animal relationship, rather than presence of horns had an influence on social stress and injuries.

In conclusion, this study contributed to the development of a welfare protocol specific for dairy goats in the Netherlands and Belgium; a protocol that is needed to increase awareness of welfare and to improve the welfare of the animals where necessary.

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7. REFERENCES

Alvarez, L., Nava, R. A., Ramírez, A., Ramírez, E., & Gutiérrez, J. (2009). Physiological and behavioural alterations in disbudded goat kids with and without local anaesthesia. Applied Animal Behaviour Science, 117(3), 190-196.

Anzuino, K., Bell, N. J., & Bazeley, K. J. (2010). Assessment of welfare on 24 commercial UK. Veterinary Record, 167, 774-780.

Ajuda, I. G., Vieira, A., & Stilwell, G. (2014). Are there differences in dairy goats claws' temperature, before and after trimming?. In Medical Measurements and Applications (MeMeA), 2014 IEEE International Symposium on (pp. 1-5). IEEE.

Andersen, I. L., & Bøe, K. E. (2007). Resting pattern and social interactions in goats—the impact of size and organisation of lying space. Applied Animal Behaviour Science, 108(1), 89-103.

Aschwanden, J., Gygax, L., Wechsler, B., & Keil, N. M. (2008). Social distances of goats at the feeding rack: Influence of the quality of social bonds, rank differences, grouping age and presence of horns. Applied Animal Behaviour Science, 114(1), 116-131.

Aschwanden, J., Gygax, L., Wechsler, B. & Keil, N. M. (2009a) Structural modifications at the feeding space: effects of partitions and platforms on feeding and social behaviour of goats. Applied Animal Behaviour Science 119, 180-192

Aschwanden, J., Gygax, L., Wechsler, B. & Keil, N. M. (2009b) Loose housing of small goat groups: influence of visual cover and elevated levels on feeding, resting and agonistic behaviour. Applied Animal Behaviour Science 119, 171–179

AWIN. (2015) AWIN welfare assessment protocol for goats.

Barroso, F. G., Alados, C. L., & Boza, J. (2000). Social hierarchy in the domestic goat: effect on food habits and production. Applied Animal Behaviour Science, 69(1), 35-53.

Battini, M., Stilwell, G., Vieira, A., Barbieri, S., Canali, E., & Mattiello, S. (2015). On-Farm Welfare Assessment Protocol for Adult Dairy Goats in Intensive Production Systems. Animals, 5(4), 934-950.

Bremmer, B., Bos, A. P., Schuiling, H. J., & Ferwerda-van Zonneveld, R. T. (2012). Vooruit met de Geit.

Caroprese, M., Casamassima, D., Rassu, S.P.G., Napolitano, F., Sevi, A. (2009). Monitoring the on-farm welfare of sheep and goats. Ital.J.Anim.Sci. vol. 8 (Suppl. 1), 343-354.

Cornelissen, J. M. R., Kortstee, H. J. M., Bremmer, B., Immink, V. M., van Eijk, O. N. M., & van der Peet, G. F. V. (2013). Vooruit met de geit: bouwstenen voor een sector met ambitie. Wageningen UR.

Dawkins, M. S. (2004). Using behaviour to assess animal welfare. animal welfare-potters bar then wheathampstead-, 13, s3-s8.

Dawkins, M. S. (2008). The science of animal suffering. Ethology, 114(10), 937-945.

Dubeuf, J. P., Morand-Fehr, P., & Rubino, R. (2004). Situation, changes and future of goat industry around the world. Small Ruminant Research, 51(2), 165-173.

Duncan, I. J. H. (2005). Science-based assessment of animal welfare: farm animals. Revue scientifique et technique-Office international des epizooties,24(2), 483.

efsa.europa.eu/en/topics/topic/animalwelfare, retrieved February 2016.

Ehrlenbruch, R., Jørgensen, G.H.M., Andersen, I.L., and Bøe, K.E., 2010. Provision of additional walls in the resting area-The effects on resting behaviour and social interactions in goats. Applied Animal Behavior Science, 122: 35-40.

gddiergezondheid.nl, retrieved May 2016.

Jackson, K. M., & Hackett, D. (2007). A note: The effects of human handling on heart girth, behaviour and milk quality in dairy goats. Applied Animal Behaviour Science, 108(3), 332-336.

Jørgensen, G.H.M., Andersen, I.L., and Bøe, K.E., 2007. Feed intake and social interactions in dairy goats--The effects of feeding space and type of roughage. Applied Animal Behavior Science, 107: 239-251.

Lawrence, A., & Conington, J. (2008). Sheep welfare: A future perspective. In C. Dwyer (Ed.), The welfare of sheep (p. 343-360). Springer.

Lehner, P. N. (1992). Sampling methods in behavior research. Poultry science, 71(4), 643-649.

Lusk, J. L., & Norwood, F. B. (2011). Animal welfare economics. Applied Economic Perspectives and Policy, 33(4), 463-483.

Loretz, C., Wechsler, B., Hauser, R., & Rüsch, P. (2004). A comparison of space requirements of horned and hornless goats at the feed barrier and in the lying area. Applied Animal Behaviour Science, 87(3), 275-283.

Martini, A., de Almeida, C. C., Guilhermino, M. M., & Lotti, C. (2015). Evaluation of dairy goat welfare in different production systems in Tuscany.Organic Agriculture, 5(3), 225-234.

Miranda-de la Lama, G. C., & Mattiello, S. (2010). The importance of social behaviour for goat welfare in livestock farming. Small Ruminant Research, 90(1), 1-10.

Morand-Fehr, P., Boutonnet, J. P., Devendra, C., Dubeuf, J. P., Haenlein, G. F. W., Holst, P., ... & Capote, J. (2004). Strategy for goat farming in the 21st century. Small Ruminant Research, 51(2), 175-183.

Muri, K., Stubsjøen, S. M., & Valle, P. S. (2013). Development and testing of an on-farm welfare assessment protocol for dairy goats. Anim. Welf, 22, 385-400.

Muri, K., Tufte, P. A., Skjerve, E., & Valle, P. S. (2012). Human-animal relationships in the Norwegian dairy goat industry: attitudes and empathy towards goats (Part I). Animal Welfare-The UFAW Journal, 21(4), 535.

Napolitano, F., De Rosa, G., Ferrante, V., Grasso, F., & Braghieri, A. (2009). Monitoring the welfare of sheep in organic and conventional farms using an ANI 35 L derived method. Small Ruminant Research, 83(1), 49-57.

oie.int, retrieved June 2016. World Organisation for Animal Health.

Pugh, D. G., & Baird, N. N. (2012). Sheep & goat medicine. Elsevier Health Sciences.

Ruis, M., Pinxterhuis, I., Vrolijk, M. (2010). Update animal welfare status of organic farming in the Netherlands. Rapport 317.

Szabó, S. (2011). Social stress in large groups of dairy goats; Influence of presence of horns and introduction management of young goats. Doctoral thesis.

Schlemmer, M. (2014). Development of a prototype on farm welfare assessment for dairy sheep. Master thesis. Livestock Sciences , University of Natural Resources and Life Sciences, Vienna.

setosa.io/ev/principal-component-analysis, retrieved May 2016.

Sevi, A., Casamassima, D., Pulina, G., & Pazzona, A. (2009). Factors of welfare reduction in dairy sheep and goats. Italian Journal of Animal Science,8(1s), 81-102.

Smith, M. C., & Sherman, D. M. (2009). Nutrition and metabolic diseases. Goat Medicine, Second Edition, 733-785.

Spruijt, B. M., van den Bos, R., & Pijlman, F. T. (2001). A concept of welfare based on reward evaluating mechanisms in the brain: anticipatory behaviour as an indicator for the state of reward systems. Applied Animal Behaviour Science,72(2), 145-171.

statline.cbs.nl, retrieved February 2016.

Swinkels, H., Karstens, M. (2015) Uitvoeringsagenda Duurzame Geitenzuivelketen. HSW consult.

Thompson, K. G., Bateman, R. S., & Morris, P. J. (2005). Cerebral infarction and meningoencephalitis following hot-iron disbudding of goat kids. New Zealand veterinary journal, 53(5), 368-370.

Veissier, I., Butterworth, A., Bock, B., & Roe, E. (2008). European approaches to ensure good animal welfare. Applied Animal Behaviour Science, 113(4), 279-297.

Verkaik, J. (2001). Oormerkgebruik bij geiten: inventarisatie van gebruikseigenschappen en-problemen. Praktijkonderzoek Veehouderij, Publicatie 153.

Vieira, A., Brandão, S., Monteiro, A., Ajuda, I., & Stilwell, G. (2015). Development and validation of a visual body condition scoring system for dairy goats with picture-based training. Journal of dairy science, 98(9), 6597-6608.

Waiblinger, S., Schmied-Wagner, C., Mersmann, D., & Nordmann, E. (2011). Social behaviour and injuries in horned and hornless dairy goats. In Animal hygiene and sustainable livestock production. Proceedings of the XVth International Congress of the International Society for Animal Hygiene, Vienna, Austria, 3-7 July 2011, Volume 1. (pp. 421-422). Tribun EU.

Webster, A. J. F. (2001). Farm animal welfare: the five freedoms and the free market. The veterinary journal, 161(3), 229-237.

Wemelsfelder, F., & Farish, M. (2004). Qualitative categories for the interpretation of sheep welfare: a review. ANIMAL WELFARE-POTTERS BAR THEN WHEATHAMPSTEAD-, 13, 261-268.

WelfareQuality®. (2009a). Welfare Quality®assessment protocol for cattle. Welfare

Wiepkema, P. R., & Koolhaas, J. M. (1993). Stress and animal welfare. Animal Welfare, 2(3), 195-218.

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8. APPENDICES

1. COMPARISON BETWEEN DIFFERENT PROTOCOLS

Indicator	Jo Vicca	Muri et al.	AWIN protocol	Welfare Quality® cattle
Animal based indicators				
Group observations				
Disease observation	X Also question to the farmer	X	X Oblivion	X
Coughing	X	X	-	X
Thermal stress	- Not relevant in temperate climates	-	X	-
QBA	X	X	X	X
Scan sampling	X	-	-	-
Individual goat observations				
Chin contact test	X	X	-	-
Nasal discharge	X	X	X	X
Ocular discharge	X	X	X	X
Pinnae pathologies in the ears	X	X	-	X
Lips/mouth	X	X	-	X
Hornes	X	-	X	X
Skin lesions	X	X	X	X
Vaccination bulbs	X	X	X	X
Enlarged lymph nodes	X	X	X	X
Coat condition	X	X	X	X
Lice	- difficult to assess	X	-	-
BCS	X	X	X	X
Chest girth	X	X	-	-
Udder Asymmetry	X	X	X	X
Udder conformation	X	X	-	-
Clinical mastitis	X	X	-	-
Udder nodules	X	X	-	-
Teat lesions	X	X	-	X
Udder hygiene	X	X	-	X
Skin lesions or impetigo on udder and teats	X	X	-	X
Skin changes on front knees (carpus)	- don't lead necessarily to problems	X	-	X
Skin changes on hocks (tarsus)	- don't lead necessarily to problems	X	-	X
Joints	X	X	-	X
Claw conformation	X	X	X	-
Cleanliness of sternum	X	-	-	X
Cleanliness of hind quarters	X	X	-	X

Diarrhea	X	X	X	X
Lameness	X	X	X	X
Farmer-animal based indicators				
Handling test approach farmer to goat	X	X	-	-
Handling test response goat to farmer	X	X	-	X
Latency to the first contact test	-	-	X	-
Resource based indicators				
Queuing during feeding	X	-	X	-
Queuing during drinking	- Not a problem	-	X	-
Kneeling at the feed lot	X	-	X	-
Leftover roughage 1 hour after feeding	- It doesn't tell anything	X	-	-
Lying area details	-	X	-	X
Possibility to climb	X	X	-	-
Enrichment	X		-	X
Space/goat	-	X	-	-
Floor type	-	X	-	-
Bedding, sufficient and cleanliness	X	-	X	X
Number of spaces at feeder	- queuing tells more	X	-	-
Feed space (cm)	- queuing tells more	X	-	-
Automatic feeder	X	X	-	X
Number of sharp protrusions in the pen	- difficult to find	X	-	-
Signs of gnawing/nibbling on interior	X	X	-	-
Type of drinkers – number of each type	X	X	-	X
Cleanliness and functioning of drinkers	X	-	-	X
Environment indicators				
Temperature	X	X	- Thermal stress	-
Draught	X	X	-	-
Humidity	X	X	-	-
Lightintensity	X	X	-	X
Ammoniac	X	X	-	-
CO2	- Not a problem	X	-	-
Hygiene of building	X	X	-	-
Management indicators				
Questions to farmer	X	-	X	X

2. SPEARMAN'RHO TEST TO FIND CORRELATIONS

Source: Ella Roelant, statistician at the KU Leuven

Correlations

Correlation Coefficient

		Aantal melkgeiten	Borstomtrek_mean	Lux melkgeiten	lichaamsafwijking	uierafwijking	lichaamsconditie	gehoorndheid	posgedrag	agressiefgedrag	spelgedrag	positiefemo	negatiefemo	QBA-Apatisch (%)	Genieten van het werk met geiten
Spearman's rho	Aantal melkgeiten	1,000	-,333	,273	,511	-,044	-,378	-,731*	-,673*	,509	,413	-,370	,685*	,397	,318
	Borstomtrek_mean	-,333	1,000	,127	-,438	,263	-,299	,328	,176	,166	,306	,103	-,636*	,044	,222
	Lux melkgeiten	,273	,127	1,000	-,243	,300	,067	,143	,079	,080	,325	,200	-,115	-,044	,305
	lichaamsafwijking	,511	-,438	-,243	1,000	-,003	,214	-,407	-,207	,062	,282	-,596	,371	,044	,143
	uierafwijking	-,044	,263	,300	-,003	1,000	,138	-,159	,025	,171	,310	,444	-,113	-,347	-,423
	lichaamsconditie	-,378	-,299	,067	,214	,138	1,000	,481	,305	-,636*	-,491	-,226	-,037	-,678*	-,048
	gehoorndheid	-,731*	,328	,143	-,407	-,159	,481	1,000	,799**	-,332	-,204	-,014	-,710*	-,128	-,011
	posgedrag	-,673*	,176	,079	-,207	,025	,305	,799**	1,000	-,117	,181	,285	-,770**	,082	-,267
	agressiefgedrag	,509	,166	,080	,062	,171	-,636*	-,332	-,117	1,000	,696*	,031	,215	,803**	-,142
	spelgedrag	,413	,306	,325	,282	,310	-,491	-,204	,181	,696*	1,000	,088	-,219	,601	,105
	positiefemo	-,370	,103	,200	-,596	,444	-,226	-,014	,285	,031	,088	1,000	-,285	-,057	-,496
	negatiefemo	,685*	-,636*	-,115	,371	-,113	-,037	-,710*	-,770**	,215	-,219	-,285	1,000	,044	,076
	QBA-Apatisch (%)	,397	,044	-,044	,044	-,347	-,678*	-,128	,082	,803**	,601	-,057	,044	1,000	,020
	Genieten van het werk met geiten	,318	,222	,305	,143	-,423	-,048	-,011	-,267	-,142	,105	-,496	,076	,020	1,000

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

3. KRUSKAL WALLIS TEST

Source: Ella Roelant, statistician at the KU Leuven

Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of liggenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of staanperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of stappenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of drinkenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of etenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of herkauwenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of browsenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of slapenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of spelperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of agressiefperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,003	Reject the null hypothesis.
The distribution of schurenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.
The distribution of krabbenperc is the same across categories of Bedrijf.	Independent-Samples Kruskal-Wallis Test	,000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is ,05.

4. COMPARISON HORNS-SKIN LESIONS

Source: Ella Roelant, statistician at the KU Leuven

Report

Horns		Severe skin lesions - head/neck	Mild skin lesions - head/neck	Enlarged lymph nods – head/neck	Mild skin lesions – hindquarters	Enlarged lymph nods - hindquarters
,0	Mean	,060	,060	,119	,060	,015
	N	67	67	67	67	67
	Std. Deviation	,2387	,2387	,3267	,4887	,1222
	Minimum	,0	,0	,0	,0	,0
	Maximum	1,0	1,0	1,0	4,0	1,0
	Median	,000	,000	,000	,000	,000
1,0	Mean	,148	,148	,037	,037	,037
	N	27	27	27	27	27
	Std. Deviation	,4560	,4560	,1925	,1925	,1925
	Minimum	,0	,0	,0	,0	,0
	Maximum	2,0	2,0	1,0	1,0	1,0
	Median	,000	,000	,000	,000	,000
2,0	Mean	,000	,000	,000	,038	,000
	N	26	26	26	26	26
	Std. Deviation	,0000	,0000	,0000	,1961	,0000
	Minimum	,0	,0	,0	,0	,0
	Maximum	,0	,0	,0	1,0	,0
	Median	,000	,000	,000	,000	,000
Total	Mean	,067	,067	,075	,050	,017
	N	120	120	120	120	120
	Std. Deviation	,2820	,2820	,2645	,3857	,1286
	Minimum	,0	,0	,0	,0	,0
	Maximum	2,0	2,0	1,0	4,0	1,0
	Median	,000	,000	,000	,000	,000

5. COMPARISON HORNS-UDDER LESIONS

Source: Ella Roelant, statistician at the KU Leuven

Report

Horns		Spleen lesions	Udder skin lesions
,0	Mean	,015	,000
	N	67	67
	Std. Deviation	,1222	,0000
	Minimum	,0	,0
	Maximum	1,0	,0
	Median	,000	,000
1,0	Mean	,074	,037
	N	27	27
	Std. Deviation	,2669	,1925
	Minimum	,0	,0
	Maximum	1,0	1,0
	Median	,000	,000
2,0	Mean	,000	,192
	N	26	26
	Std. Deviation	,0000	,4915
	Minimum	,0	,0
	Maximum	,0	2,0
	Median	,000	,000
Total	Mean	,025	,050
	N	120	120
	Std. Deviation	,1568	,2544
	Minimum	,0	,0
	Maximum	1,0	2,0
	Median	,000	,000

PROTOCOL 'WELFARE SCORE OF DAIRY GOATS'

To take:
-stopwatch
-centimeter
-collar to hold the goat
-thermometer
-hygrometer
-lux meter
-draught meter
-protocol sheets

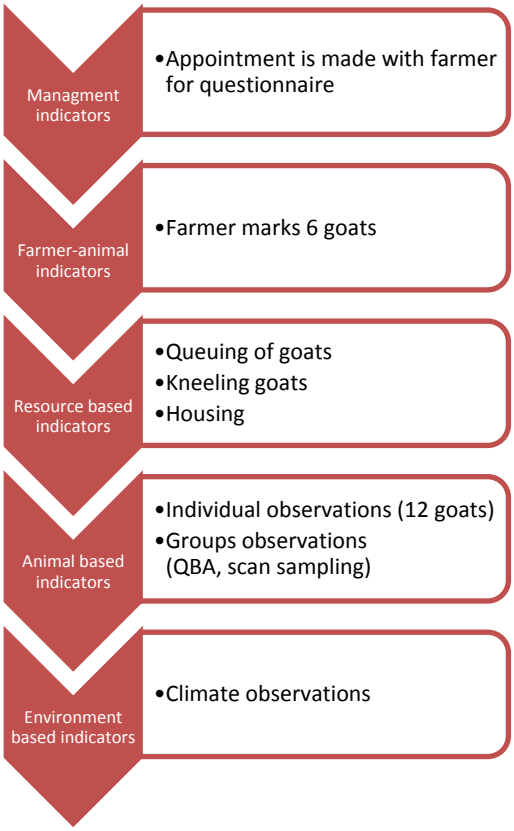
The protocol can be done in 3 hours. The protocol is made for the welfare of lactating goats in organic as well as conventional systems. The farm visit is done from morning feeding on. Recommended is to only visit one farm per day and to keep at least one day in between two visits to minimize disease transmission. On farm, group observations and individual observations are done. 12 goats are selected for individual assessment. 6 goats that represent the farm are selected by the farmer, 6 goats are ad random selected. Goats need to be housed during the observations and the farmer needs to be around to answer a questionnaire.

The observer should arrive around morning feeding. When arrived on the farm an appointment is made with farmer for the questionnaire later in the morning. The farmer is asked to give a short explanation about the structure of the stable (how many pens are there, where are the lactating goats, where is the milk parlor, etc.). A sketch of the building is made. The farmer is asked if the observer is allowed to enter the pens and catch the goats and if the farmer can mark 6 goats that represent the farm. The test human-animal interaction can be done. Then resource based indicator tests can be done starting with the test: queuing of the goats.

Individual goat observations are done on 12 goats. A goat can be randomly selected by counting ten goats and taking the last one. It can be difficult to catch the goat, therefore it can be handy to have an assistant. It is important to take goats from different pens and different ages. The goat can be held with a collar. First the goats' fear of unfamiliar humans is assessed (chin contact test) by lifting the hand toward the goat with the palm pointing upwards toward the goat's chin. Then the rest of the health check is done.

After the individual goat observations, the group observations are done as the Qualitative behavior analysis and the scan samplings.

Around 11h environment indicators are measured outside and inside on different spots in the stable on the height level of the goats. Resource based indicators, apart from queuing and kneeling at the feedlot, are looked at in between other observations. When the farmer has time, for example during coffee break, the questionnaire is done.



Farm:
……
……
……

Date of visit: ……..

Time of visit: ……..

Sketch of the building (roughly indicating sizes, feeding places, drinkers, milk parlor, rest places, etc.) + Note all pens including group size, number of group and current phase of production (lactating, dry). Indicate the walking routes of the goats and indicate the 4 places used for the scan sampling.

WP ... water points
FP ... feeding place
AO…access to outdoor run
AP…access to pasture
MP ... milking parlor
WA ... waiting area for milking
PL ... pens for lambing
B … buck

1. Handling test

Place of assessment	In the pen
Assessed	The farmer is asked to mark 6 goats of different pens that represent the herd. The approach of the farmer is scored as well as the response of the goat.
Time	-

Score	Goat 1	Goat 2	Goat 3	Goat 4	Goat 5	Goat 6
Approach of farmer						
Response of goat						

Score approach of farmer:
1. Positive physical and verbal interactions.
2. Positive physical or verbal interactions.
3. Neither positive nor negative physical interactions (neutral), no verbal interactions.
4. Negative verbal interactions and/or mild negative physical interactions
5. Strongly negative physical interactions, with or without negative verbal interactions

Positive verbal interaction: Talks to and calls on the goats with gentle and quiet voice.
Positive physical interaction: Petting, stroking and other friendly touches.
Negative verbal interaction: Whistling, shouting. Loud voice.
Negative physical interaction: Hitting, kicking, tugging, rough handling.

Score response of goats:
1. Positive reaction, no fear; approaching the farmer immediately and initiating physical contact
2. Somewhat positive reaction, no fear; approaching stockperson and initiating contact during the testing time
3. Indifferent: Neither approaches nor avoids
4. Mild fear: Attempts to avoid stockperson, but no panic
5. Strong fear/panic: Avoids immediately, difficult to catch

1. Queuing during feeding

Place of assessment	Outside the pen with view on two feeding alleys if possible, if not assessments per pen are done one after the other.
Assessed	The amount of goats that is queuing. A goat is queuing when she is waiting behind another goat to get access to the feeding place with her head in the direction of the feeding alley
Time	Per pen: every 2 minutes for 14 minutes in total

Pen ……

Time	Start	After 2’	After 4’	After 6’	After 8’	After 10’	After 12’	After 14’
Number of waiting goats								

Pen ……

Time	Start	After 2’	After 4’	After 6’	After 8’	After 10’	After 12’	After 14’
Number of waiting goats								

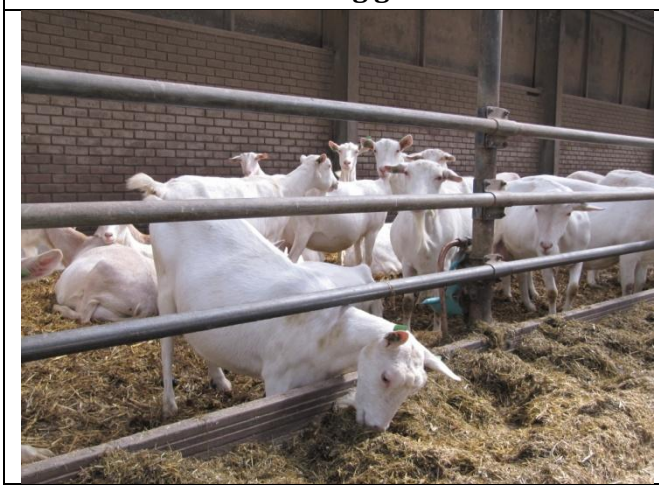
Queuing during feeding	**Queuing during feeding**
	

2. Goats kneeling at the feeding rack

Place of assessment	Outside the pen with view on two feeding alleys if possible, if not assessments per pen are done one after the other.
Assessed	Amount of kneeling goats at the feeding rack is counted. This is a snapshot.
Time	1 minute

Pen					
Number of kneeling goats					

Kneeling goat



Indicator	Score	Result
House type	0 = Non-insulated 1= Insulated	
Hygiene of the building	0= Clean: may be some areas with dirt, but the building is obviously cleaned regularly 1 = Dirty: clear soiling of large areas and maybe cob web in the ceiling. 2 = Very dirty: dirt/soiling all over the place.	
Enrichment	0 = No 1 = Yes (for example brushes, climbing objects, browsing material)	specify:
Possibility to climb	0 = No 1 = yes	
Enrichment outside pen	0 = No 1 = Yes (for example brushes, climbing objects, browsing material)	specify:
Automatic feeder	0= No 1 = Yes	
Signs of gnawing/nibbling on interior	0 = No 1 = Yes 2= Not assessable	
Type of drinkers – number of each type	-nipples: -water bowls: -other:	
Drinkers function well	0 = No 1 = Yes	
Drinkers are clean	0 = No 1 = Yes	
Bedding amount	0 = Not thick enough (test by falling on your knees, if painful not thick enough) 1 = Thick enough	
Bedding cleanliness	0 = Clean 1= Moderate clean 2 = Dirty or wet	

ANIMAL BASED INDICATORS
START: 1 HOUR AFTER MORNING FEEDING

Place of assessment	Different pens
Assessed	Behaviour of goats by slowly walking through the stable and observing the behavior of the goats. In the list below (n.3) an indication can be given on the scale bar how many goats are showing the emotion.
Time	10 minutes

1. **Amount of goats with clearly presence of a disease: ……**
2. **Amount of goats coughing: ……..**
3. **Qualitative Behaviour Analysis**
    a. Resting
    Min._____I_____Max.
    b. Agressive
    Min._____I_____Max.
    c. Inquisitive/interested
    Min._____I_____Max.
    d. Fearfull
    Min._____I_____Max.
    e. Calm/indifferent
    Min._____I_____Max.
    f. Active
    Min._____I_____Max.
    g. Apathetic
    Min._____I_____Max.
    h. Relaxed
    Min._____I_____Max.
    i. Agitated
    Min._____I_____Max.
    j. Frustrated
    Min._____I_____Max.
    k. Friendly
    Min._____I_____Max.
    l. Irritated
    Min._____I_____Max.
    m. Positive behaviour
    Min._____I_____Max.
    n. Playful
    Min._____I_____Max.
    o. Bored
    Min._____I_____Max.
    p. Uncomfortable
    Min._____I_____Max.
    q. Social
    Min._____I_____Max.
    r. Tense
    Min._____I_____Max.
    s. Lively
    Min._____I_____Max.

4. Scan sampling (See Tabel 1):

Place of assessment	4 segments with around 25 goats. Every segment has to be relevant for the farm (frequently visited, feeding place, rest place).
Assessed	Amount of goats that are showing the following behavior is counted Locomotion: - Laying - Walking - Standing - Running Ingestion: - Drinking - Eating - Ruminating - Browsing Other behavior: - Sleeping - Playing - Aggressiveness - Scratching - Crabbing - Licking
Time	Per segment 5 min, 2 times. Every 30 seconds the behavior is noted.

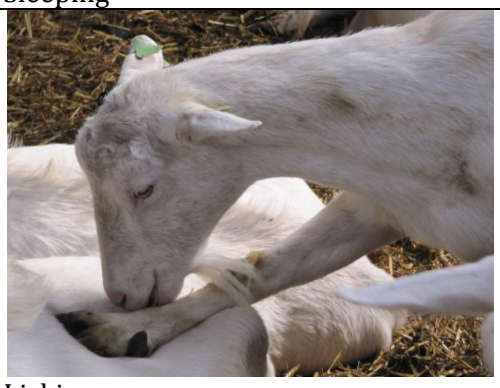

Laying and standing


Eating


Drinking


Sleeping


Browsing


Licking

- TABLE 1: Scan sampling

Pen: ……..	Time: ……..									
Behaviour										
Laying										
Walking										
Standing										
Running										
Drinking										
Eating										
Ruminating										
Browsing										
Sleeping										
Playing										
Aggressiveness										
Scratching										
Crabbing										
Licking										

Pen: ……..	Time: ……..									
Behaviour										
Laying										
Walking										
Standing										
Running										
Drinking										
Eating										
Ruminating										
Browsing										
Sleeping										
Playing										
Aggressiveness										
Scratching										
Crabbing										
Licking										

Pen: ……..	Time: ……..									
Behaviour										
Laying										
Walking										
Standing										
Running										
Drinking										
Eating										
Ruminating										
Browsing										
Sleeping										
Playing										
Aggressiveness										
Scratching										
Crabbing										
Licking										

Pen: ……..	Time: ……..									
Behaviour										
Laying										
Walking										
Standing										
Running										
Drinking										
Eating										
Ruminating										
Browsing										
Sleeping										
Playing										
Aggressiveness										
Scratching										
Crabbing										
Licking										

Place of assessment	In the pen
Assessed	12 goats are individually observed. 6 goats are chosen by the farmer in the handling test, 6 goats are chosen ad random by the observer. Take goats from different pens.
Time	-

Comments: If you find other abnormalities you consider relevant in terms of animal welfare (e.g. vaccination granulomas, rib fractures, damaged/disfigured horns), make a note of this under "Remarks".

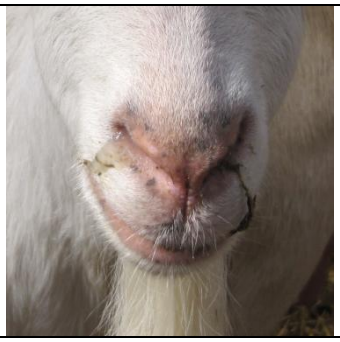
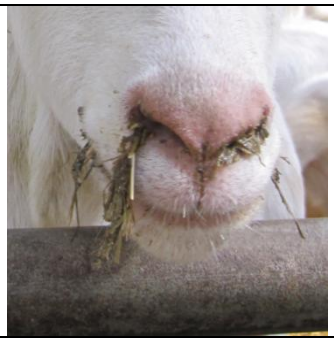
Observations in front of the goat (Table 2)

a. **Chin contact test**
Stand in front of the animal, move a stretched out arm with the hand palm upwards slowly towards the chin of the goat. Observe the reaction.

1 = Full acceptance
2 = Short contact before the goat pulls her head back
3 = Full avoidance

b. **Nasal discharge**
Definition: Clearly visible discharge from the nostrils; transparent to yellow/green, often thick consistency.

0 = Dry nostrils, or < 1cm transparent discharge
1 = transparent discharge > 1cm
2 = yellow/green discharge, regardless of amount (may be dried up)

0	1	2
		

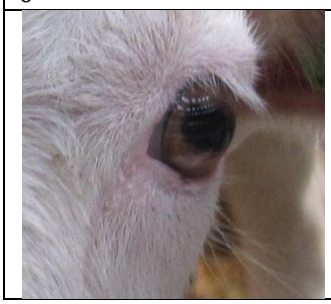
c. Ocular discharge

Definition: Clearly visible discharge from the eye, at least 1 cm long.

0 = No ocular discharge

1 = Ocular discharge, transparent fluid > 1 cm

2 = Yellow/green discharge, swelling or redness of the eye

0	1	2
		

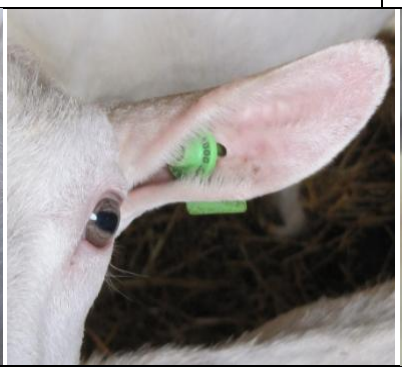
d. Pinnae pathologies

Definition: Signs of inflammation or damage to the ear, caused by ear tags.

0 = Normal (no signs of inflammation or damage/laceration)

1 = Clearly enlarged hole or signs of inflamed skin around the eartag perforation

2 = Completely lacerated ear due to fully torn out ear tag

0	1	2
		

e. Lips/mouth

Definition: Lesions on the lips or in the corner or the mouth.

1 = Normal

2= Lesion/scab on the lips/in the corner or the mouth

0	1
	

f. Horns

0 = absent
1 = unsuccessful disbudded but with (parts of) horns growing back
2 = not disbudded

0	1	2
		

g. Skin lesions head and neck

Definition: patches with hair loss or lesions/swellings
- For mild alterations: only register alterations with a diameter > 2 cm
  - Patch with hair loss
  - Skin not damaged
  - Hyperkeratosis possible
- For severe alterations: register all alterations regardless of size
  - Damaged skin either in form of wound or scab
  - Swellings (in integument; not joints, lymph nodes etc.)
  - Ulcerations (including orf)
  - Severe thinning of the coat or dematitis (e.g. due to ectoparasites)

Exceptions:
- Skin changes/lesions on ears (separate variable)
- Skin changes/lesions on carpal (knee) and tarsal (hock) joints (separate variables)
- Teat lesions (separate variable under udder health)
- Skin changes/lesions on udder (separate variable)

- If necessary, fill in details under «Remarks».

Hair loss	Mild lesion	Severe lesion
		

h. Vaccination bulbs
Palpate gently with a flat hand and register the number of vaccination bulbs

Vaccination bulbs

i. Abscessed or enlarged lymph nods
Palpate gently with a flat hand and register the number of clearly enlarged or abscessed lymph nodes

j. Chest girth
Use a tape measure and measure the girth at the level immediately behind the elbow joint. Make sure the tape measure is close to the skin, but do not pull tight. Register the girth in cm.

Observations behind the goat (Table 3)

a. Skin lesions hindquarters
Definition: patches with hair loss or lesions/swellings
- For mild alterations: only register alterations with a diameter > 2 cm
    - Patch with hair loss
    - Skin not damaged
    - Hyperkeratosis possible
- For severe alterations: register all alterations regardless of size
    - Damaged skin either in form of wound or scab
    - Swellings (in integument; not joints, lymph nodes etc.)
    - Ulcerations (including orf)
    - Severe thinning of the coat or dematitis (e.g. due to ectoparasites)

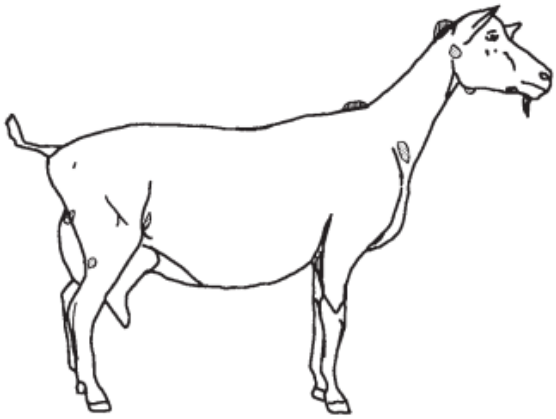
    Exceptions:
    - Skin changes/lesions on ears (separate variable)
    - Skin changes/lesions on carpal (knee) and tarsal (hock) joints (separate variables)
    - Teat lesions (separate variable under udder health)
    - Skin changes/lesions on udder (separate variable)

- If necessary, fill in details under «Remarks».

Mild lesion


b. Vaccination bulbs
Palpate gently with a flat hand and register the number of vaccination bulbs

c. Abscessed or enlarged lymph nods
Palpate gently with a flat hand and register the number of clearly enlarged or abscessed lymph nodes



Location of common swellings caused by caseous lymphadenitis and caprine arthritis encephalitis. (Smith & Sherman, 2009)

d. Coat condition
0 = normal coat condition
1 = abnormal coat condition (too long, tangles, ruffled, scratched)

0	1
	

e. Body Conditie Score
(1 – 5, vb. 1.75 – 2.0 – 2.5 - ….). Smith & Sherman (2009)

Lumbar score:

0 The animal is extremely emaciated. The intervertebral articulations are easily felt and the e in direct contact with the bones.

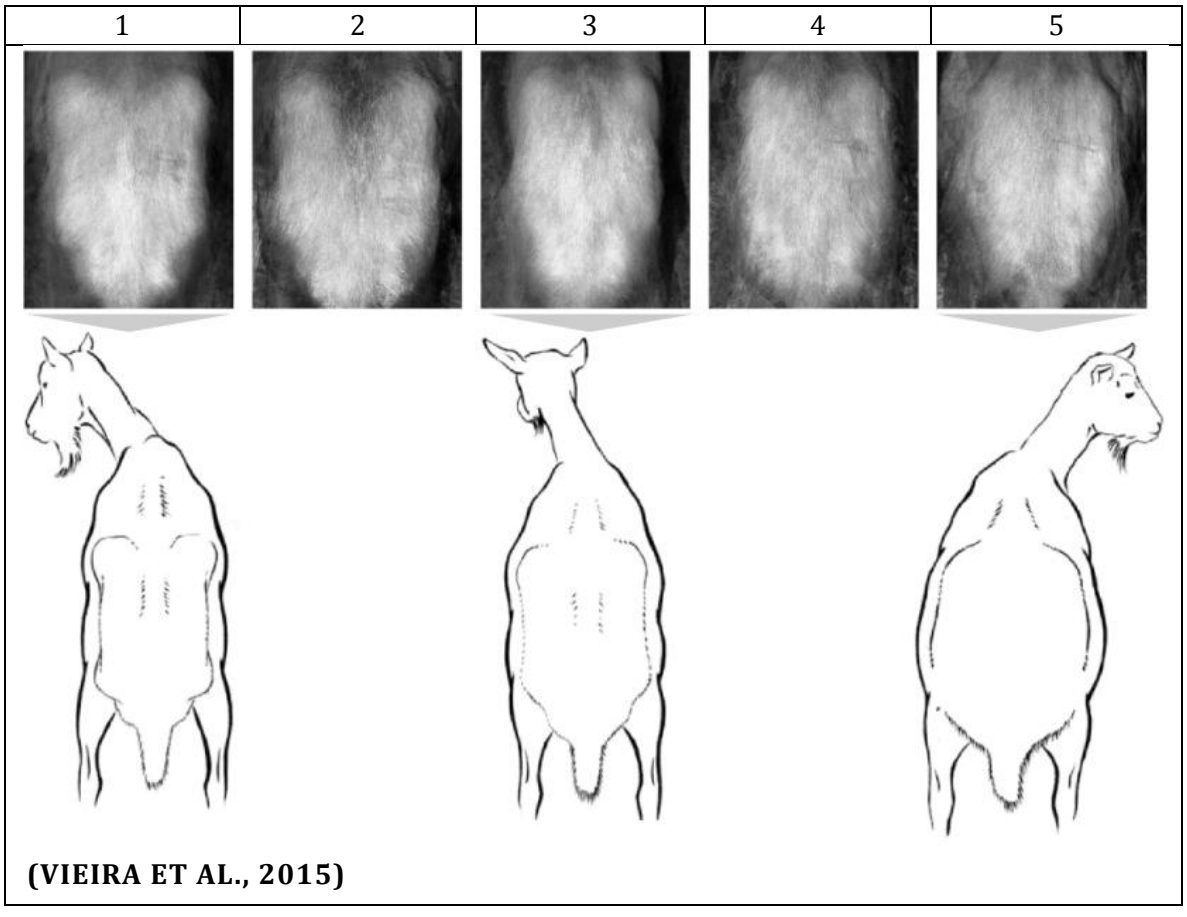
1 Muscle extends at most two-thirds of the distance out along the transverse spinal processes. Intervertebral articulations are still palpable but barely visible.

2 Dorsal and transverse spinous processes are prominent, and the skin forms a concave line between them.

3 Spinous processes are still easily felt. The space in the vertebral angle is filled with muscle and the skin determines a straight line between dorsal and transverse processes.

4 Dorsal and transverse spinous processes are difficult to detect and the skin forms a convex line between them.

5 There is a prominent groove down the back line and the fat and muscles mound up on each side of this groove.



(VIEIRA ET AL., 2015)

Limbs and joints (Table 4)

a. Lameness

Can be noticed when goat is released

0 = No lameness
1 = Short striding gait with one limb
2 = Short striding gait with more than one limb, or strong reluctance to bear weight on one limb
3 = Does not support weight on one limb, or strong reluctance to put weight on two or more limbs, holding a limb up whenever possible

b. **Swollen joints**, defined as clearly increased diameter of the joint due to accumulation of extra fluid; may feel warm.

-Carpi (front knee)
-Sum of swellings at the other joints

Claws and cleanliness (Table 5)

a. Claw conformation

Lift the left front claw and look at the ventral aspect.

0 = Normal
1 = Mildly overgrown. Side walls somewhat turned under the soles, covering < 50% of the surface of the sole. Toe length likely extended.
2 = Severely overgrown. Sidewalls markedly turned under the foot, covering > 50% of the sole surface. Claws in this category also have clearly extended toe length (which may bend upwards) and may be asymmetrical/crooked.
3 = Extremely overgrown, to the extent that the toe length is severely extended and not touching the floor and the foot tipped backwards, AND/OR cork screw claws, where the turned side wall extends beyond the opposite side of the sole (and may continue bending upwards). This is usually possible to see without lifting the foot.
4 = Other severe claw abnormalities that are not possible to correct by trimming (could be congenital or the result of chronic problems with the claws or skeletal deviations).

0	4
	

b. Cleanliness of sternum

Include all patches of dirt of > 5x5 cm, does not include discolouration of white coat.
0 = Clean
1 = Separate or continuous patches of dirt

1

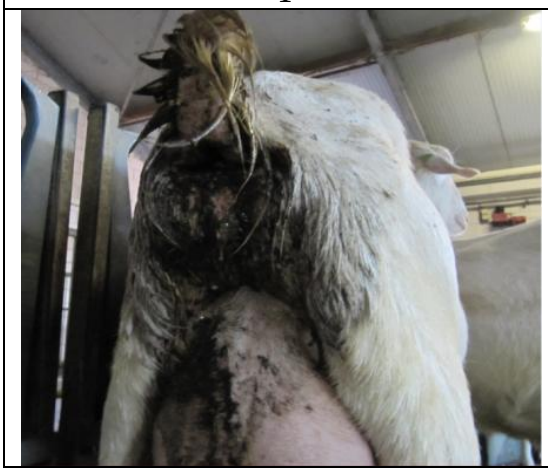
c. Cleanliness of hind quarters

Include all patches of dirt of > 5x5 cm, does not include discolouration of white coat.
0= Clean
1= Separate or continuous patches of dirt above the coronary band

1

d. Diarrhea
Based either on witnessing the animal defaecate or observing clear signs of diarrhoea around the perineum.

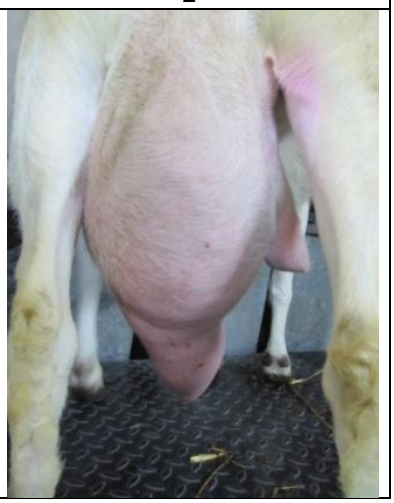
Score:
0 = No
1 = Yes

1


Udder (Table 6)

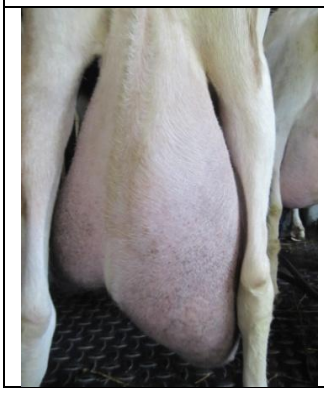
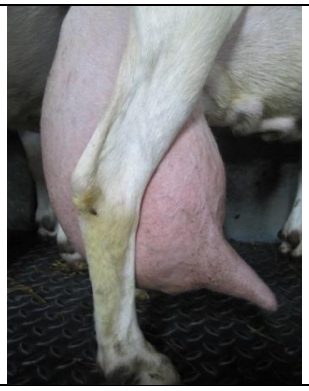
Visual inspection: Look at the udder from behind.
Palpation: If the goat becomes stressed by the udder palpation, evaluate without touching. This should be noted under "comments".

a. Asymmetry
Assess whether the udder is symmetrical (equal size of the two glands).
0 = No asymmetry
1 = Asymmetry
2 = one gland missing (resulting from gangrene or amputation)

1	2
	

b. Udder conformation
0 = Normal: the lowest part of the udder (apart from the teats) is above or at the level of the hocks.
1 = Pendulous udder: the lowest part of the udder (apart from the teats) is below the hocks.

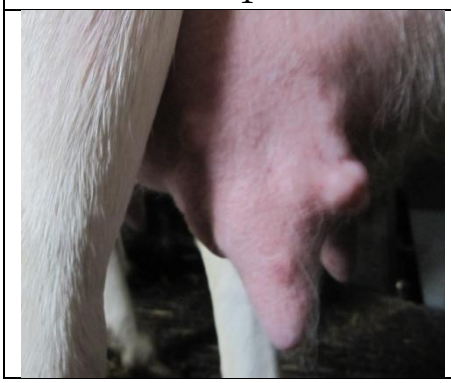
1

c. Clinical mastitis
Definition: Redness, swelling, signs of pain, heat, firmer than normal udder tissue.
0 = No
1 = Yes

d. Clear, superficial nodules in the udder
Definition: Distinct nodules that are visible or noticeable on light palpation.
0 = No
1 = Yes

1



e. Teat lesions
Damage caused by stepping or milking machine.
0 = No
1 = Yes

1

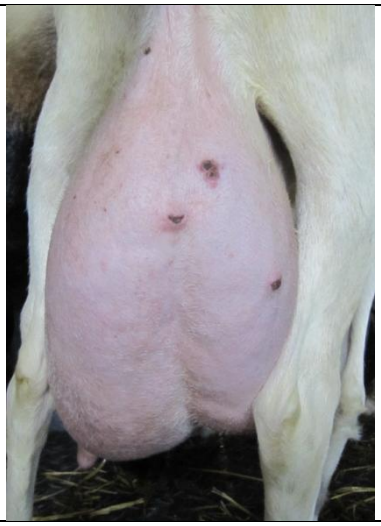
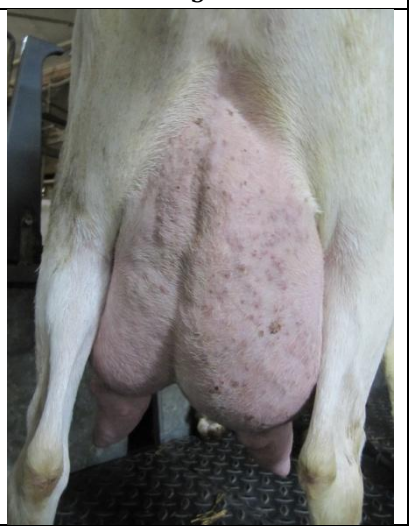

f. Skin lesions or impetigo on udder and teats

0 = Normal, healthy skin

1 = Sporadic or diffusely scattered dry nubs without redness, weeping or scab formation.

2 = Sporadic nubs/vesicles with redness, weeping or scabs

3 = Diffusely scattered nubs/vesicles with redness, weeping or scabs, covering more than 1/3 of the posterior surface of the udder (impetigo)

1	2	3
		

g. Hygiene – udder

0 = Clean

1 = Traces of vaginal discharge on posterior side of udder (may be amnionic fluid from parturition, brown mucus or discharge from vaginitis/metritis), or small patches with dirt (<5x5cm)

2 = Distinct patches (> 5x5cm) or diffuse soiling with dirt (faeces) on the udder; any dirt on the teats

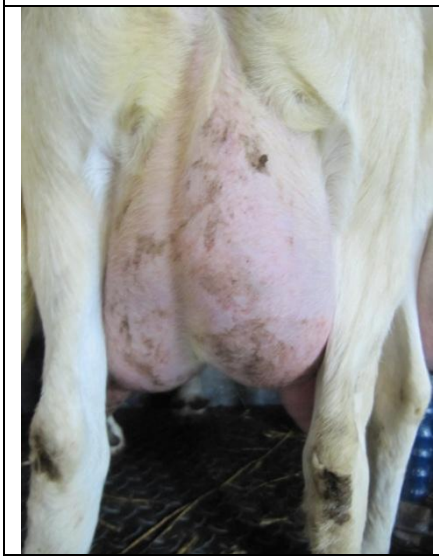
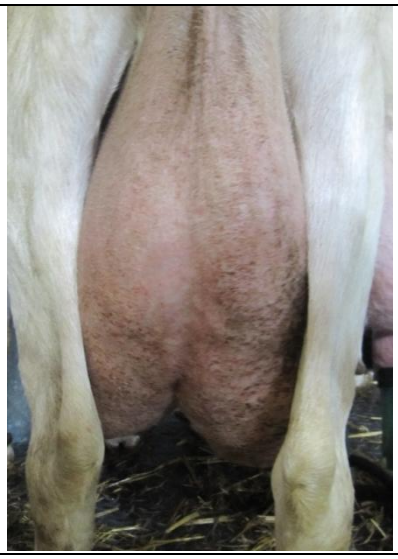
1	2
	

TABLE 2: Observations in front of the goat

Farm: Date:

ID goat	Chin contact test			Nasal discharge			Ocular discharge			Pinnae pathologies			Lips/mouth		Horns			Mild skin lesions (< 2 cm) (number) Head and neck	Severe skin lesions (> 2 cm) (number) Head and neck	Vaccination granuloma's (number) Head and neck	Abscessed or enlarged lymph nods (number) Head and neck	Chest girth (cm)
	0	1	2	0	1	2	0	1	2	0	1	2	0	1	0	1	2					
1.																						
2.																						
3.																						
4.																						
5.																						
6.																						
7.																						
8.																						
9.																						
10.																						
11.																						
12.																						

7-12 selected by the farmer

Remarks:

TABLE 3: Observation behind the goat

Farm: Date:

ID goat	Mild skin lesions (< 2 cm) (number) trunk and limbs	Severe skin lesions (> 2 cm) (number) trunk and limbs	Vaccinationgranuloma's trunk and limbs	Abscessed or enlarged lymph nods (number) trunk and limbs	Coat condition		BCS – lumbar (0-5)
					0	1	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

Remarks:

TABLE 4: Limbs and joints

Farm: Date:

ID goat	Lameness (0-3)	Swelling Carpi (front knee)	Sum swellings other joints
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			

Remarks:

TABLE 5: Claws and cleanliness

Farm: Date:

ID goat	Claw confirmation					Cleanliness sternum		Cleanliness hindquarters		Diarrhea	
	0	1	2	3	4	0	1	0	1	0	1
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

Remarks:

TABEL 6: Udder

ID goat	Udder - Asymmetry			Udder - conformation		Clinical mastitis		Udder - nodules		Udder -Teat lesions		Udder - Skin lesions				Udder - hygiene		
	0	1	2	0	1	0	1	0	1	0	1	0	1	2	3	0	1	2
1.																		
2.																		
3.																		
4.																		
5.																		
6.																		
7.																		
8.																		
9.																		
10.																		
11.																		
12.																		

Remarks:

Place	Outside and on different places in the pots on goat height
Assessed	Temperature (°C), Draught (m/s), Humidity (%), Light intensity (Lux), NH_3 using measuring instruments
Time	Around 11h am

Place	**Temperature (°C)**	**Draugth (m/s)**	**Humidity (%)**	**Lightintensity (Lux)**	**NH3 (ppm)**
Outside					
Inside 1					
Inside 2					
Inside 3					

- Describe in your own words your **general impression** of the herd (i.e. health, indoor environment, human-animal relationships).

……
……
……
……
……
……
……
……
……
……
……

KEY REFERENCES:

Jo Vicca. Dr. in Veterinary Medicine (behavior, welfare, sustainable animal husbandry and agriculture), teacher and researcher in KU Leuven

Anzuino, K., Bell, N. J., & Bazeley, K. J. (2010). Assessment of welfare on 24 commercial UK. *Veterinary Record*, *167*, 774-780.

AWIN. (2015) AWIN welfare assessment protocol for goats.

Muri, K., Stubsjøen, S. M., & Valle, P. S. (2013). Development and testing of an on-farm welfare assessment protocol for dairy goats. Anim. Welf, 22, 385-400.

Muri, K., Tufte, P. A., Skjerve, E., & Valle, P. S. (2012). Human-animal relationships in the Norwegian dairy goat industry: attitudes and empathy towards goats (Part I). Animal Welfare-The UFAW Journal, 21(4), 535.

Smith, M. C., & Sherman, D. M. (2009). Nutrition and metabolic diseases. Goat Medicine, Second Edition, 733-785.

Vieira, A., Brandão, S., Monteiro, A., Ajuda, I., & Stilwell, G. (2015). Development and validation of a visual body condition scoring system for dairy goats with picture-based training. Journal of dairy science, 98(9), 6597-6608.

WelfareQuality®. (2009a). Welfare Quality®assessment protocol for cattle. Welfare

The control practices of Gastro-intestinal nematodes in organic goat farms in the Netherlands.

Rozemarijn Kooring Master Thesis organic agriculture February-July 2016

Supervisors: Cynthia Verwer – Louis Bolk institute, Egbert Lantinga – WUR, Emelie Ollion – ISARA

Abstract

Gastrointestinal nematodes can cause problems in organic goat production where goats need to be on the pasture a part of the year. Good grazing management and the right use of anthelmintics can keep it under control. But anthelminitc resistance is growing; there is a need for alternative control measures. To get a better insight in helminth control practices used by the organic goat farmers in the Netherlands, the way they get their information about gasto-intestinal nematodes and their opinion about alternative treatment methods, a questionnaire study was done. Most farmers are using the strategy of minimal grazing on the same part of grassland, so rotational grazing, plus a group treatment once a year with anthelmintics. Few farmers are using alternative control measures but would accept alternative control methods that may incur greater costs and labour input.

Content

Background
- Introduction
  - Gastro intestinal nematodes
  - Anthelmintics and parasite resistance
- Preventive control measures
  - Antoparasitic plants
  - Grazing strategies and pasture systems

Material and Methods
Results and Discussion
Conclusion
References
Appendix

Background

Introduction

One of the main problems in the organic dairy goat production is infection of the gastrointestinal tract with parasitic nematodes (Rinaldi et al., 2007). Gastrointestinal nematodes (GIN) infection is strongly associated with grazing management and has profound depressive impacts upon long-term animal productivity (Hoste et al., 2005). Especially high productive animals or animals that are close to parturition are susceptible to an infection of parasites. The usual use of anthelmintics as control measure, either to prevent or to cure, is questioned because of the resistance of parasites against

certain compounds. Among attentive control measures the resistance and resilience to parasitic infections of the host animal is improved. A question from the goat sector is to get more information about good control measures either curative or preventive without economic loss. To get a better insight in helminth control practices used by the organic goat farmers in the Netherlands, the way they get their information about gasto-intestinal nematodes and their opinion about alternative treatment methods, a questionnaire study is done. The aim of the research is to answer the following research questions.

- What are the main practices of helminth control in organic goat farms in the Netherlands?
  -What could be further research projects?
  - What alternative control measures are accepted by farmers?

Gastro intestinal nematodes

Lots of research to Gastrointestinal nematodes is done on sheep while little on goats. Results on the interactions between GIN species in sheep are implicated on goats which sometimes cause errors in the way of controlling infections (Hoste et al., 2010). For years, goats are treated with the recommended sheep dose which resulted in an under dosing thus causing a reduced efficacy. This could also partly explain why the prevalence of anthelmintic resistance in nematodes is so high in goats compared with sheep (Chartier et al., 1998; Jackson et al., 2000). Major differences between goats and sheep were found in the intake behaviour and susceptibility between the species. Goats are trying to avoid infection with browsing while sheep graze the grass shortly from the ground but they are less susceptible for GIN (Jallow et al., 1994).

The gastrointestinal nematodes have a simple direct life cycle. Eggs in the manure will develop into larvae (L1), the larvae will grow in two to three weeks and will disperse in the pasture (L2). The larvae are taken up by the goat and will mature into adult worms in the abomasum in two to three weeks. Larvae not taken up by the goat will die in the pasture in 12 weeks. Adult worms will produce eggs and the cycle can start again. See Figure 1.

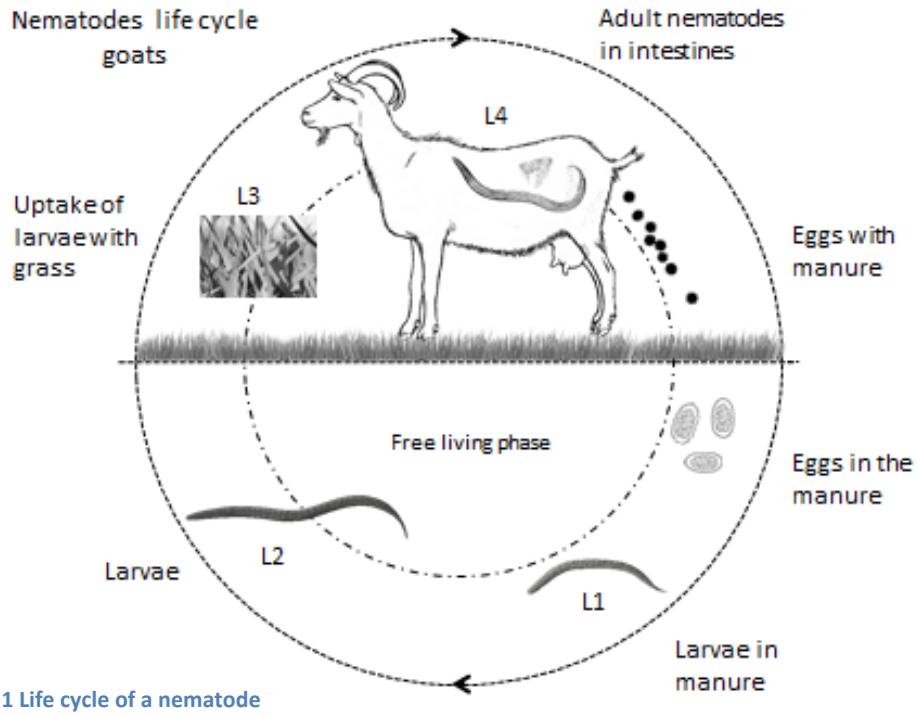


Figure 1 Life cycle of a nematode

The actual density of infective larvae on pasture is related to the stocking density, the effectiveness of the worming program, and the environment. In winter almost all eggs in the pasture will die. Most occurring worm types are listed in Table 1.

Control measures against gastrointestinal nematodes should can be curative and preventive. The fact the animal is infected with a parasite does not necessarily indicate disease. Only when parasite loads become excessive or when an animal's natural immunity to disease becomes suppressed (such as with stress, starvation, etc.) it will show the symptoms of disease. But there can be hidden costs of sub-clinical diseases, for example production loss and decreased reproduction. Worms cannot be eradicated from the environment so goats will be constantly reinfected. But new infections can be limited with good control measures to an extent that there will be no economic losses. A combination of treatment of goats with anthelmintics and good pasture management and is done mostly. The best time to treat the animals is just before goats are moved to a less contaminated environment. Such as a pasture that is given rest for a certain time or grazed by a species that is not a host for nematodes. The problem with curative control measures is that the milk of treated animals cannot be sold. Therefore farmers tend to treat their herd in the dry period but this period is not always the best time for the nematodes to be treated. Also problems with anthelmintic resistance can occur.

Type of worm	*Haemonchus contortus*	*Teladorsagia circumcincta*	*Trichostrongylus spp*
Symptoms	anaemia	Diarrhoea	Diarrhoea
Time of symptoms	June-September	June-November	July-January
Amount of eggs	A lot	Little	Little

Table 1 Most common nematode species in goats (Bovex et al., 2009)

Anthelmintics and parasite resistance

According to the article of Scarfe (1993) there are four ways anthelminthic drugs can be used: strategically; tactically; suppressively; and for salvaging animals.

Strategic treatments, primarily aimed at hypobiotic (dormant) worms in winter. In the hypobiotic state, nematodes save energy by not producing eggs and like this surviving the winter time inside the host. In spring, when good conditions for worms return, egg production is rising. Spring lambs are susceptible new hosts. A treatment in this time of the year can thus be very effective.

Tactical treatments, when the time is favourable for the transmission of parasites a treatment is done to eliminate worms from the gut before they have the opportunity to reproduce and further contaminate the environment. A treatment is done after a period of rainfall, when animals are moved to a new pasture or when faecal worm egg counts show an increase in worms.

Suppressive treatments, may be given at regular intervals. When transmission rates are relatively low a small dose of anthelmintic can be given every 3 weeks, the time from egg to reproducing adult worms. However, this method is expensive and will also eventually lead to resistance to the anthelminthics used.

Salvage, to save animals that have a high infection rate. This is not a control method. Although anthelmintics may remove thousands of worms from each of the treated animals, the pastures from which they came have billions of larvae awaiting ingestion. When clinical symptoms can be seen in a goat (diarrhea, endema, anema) it takes some months to return to a normal state, in this time the goat is extra susceptible for new infections.

The phenomenon of anthelmintic resistance is spread in many countries with differences in prevalence. Research to anthelminthic resistance in northern Italy showed a resistance in 30% of the tested flocks. With a questionnaire to farmers the importance of education was pointed out. Using the correct dose rates in goats and the rotation of different anthelmintic classes, because Anthelminthic resistance can develop even at low frequencies of treatment (Zanzani et al., 2014). Also on farms in France underdosing was a reason for resistance (Chartier et al., 1998).

Anthelmintic resistance can develop in several species of nematodes to one type of anthelmintic or in one species to several types of anthelmintic. The frequency of anthelmintic treatment could be reduced and the type of anthelmintics used could be different each time in order to maintain the efficacy of the available anthelmintics (Chartier et al., 1998). But with the latter attention should be paid to the fact that the worms can become resistant to several anthelmintics.

Preventive control measures

Antoparasitic plants

The consumption of browsing materials and then especially the presence of higher concentrations of secondary metabolites in the consumed plants (alkaloids, terpenes, phenolics, sesquiterpene lactones, tannins) have antiparasitic properties (Kayser et al., 2003; Hoste et al., 2005). But it is difficult to conclude this because goat's that have access to shrubs are mostly kept in an extensive system where parasite infections occur less often due to the low stocking rates and lower concentration of parasites on pastures. However, several in vitro and in vivo studies suggest condensed tannins have anthelmintic effects against ruminant nematode parasites (Paolini et al., 2003; Min et al. 2003; Kabasa et al., 2000). Tannins may form non-biodegradable complexes with protein in the rumen, in this way more proteins are released in the small intestine. This indirectly improves resistance against parasites in the abdomen. Tannins may also have direct effects of parasites and the tannins in the manure can affect the viability of the parasite larvae (Waller, 2006).

There is a search for bioactive Plant Secondary Metabolites (PSMs) in nature, either by the drug industry to develop new anthelmintics as by the holistic approach to use a variety of plants in pastures for self-medication and disease control. Management programs for seeding and distributing 'medicinal' plant species could make a forage mix with more potential for self-medication (Villalba et al., 2007; Knox et al., 2006; Min et al., 2004). It's best to have a pasture with plants with different PSM profiles that complement one another so the animals can choose what they want to eat. The positive effect (medicine) or negative effect (toxic) of PSMs is very dependent on the dose. The anti-nutritional properties of PSMs could have a negative impact on the animal's performance but animals naturally limit their consumption. By offering a variety of plants large doses of one PSM are avoided and the toxic effects reduced. This also might provide the variability needed to prevent or diminish the development of resistance of parasites. Parasitized animals may increase their grazing

time to include medicinal plants in their diets (Githiori et al., 2006). See Table 2 for an example of species that can be used to control GIN.

Used antoparasitic plant species	
Black locust (*Robinia pseudoacacia*)	Fennel (F*eniculum*)
Blackthorn (*Prunus spinosa*)	Garlic (*Allium sativum*)
Wormwood (*Artemisia absinthum*)	walnut (*Juglandaceae*)
Sage (*Salvia*)	Pumpkin seed shell (*Cucurbita pepo*)
Gentian (*Gentiana*)	Chinese bushclover (*Lespedeza*)

Table 2 Examples of species that can be used to control GIN (Shepard, 2013)

Grazing strategies and pasture systems

Drought, bare soil, rotation systems, alternate species grazing, dung destroying insects may all contribute to the demise of parasites (Waller and Thamsborg, 2004; Torres-Acosta and Hoste, 2008). Overgrazing increases the chance on parasitic problems by the high transmission rate and the insufficient food provision. Rotation schemes can be a good grazing strategy but rapid rotation schemes only increase the parasite loads in the goats (Waller, 2009). Most rotation schemes are focused on high productivity. It's a cycle of about 30 days from one production peak to another. Unfortunately, this 30- day interval is also about the same time necessary to ensure that the previous worm parasite contamination has now been converted into the highest level of infectiousness for the next grazing group. Recommended is to let the pasture rest for a period of at least 6 months in winter and 3 month in summer (Bovex et al., 2009). The pasture can be used to make hay. Alternate grazing or co-grazing with different species can also be a strategy. Most parasite species are the same for goat and sheep but for cattle, horses, poultry or pigs this is not the case. Also alternate use of the land is effective; tilling the land can destroy a large amount of larvae.

Material and Methods

This study is part of a larger research project of FIBL. A questionnaire is adapted for Dutch circumstances including the number of animals, number of ha., grazing hours, grazing practice against helminthes, monitoring and control strategy for helminthes, resistance of worms against anthelmintics and opinions about future perspectives (Appendix). The questionnaire is first put on a meeting day from 'de Groene Geit', an association for organic goat farmers in the Netherlands. 12 questionnaires were filled in. Then goat farmers on the list of 'de groene geit' and SCAL were called to ask if they could fill in the questionnaire of grassland control measures against gastrointestinal nematodes. 28 of the 62 farmers responded on the questionnaire. This is a respond rate of 45%. The data is put into excel and a descriptive analysis is made out of the data.

General farm characteristics of farms taking part in survey	
Mean herd size (Range)	590 (100-1155)
Mean years since organic (± SD)	15,5 (±9)
Mean area (ha) (Range)	47 (8-490)
Mean time on pasture (month/year)	6 months

Results and Discussion

Due to the weather circumstances in the Netherlands goats can graze around 6 months/year and kids 5 months/year. During those 6 months most of the farmers keep to some kind of pasture management for control of gastrointestinal nematodes. The different management practices they could indicate in the questionnaire were: minimal grazing on the same area (50%), young stock use lower risk areas (23%), reduced stocking rates (16%), alternate species grazing (5%), other (5%). The other practices were: mowing in spring, then alternate grazing (see Figure 2). One time mowing then the goats graze the rest of the season. Minimal grazing on the same area include strip grazing, alternating animals on pasture (3 weeks grazing, 12 weeks rest), rotational grazing and keeping the grass long.

Only on 1 farm the presence of liver flux was diagnosed and few farms do control measures against liver flux. The different measures they could indicate in the questionnaire were: pasture drainage (16%), fencing of streams and ponds (12.5%), pasture rotation from infectious to non-infectious during grazing season (8.3%). Some indicated their farm is not sensitive for liver flux due to the location on sandy soil.

The monitoring of infection of worms or liver flux in the herd is mostly done by analysis of faecal samples, diarrhea, loss of body condition or milk yield. Also good indicators are hair quality or anaemia.

Farmers are applying management measures mostly according to their own experience in combination with new ideas from diverse media. Some farmers have study groups to discuss with other farmers about control measures.

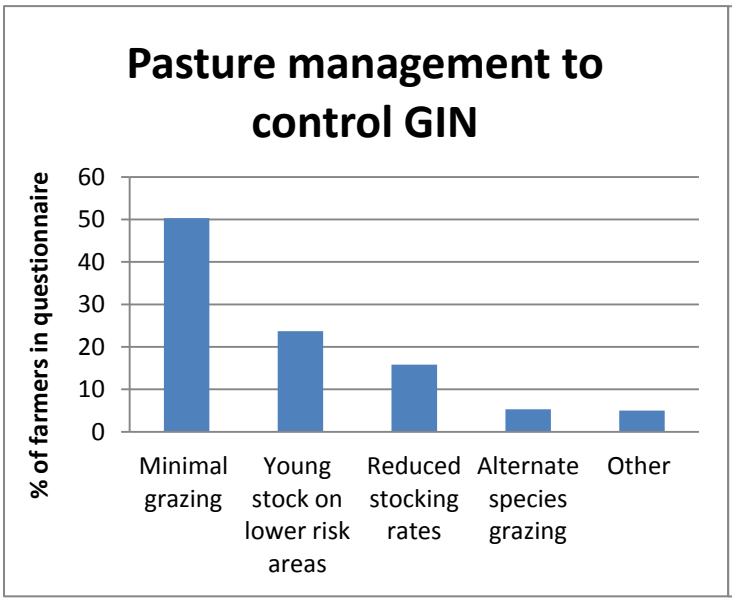


Figure 2 Pasture management to control gastrointestinal worms

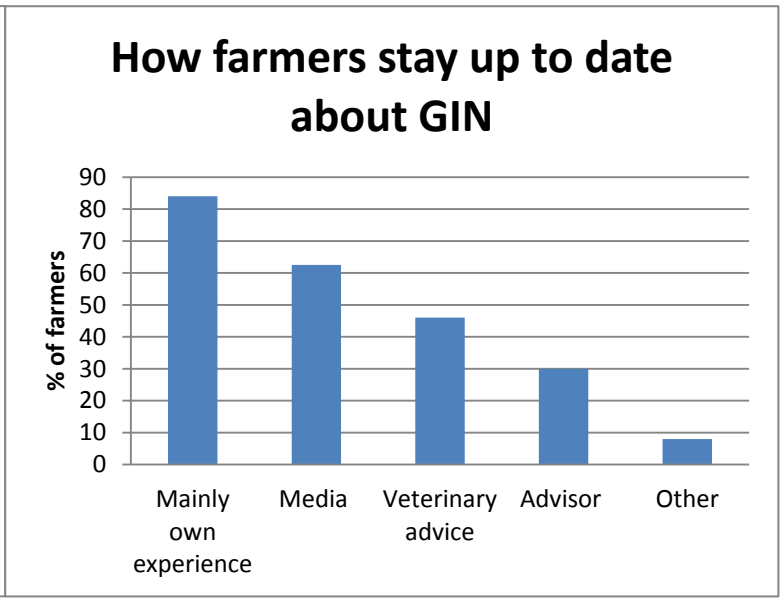


Figure 3 How farmers stay up to date about GIN

Most farmers are treating their animals once a year as a group just before the housing period or when the animals are dry in winter. This can be called a strategic treatment aimed to kill all hypo biotic (dormant) worms in late winter. Little anthelmintic resistance is confirmed, in two cases there is resistance against macro cyclic lactones. Alternative control methods are not used a lot. Some farmers are feeding bioactive plants, some use homeopathy and phytotherapy.

Although anthelmintic resistance is not occurring a lot on these farms (or the famers don't know there is resistance on the farm) the farmers think anthelmintic resistance will worsen in the future and they don't have trust that the industry will develop new anthelmintics before it becomes a problem. They would accept alternative control methods that may incur greater cost and labour input such as sample collection, animal monitoring and new products. A derogation to keep the animals permanently indoors is not accepted.

Conclusion

Although previous research indicated that gastrointestinal nematodes are a main problem in organic goat system it seems that in the Netherlands most of the farmers have it under control. Also in few cases anthelmintic resistance is monitored. Both can be due to the fact that farmers don't know their herd is infected or that there is anthelmintic resistence. Most of the farmers have a kind of pasture management for control of gastrointestinal nematodes whereof minimal grazing on the same area of the pasture is the most used management practice. The animals are treated once a year as a group just before the housing period or when the animals are dry in winter. This is not always the best time for the nematodes to be treated. Further research can be done to the prevalence of gastrointestinal nematodes on organic goat farms in the Netherlands and ways of monitoring that can be done by the farmers themselves so that gastrointestinal nematodes can be noticed easier. Because, while the farmers may not know the occurrence of gastrointestinal worms on their farm, it can have a negative economic influence. More promotion can be given to alternative control methods such as the use of browsing materials high in concentration of secondary metabolites since different researches proved this to be effective. Few farmers are using alternative control practices now but would accept alternative control methods that may incur greater costs and time input.

References

Anthony, J. P., Fyfe, L., & Smith, H. (2005). Plant active components–a resource for antiparasitic agents?. *Trends in parasitology*, *21*(10), 462-468.

Athanasiadou, S., & Kyriazakis, I. (2004). Plant secondary metabolites: antiparasitic effects and their role in ruminant production systems. *Proceedings of the Nutrition Society*, *63*(04), 631-639.

Bovex, F. P. O., Levacol, L., Endex, W. L., & Prontax, D. D. (2011). Weidegang van geiten.

Chartier, C., Pors, I., Hubert, J., Rocheteau, D., Benoit, C., & Bernard, N. (1998). Prevalence of anthelmintic resistant nematodes in sheep and goats in Western France. *Small Ruminant Research*, *29*(1), 33-41.

Githiori, J. B., Athanasiadou, S., & Thamsborg, S. M. (2006). Use of plants in novel approaches for control of gastrointestinal helminths in livestock with emphasis on small ruminants. *Veterinary parasitology*, *139*(4), 308-320.

Hoste, H., Sotiraki, S., Landau, S. Y., Jackson, F., & Beveridge, I. (2010). Goat–Nematode interactions: think differently. *Trends in parasitology*, *26*(8), 376-381.

Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg, S. M., & Hoskin, S. O. (2006). The effects of tannin-rich plants on parasitic nematodes in ruminants.*Trends in Parasitology*, *22*(6), 253-261.

Hoste, H., Torres-Acosta, J. F., Paolini, V., Aguilar-Caballero, A., Etter, E., Lefrileux, Y., ... & Broqua, C. (2005). Interactions between nutrition and gastrointestinal infections with parasitic nematodes in goats. *Small Ruminant Research*, *60*(1), 141-151.

Jackson, F., & Coop, R. L. (2000). The development of anthelmintic resistance in sheep nematodes. *Parasitology*, *120*(07), 95-107.

Jallow, O. A., McGregor, B. A., Anderson, N., & Holmes, J. H. G. (1994). Intake of trichostrongylid larvae by goats and sheep grazing together.*Australian veterinary journal*, *71*(11), 361-364.

Knox, M. R., Torres-Acosta, J. F. J., & Aguilar-Caballero, A. J. (2006). Exploiting the effect of dietary supplementation of small ruminants on resilience and resistance against gastrointestinal nematodes. Veterinary Parasitology,139(4), 385-393.

Lisonbee, L. D., Villalba, J. J., Provenza, F. D., & Hall, J. O. (2009). Tannins and self-medication: implications for sustainable parasite control in herbivores.*Behavioural Processes*, *82*(2), 184-189.

Min, B. R., Pomroy, W. E., Hart, S. P., & Sahlu, T. (2004). The effect of short-term consumption of a forage containing condensed tannins on gastro-intestinal nematode parasite infections in grazing wether goats. *Small Ruminant Research*, *51*(3), 279-283.

Paolini, V., Bergeaud, J. P., Grisez, C., Prevot, F., Dorchies, P., & Hoste, H. (2003). Effects of condensed tannins on goats experimentally infected with Haemonchus contortus. *Veterinary parasitology*, *113*(3), 253-261.

Scarfe, A. D. (1993). Approaches to managing gastrointestinal nematode parasites in small ruminants. *Retrieved March*, *7*, 2016.

Shepard, M. (2013). Restoration agriculture (No. 631.584 S547r). Texas, US: Acres, 2013.

Torres-Acosta, J. F. J., & Hoste, H. (2008). Alternative or improved methods to limit gastro-intestinal parasitism in grazing sheep and goats. *Small Ruminant Research*, *77*(2), 159-173.

Villalba, J. J., & Provenza, F. D. (2007). Self-medication and homeostatic behaviour in herbivores: learning about the benefits of nature's pharmacy.

Waller, P. J., & Thamsborg, S. M. (2004). Nematode control in 'green'ruminant production systems. *Trends in parasitology*, *20*(10), 493-497.

Waller, P. J. (2006). Sustainable nematode parasite control strategies for ruminant livestock by grazing management and biological control. *Animal Feed Science and Technology*, *126*(3), 277-289.

Waller, P. J., Bernes, G., Thamsborg, S. M., Sukura, A., Richter, S. H., Ingebrigtsen, K., & Hoglund, J. (2001). Plants as De-Worming Agents of Livestock in the Nordic Countries: Historical Perspective, Popular Belifs and Prospects for the Future. *Acta Veterinaria Scandinavica*, *42*(1), 31-44.

Zanzani, S. A., Gazzonis, A. L., Di Cerbo, A., Varady, M., & Manfredi, M. T. (2014). Gastrointestinal nematodes of dairy goats, anthelmintic resistance and practices of parasite control in Northern Italy. *BMC veterinary research*, *10*(1), 1.

Appendix

Small ruminant questionnaire PrOPara

France		Lithuania		UK		
Netherlands	1	Switzerland				

1 Is the farm organic (small ruminant systems)?

Please mark the farm system with "1"

Conventional	
Organic	1
In-conversion	

If organic, for how many years since starting conversion?

2 Please indicate the approximate number of animals (if of economic importance)

	Approx. Number		Approx. Number
Breeding ewes (meat)		Breeding goats (dairy)	
Lambs (meat)		Growing kids (dairy)	
Breeding ewes (dairy)		Breeding goats (meat)	
Growing lambs (dairy)		Kids (meat)	

	Approx. Number			Approx. Number
Cows		Other (*specify*)		
Growing cattle >1yr		Other (*specify*)		
Beef (young stock) <1yr		Other (*specify*)		

3 Please indicate the approximate area of varying grassland and crop types

	Approx. Area (ha)	
Permanent pasture		
Temporary leys		
Arable and permanent cropland		comment (optional)
Other (e.g. Rangelands, woods and shrubbery)		
Total area		
Additional grazing (e.g. mountain grazing, transhumance)		*1=Yes, 2=No, 3=Don't know*

4 Please indicate the typical number of hours grazed daily

Please mark the appropriate answers with "1", more than one mark per column possible

		Breeding sheep/goats (dairy)	Breeding sheep/goats (meat)	approx. Duration (month)	Growing lambs/kids (dairy)	Growing lambs/kids (meat)	approx. Duration (month)
Grazing	12 - 24 hrs						
	1 - 12 hrs						
	Housed (zero grazing)						

5 Use of specific grazing routines/pasture management to control gastrointestinal worms / liver fluke (fasciola hepatica)

			Heard of	Tried on-farm	Currently utilised
			1=Yes, 2=No, 3=Don't know		
a) Worms	Reduced stocking rates				
	Alternate species grazing				
	Young stock use lower risk areas (see definition)				
	Minimal grazing to reduce worm infection				
	Other (specify)				

b) Liver fluke Is liver fluke a diagnosed problem (e.g. lab/slaughterhouse) on your farm?

1=Yes, 2=No, 3=don't know If "no" then skip this question and move on to Q6

	Heard of	Tried on-farm	Currently utilised
	1=Yes, 2=No, 3=Don't know		
Pasture drainage			
Fencing of streams and ponds			
Pasture rotation from infectious to non-infectious during grazing season*			
Other (specify)			

** The "pasture rotation" option means to move animals from wet (and therefore potentially infective) pastures to dry pastures during the grazing season.*

6a Please list the 3 main methods used for monitoring worms and liver fluke

Please mark up to 3 boxes per column with "1"	Gastro-intestinal worms	Liver flukes
Analysis of faecal samples		
Slaughterhouse feedback (liver)		
Diarrhoea		
Poor/dull fur/hair quality		
Anaemia		
Loss of weight/body condition/milk yield		
Other (specify)		

6b What/who helps you stay up to date with the parasite challenge?

More than one answer possible.

Please mark the appropriate answer with "1"

Articles in magazines, media information	
Veterinary advice	
Advisor (other than vet)	
Mainly own experience	
Other (specify)	

7 Do you typically use commercial anthelmintics (dewormers) for the hereafter mentioned groups to control worms and liver fluke?

Please mark the appropriate answers with "1"

	Gastro-intestinal worms				Liver flukes			
	Breeding sheep/goats (dairy)	Breeding sheep/goats (meat)	Growing lambs/kids (dairy)	Growing lambs/kids (meat)	Breeding sheep/goats (dairy)	Breeding sheep/goats (meat)	Growing lambs/kids (dairy)	Growing lambs/kids (meat)
No treatments used for this group								
Animals are usually treated								
Animals are usually treated as a group*								
Typical number of treatments per year and animal								

**a group could be e.g. only reproducing animals or e.g. only first lactating ewes*

8 If you use commercial anthelmintics (dewormers) when are they usually applied?

Please mark the appropriate answers with "1"

	Gastro-intestinal worms				Liver flukes			
	Breeding sheep/goats (dairy)	Breeding sheep/goats (meat)	Growing lambs/kids (dairy)	Growing lambs/kids (meat)	Breeding sheep/goats (dairy)	Breeding sheep/goats (meat)	Growing lambs/kids (dairy)	Growing lambs/kids (meat)
Pre-breeding season/when dry								
At lambing								
At start of grazing season (around turnout)								
At start or during housing period								
Before transferring to clean (low-risk) pasture								
At weaning								
Other (please specify)								

9 Ohter (alternative) control methods

		Heard of	Tried on-farm	Currently utilised
		1=Yes, 2=No, 3=Don't know		
a	Feeding bioactive plants e.g. chicory, sainfoin			
b	Increased protein supply around parturition and lactation			
c	Use of breeds with greater resistance to infection			
d	Culling susceptible animals in your herd			
e	Drench only part of flock			
f	Drench individual animals only			
g	Use of homeopathy			
h	Use of phytotherapy (e.g. herbs)			
i	Other (specify)			

10 Frequent deworming of the whole flock may lead to worms or flukes that are resistant to commercial anthelmintics; against this background, indicate if you agree or disagree with the following statements:

	Please mark with a "1" (Only one per question/row)	Disagree strongly	Disagree	Not sure	Agree	Strongly agree
a	Anthelmintic resistance will worsen in the future					
b	To prevent further anthelmintic resistance farmers may have to accept reduced production through less treatments					
c	Industry will develop improved treatments/vaccines before resistance becomes a problem					
d	I would accept alternative control methods that may incur greater costs; e.g. monitoring, products or new equipment					
e	I would accept alternative control methods that may incur greater on farm labour input; e.g. sample collection, animal					
f	Increased focus on monitoring and treating individual animals is a feasible worm control strategy					
g	If anthelmintic resistance becomes a serious problem a derogation is needed to keep the animals permanently indoors					

11 Have you had anthelmintic resistance confirmed on your farm for liver fluke or worms?

1=Yes, 2=No, 3=Don't know		*1=Yes, 2=No, 3=Don't know*	
Gastrointestinal worms		Liver flukes	

If yes, to which active component?				Yes=1
	Worms	Benzimidazole	(White drenches)	
		Levamisole	(Clear drenches)	
		Macrocyclic lactones	(Ivermectin/Moxidectin)	
		Monepantel	Zolvix	
	Liver fluke	Triclabendazole	(White, liver fluke)	
		Albendazole	(White, liver fluke)	
		Closantel	(Liver fluke)	
		Clorsulon	(Liver fluke)	

12 Final Comments