Menu

Genetic markers for Haemonchus contortus in sheep

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Genome wide association study to identify genetic markers associated with resistance to Haemonchus contortus in sheep

Industry Sector: Cattle And Small Stock

Research Focus Area: Livestock Production With Global Competitiveness: Breeding,Physiology And Management

Research Institute: Department Of Agriculture Forerst And Fisheries (DAFF)

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The Research Team

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Aims Of The Project

1. Collect blood samples and data on resistance to H. contortus on a sheep flock on a farm with major Haemonchus anthelmintic resistance problems
2. Analyse the data, estimate genetic parameters and develop a protocol for recording of resistance to H. contortus under SA conditions
3. Conduct various genomic studies to identify genetic markers linked to resistance

Executive Summary

The objective of this study was to compare four commonly used growth promotants in a commercial sheep feedlot. The steroidal growth promotants chosen for this trial were Ralgro (zeranol), Revalor G (Rev G; TBA/oestrogen- 17β), Revalor H (Rev H; TBA/oestrogen- 17β) and Zilmax® (zilpaterol hydrochloride). The growth promotants were compared with one another and within three sex groups, namely ewe, ram and wether (castrates), to determine which molecule or combination of molecules, if any, had the most benefit and profitability when measured against a control group. Sheep were stratified based on initial weights and then randomly allocated to treatment groups in a completely randomised control study. All sheep originated from the same farm, and they were of similar age, breed, transport method, processing method, feed (the only difference being the groups receiving Zilmax® during the last 18 days of feeding, making provision for 3 days withdrawal), weather conditions, housing and time on feed. A time constant termination date was used in this study, in order to measure the performance of lambs in treatment groups over time.

The issue of resistance of internal parasite species to worm remedies is widespread throughout South Africa and the world and affects all small stock farmers. Especially *Haemonchus contortus* causes major losses among sheep in the summer rainfall regions in South Africa. For some areas, farming with animals resistant to nematodes seems to be the only solution in the long run. Genetic variation in resistance to nematode infestation in sheep, based on faecal egg count (FEC) as a criterion, has been reported for various breeds. Successful breeding programs for resistance have been reported for Australian and New Zealand sheep. There are, however, no large scale active breeding programs for resistance in South African sheep.

Because of the difficulty of routinely collecting phenotypic data associated with resistance to internal parasites, suitable data sets for the estimation of genetic parameters for resistance against *H. contortus* are scarce in South Africa. The history of and recent selection practices followed in the Wauldby Dohne Merino flock makes it an ideal resource for research into resistance to *H. contortus* in South African sheep.

In 2011, a project aimed at selection for resistance against *H. contortus* was started on the Wauldby Dohne Merino flock. Apart from full pedigree information, data on faecal egg counts (FEC), Famacha© score (FAM) and body condition score (BCS) were collected annually on all lambs born since 2011. FEC, FAM and BCS of all lambs were recorded from the middle of January onwards. FAM was recorded weekly and FEC and BCS every 14 days until the end of June when Haemonchus challenge had decreased. Lambs were only drenched when they had a FAM of 2.5 or more, in conjunction with a BCS of less than 1.5. Any lamb that was drenched was recorded as “Dosed” and those lambs that did not require any drenching as “Not dosed”. Replacement rams and ewes were selected from the animals that did not need dosing on the basis of a selection index incorporating FEC, FAM and BCS.

Data were analysed to compile protocols for selection against resistance to *H. contortus* in SA sheep.

Objective

The objective of this study is to identify of genetic markers for resistance to *Haemonchus contortus* in SA sheep, which could be included in the selection plan. See aims for the objectives of the three phases of the projects.

Results

The Dohne Merino lambs at Wauldby were subjected to severe *H. contortus* challenge. This is evident from the very high maximum FEC values recorded, even at the last two recordings during June. FEC ranged from 0 to 54100 epg among recordings over the trial period. Despite the high FEC challenge, mean FAM was still low, which is indicative of the high resilient status of the Wauldby flock. Dosing status had a significant effect on FAM, BCS and FEC. The Not dosed lambs had lower FEC, higher BCS and lower FAM compared to the lambs that were dosed. FAM increased and BCS decreased as the number of treatments received increased.

During the first year of the trial, 33% of the ram lambs and 45% of the ewe lambs were not dosed throughout the annual recording period. These percentages increased annually until 77% of the ram lambs and 82% of the ewe lambs did not need any drenching in 2016. One of the most significant results of the trial to date was the increase in percentage offspring of the sires that did not need drenching. The best performing sire used during 2011 had 53% lambs that did not need drenching, while 74% lambs of the poorest sire needed anthelmintic treatment. In 2016, the best performing sire had 97% lambs that did not need drenching, while 37% lambs of the poorest sire needed anthelmintic treatment.

FAM had a high genetic correlation and moderate phenotypic correlation with FEC. The highest heritability and repeatability of the resistance traits were recorded for BCS, but BCS had a moderate genetic and a low phenotypic correlation with FEC. In this study, BCS of the lamb, in combination with FAM, was considered in the decision whether to treat the lamb or not. However, due to the low phenotypic correlation between BCS and faecal egg count, BCS of an animal by itself is not an accurate indication of the existing level of *H. contortus* infection. The low phenotypic correlation estimated between BCS and FEC in this study is also indicative that other factors apart from worm load influence BCS in growing lambs.

Body weight, fleece weight and coefficient of variation of fibre diameter had favourable genetic correlations with FEC, FAM and BCS, while fibre diameter and staple length were unfavourably correlated with FEC. Inclusion of FEC in the selection protocol should therefore not adversely affect body weight and wool production.

As far as the application of FAM as criterion for the selection of resilient or resistant sires and dams is concerned, it should be used in combination with other resistance indicators such as FEC. During the high challenge summer rainfall period FAM will be recorded weekly or bi-weekly, therefore more FAM recordings will be available for inclusion in a final selection protocol. Due to its favourable genetic correlations with FEC and the production traits, and the fact that BCS of the Not dosed lambs in this study was higher than BCS of the Dosed lambs, BCS could be included in the selection protocol to be used for selection against resistance to *H. contortus*. BCS and FEC can be recorded at the beginning (January), at the peak (middle to end of March) and towards the end of the *H. contortus* season (June). Lambs that did not require any anthelmintic treatment up until selection age could be selected on the basis of a selection protocol incorporating these FEC and BCS recordings, together with all the recorded FAM.

The following selection indices, including FEC with or without incorporating FAM and BCS, were compiled / suggested:

- SI1 = (-1 x FEC169 -1 x FAM +1 x BCS169) +10
- SI2 = (-1 x FEC169 -1 x FAM) +10
- SI3 = (-1 x FEC169) +10

As far as the genomic study is concerned, there were definite genetic differences among the animals in the flock and three genetic clusters were observed. Animals in the most resistant cluster had significantly lower FEC, lower FAM and higher BCS than the animals in the other two clusters. The sires of the animals in the resistant cluster also had more favourable EBVs for FEC and FAM.

The results of the genomic study further indicated the possibility of selection signatures on the same chromosomes in the Wauldby Merino animals than those on which QTL for faecal egg count and *H. contortus* FEC are reported in the sheep genomic databases. These will be further investigated in a comprehensive GWAS study.

Conclusion

The results indicate that progress was made when selecting for resistance to *H. contortus* in the Wauldby Dohne Merino flock.
There is genetic variation in host resistance against *H. contortus* in the Wauldby Dohne Merino flock.
Sires in one genetic cluster are highly resistant and can be used in a breeding program to develop sheep that are resistant to *H. contortus* infections.
Moderate heritabilities and genetic correlations were estimated for and among FAM, BCS and FEC in this flock. Except for the unfavourable genetic correlation with fibre diameter, no detrimental genetic correlations between the resistance and production traits were estimated.
These results were used to develop protocols for selection for resistance to *H. contortus* under South African conditions. The developed protocols need to be validated on various farms before they can be implemented on a wider scale.

Popular Article

PROTOCOL FOR SELECTION FOR RESISTANCE TO HAEMONCHUS CONTORTUS IN SOUTH AFRICAN DOHNE MERINO SHEEP

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INTRODUCTION

The issue of resistance of internal parasite species to worm remedies is widespread throughout South Africa and the world and affects all small stock farmers. *Haemonchus contortus* is the most important parasite and causes the most losses among sheep in the summer rainfall regions of South Africa. For some areas, farming with animals resistant to nematode infestation seems to be the only solution in the long run.

Because of the difficulty of routinely collecting phenotypic data associated with resistance to internal parasites, suitable data sets for the estimation of genetic parameters for resistance against *H. contortus* are scarce in South Africa. The history of and recent selection practices followed in the Wauldby Dohne Merino flock makes it an ideal resource for research into resistance to *H. contortus* in South African sheep. The farm Wauldby is located in the Stutterheim district in the Eastern Cape Province in a high summer rainfall area (800 mm annually). Wauldby has a well-documented history of heavy *H. contortus* challenge and *H. contortus* resistance and in the past the farm was used for several trials relating to resistance of *H. contortus* to anthelmintics.

In 2011, a project aimed at selection for resistance against *H. contortus* was started on the Wauldby Dohne Merino flock. Data on faecal egg counts (FEC), Famacha© score (FAM) and body condition score (BCS) were collected annually on all lambs born since 2011. FEC, FAM and BCS of all lambs were recorded from the middle of January onwards. FAM was recorded weekly and FEC and BCS every 14 days until the end of June when Haemonchus challenge had decreased. Lambs were only drenched when they had a FAM of 2.5 or more, in conjunction with a BCS of less than 1.5. Any lamb that was drenched was recorded as "Dosed" and those lambs that did not require any drenching as "Not dosed". Data on all lambs were recorded throughout until the end of June, irrespective whether they needed drenching or not.

Selection in the flock was aimed at increasing resistance to *H. contortus*, while maintaining reproductive performance, body weight, wool weight and fibre diameter and improving wool quality traits. Selection for the production traits was done on the basis of selection indices and BLUP of breeding values for the mentioned traits measured at 14 months of age. Selection for resistance to *H. contortus* was based on a selection index incorporating FEC, FAM and BCS.

A selection line, in which the most resistant ewes were mated to the most resistant rams, has been established in 2012 as part of the project. These animals were run together with the rest of the flock animals, except during mating. Only ram and ewe lambs that had never been drenched were considered for selection into the selection line. Three rams and about 20 young ewes were selected annually for the selection line since 2012. Currently the selection line consists of 120 ewes, which are mated in three groups of 40 ewes each to the three most resistant rams in single sire mating camps. All progeny born in both the selection line and the rest of the flock were evaluated together. Rams and ewes performing the best in terms of resistance could be selected for the selection line, whether their parents came from the selection line or the other flock animals.

RESULTS TO DATE

The data collected over the years were used to estimated heritabilities and genetic correlations among the traits. Moderate heritabilities for and favourable genetic correlations among FEC, FAM and BCS were estimated. It will be impractical and expensive to record FEC every second week under commercial farming conditions. A combination of FEC recordings at the beginning, at the peak (middle to end of March) and towards the end of the season, proved to be the best alternative for selection purposes.

FAM had a high genetic correlation with FEC. In this study on-going first stage selection was done by identifying animals unsuitable for inclusion in the selection line on the basis of FAM and BCS. Identifying animals that required anthelminthic treatment according to FAM will ensure that only truly susceptible animals are identified and destined to be culled. Resilient as well as resistant animals will not be targeted and will remain untreated and available for final stage selection. As far as the application of FAM as criterion for the selection of resilient or resistant sires and dams is concerned, it should be used in combination with other resistance traits such as FEC. During the high challenge summer rainfall period, FAM will be recorded weekly or bi-weekly, therefore more FAM recordings will be available for inclusion in a final selection protocol.

The highest heritability and repeatability of the resistance traits were recorded for BCS, but BCS had a moderate genetic correlation with FEC. In this study, BCS of the lamb, in combination with FAM, were considered in the decision whether to treat the lamb or not. However, due to the low phenotypic correlation between BCS and FEC, BCS of an animal by itself is not an accurate indication of the existing level of *H. contortus* infection. By the time BCS is affected by *H. contortus per se,* the animal would have shown other clinical signs of Haemonchosis. Due to the fact that BCS of the Not dosed lambs in this study was higher than BCS of the Dosed lambs, BCS was included in one of the selection indices. BCS and FEC can be recorded at the beginning (January), at the peak (middle to end of March) and towards the end of the *H. contortus* season (June), as mentioned above.

SELECTION INDICES (SI)

The following selection indices, including FEC with or without incorporating FAM and BCS, were compiled / suggested:

SI1 = (-1 x FEC169 -1 x FAM +1 x BCS169) +10

SI2 = (-1 x FEC169 -1 x FAM) +10

SI3 = (-1 x FEC169) +10

For all the animals on which data were collected to date in the Wauldby flock, these three SI options were calculated. These three selection indices were evaluated on the data of the Wauldby animals born in 2015, 2016 and 2017. When the data of all the available animals were evaluated, basically the same animals will be selected with SI1 and SI2. Where selection is based only on FEC (SI3), somewhat different animals were selected in some years than when FAM and BCS were included in the selection index.

When the data of only a selected proportion of 5% rams and 25% ewes were evaluated, again basically the same animals will be selected with SI1 and SI2. However, rather different animals will be selected when only FEC was used as selection criteria. What this implies is that selection should preferably be done on SI1 or SI2. FAM should be included together with FEC, but the inclusion of BCS is optional.

PROTOCOL FOR SELECTION FOR RESISTANCE AGAINST H. CONTORTUS

The following protocols can be followed for selection for resistance against H. Contortus in stud and commercial flocks respectively.

Stud Animals

Follow the normal internal parasite control program before weaning, i.e. routine pooled FEC.If the lambs needed to be drench before weaning, FEC, FAM and BCS of all the lambs could be recorded before drenching. All lambs could then be drenched after data collection.After weaning, recording of individual ram and ewe lambs should take place.FAM should be recorded every 14 days until the end of June when Haemonchus challenge has decreased.Individual FEC and BCS should be recorded at the beginning (January) and twice during the summer season (March and May).Lambs should only be drenched when they have a FAM of 2.5 or more.Any lamb that was drenched should be noted and culled.Replacement rams and ewes should be selected from the animals that did not need dosing on the basis of one of the above selection indices incorporating FEC and FAM, with or without BCS.Adult ewes should only be drenched on FAM (Targeted selective treatment). Note and cull ewes that need repeated drenching.Evaluate existing sires on the performance of their offspring.If rams are bought, buy only rams resistant to internal parasites.

Commercial Animals

Follow the normal internal parasite control program before weaning, i.e. routine pooled FEC.After weaning only ewe lambs should be recorded.FAM should be recorded every 14 days until the Haemonchus challenge has decreased.FEC should be monitored through monthly pooled FEC samples.Lambs should only be drenched when they have a FAM of 2.5 or more.Any ewe lamb that was drenched should be noted and lambs that needed 2 or more drenchings should be culled.Adult ewes should only be drenched on FAM (Targeted selective treatment). Note and cull ewes that need repeated drenching.Individual FEC of all adult rams should be recorded during the peak Haemonchus season. Before faecal sampling, the rams should not receive any anthelmintic treatment for at least 3 to 4 weeks. Cull rams with too high FEC.Buy only rams resistant to internal parasites.

CONCLUSIONS

Progress was made when selecting for resistance to *H. contortus* in the Wauldby Dohne Merino flock. These results were used to develop protocols for selection for resistance to *H. contortus* under South African conditions. The developed protocols need to be validated on various farms before they can be implemented on a wider scale.

ACKNOWLEDGEMENTS

Mr Robbie Blaine and the personnel at Wauldby for their valuable contribution in the execution of the project and RMRD-SA for funding of the project.

Conclusions

Please contact the Primary Researcher if you need a copy of the comprehensive report of this project –

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Cattle and Small Stock, Livestock Production, physiology and management, with global competitiveness

2019, CSS, Online, Snyman, UP

‹ Modeling veld production using MODIS LAI – Phase 3

› Genotype imputation for indigenous beef cattle

DEADLINES for RESEARCHERS 2021

Proposals for 2021: TBC
Progress reports: 28 Jan 21
Final reports: 29 Jan 21 Final includes comprehensive report and popular article

COMMITEE MEETINGS for 2021

RMRDSA CSS Planning - TBC
Project Committee - TBC
Pork Planning - TBC

Calendar

< Apr 2021 >

Sun	Mon	Tue	Wed	Tur	Fri	Sat
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

PORK Priority Areas

Cattle & Small Stock Programmes

1 Sustainable natural resource utilisation

2 Improvement of Livestock production and forage

3 Management of agricultural risk to create a resilient Red Meat sector

4 Sustainable health and welfare for the Red Meat sector

5 Enhancement of production and processing of Animal Products

6 Consumer and market development of the Red Meat sector

7 Commercialisation of the emerging sector