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MEASURED GOATS: AN OVERVIEW OF A MEAT GOAT REFERENCE POPULATION

T. Granleese[1], S.I. Mortimer[1], T. Atkinson[4], G. Refshauge[3], T. Bird-Gardiner[4], F. Haynes[1], D.J. Brown[2], P. Alexandri[2] and S.F. Walkom[2]

[1]NSW Department of Primary Industries, Armidale NSW, 2351 Australia
[2] Animal Genetics Breeding Unit*, University of New England, Armidale, NSW, 2351 Australia
[3] NSW Department of Primary Industries, Cowra, NSW 2794 Australia
[4] NSW Department of Primary Industries, Trangie NSW2823 Australia

SUMMARY

New South Wales Department of Primary Industries' second-most western station, Condobolin Agricultural Research and Advisory Station will be host to the "Measured Goats in the Rangelands project". This five-year co-investment between New South Wales Department of Primary Industries and the Meat and Livestock Donor Company project will also work collaboratively with the Animal Genetics and Breeding Unit. The project will utilise three goat breeds – Boer, Kalahari Red and wild "Rangeland", both in purebred and crossbred forms to become a multi-breed genomic reference population. All project animals born will have a goat specific 70k SNP genomic test to identify parentage, breed composition and heterozygosity. Furthermore, performance, health, reproduction and structural traits will be recorded in large contemporary groups. The aim is to breed and measure over 8,000 animals in a self-replacing style breeding nucleus over 4 years. This project aims to provide trait and breed means, update genetic parameter estimates for meat goats, obtain heterosis estimates, and provide new links into the KIDPLAN database. The project will also generate new traits and knowledge to update the assumptions used for the KIDPLAN analysis. Finally, the project has a major adoption and extension focus to increase the uptake and adoption of KIDPLAN breeding values at a seedstock and commercial level.

INTRODUCTION

Currently little is known about the phenotypic and genetic performance of Rangeland goat (captured feral goats) and their crossbred progeny. The Australian Rangeland goat population, however, underpins the Australian goat meat industry which is an export industry valued at $235 million per annum (MLA 2020). Rangeland does will continue to be the basis of the goatmeat industry owing to their numbers relative to the limited number of pure or crossbred does. To date, the majority of goatmeat is supplied from harvest enterprises that capture goats from a semi-feral state. However, the National Goat Meat Forecasting Committee and other industry sources, as well as an industry survey (Williams and Williams 2019), are reporting a rapid and unprecedented increase in the number of producers in NSW and Queensland operating managed and semi-managed goat enterprises.

Given the limited numbers of animals contributing to genetic parameter estimations in a single breed for meat goats, producers want to know whether crossbreeding approach will achieve production gains within their herds while maintaining the rangeland goat's hardiness and suitability to semi-arid and arid environments. Well-designed Research and Development programs can capitalise on this interest to engage producers in herd improvement using genetic strategies. There is also a need to investigate the performance and genetic variation within rangeland herds to determine and demonstrate the potential for production gains through selection.

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This proposal has been developed through a consultation process with goatmeat producers from NSW and Queensland who operate a range of enterprises (including extensive commercial, seedstock and harvesting) typical of the industry. With the industry focused on increasing national supply, transitioning harvest enterprises to managed production systems, improving farm profit and meeting consumers preferences, there is a clear need to prioritise working with producers to establish and implement selection and crossbreeding strategies that will realise the potential within rangeland herds for relatively rapid genetic gain in production and welfare traits.

There is considerable potential for genetic improvement in Rangeland herds, although the benefits from research in genetics and genomics are yet to be realised (Kijas 2012; Aldridge and Pitchford 2018). Kijas (2012) reported that the Rangeland population was one of the most genetically diverse in domesticated species in the world. One of his main conclusions was "if selection pressure was applied to almost any trait, the population would quickly respond and exhibit strong genetic gain.". Both Aldridge and Pitchford (2018) and Williams and Williams (2019) suggest that performance recording and understanding genetic parameters of Rangeland goats would help increase breeding goat enterprise's profitability by better understanding the genetic capability of Rangeland goat genetics and hence make more informed selection decisions.

Currently a small population of 400-600 Boer goats (KIDPLAN database) are performance recorded annually where KIDPLAN breeding values are calculated by Sheep Genetics (MLA). This pipeline needs to be used more as the benefits of genetic selection to improve performance, reproductive, health and survival traits has been well documented across all domestic livestock species farmed around the world. Given the potential for rapid gains due to high diversity, Rangeland goat production systems can rapidly increase performance and hence on-farm profitability.

This project aims to collect a dataset of up to 9,000 animals that will be genome tested using a 70k goat specific SNP chip while also recorded for phenotypes. The data collected will also be submitted to the KIDPLAN database. The dataset will include 3 breeds (Boer, Rangeland and Kalahari) so breed-by-breed comparisons can be made for an eventual multi-breed evaluation. Furthermore, the project has a comprehensive adoption and extension arm to help deliver a larger uptake of breeding values at a seedstock and commercial breeder level. Finally, the project will be available to overlay/sister projects eliciting considerable interest has been made if this project proceeds. This includes but not limited to providing links between current KIDPLAN participants, a potential KIDPLAN analysis upgrade and "Going Ahead with Goats" project led by Local Land Services and meat science overlays.

MATERIALS AND METHODS

Site. Condobolin Agricultural Research and Advisory Station will host the project in central-west New South Wales, Australia. The site is a New South Wales Government research station. Condobolin has a semi-arid climate with median annual rainfall of 386mm with a pasture growing profile between Autumn and Spring and is well-suited for goat research.

Time. The project will be run over 5 years starting in 2024. The project will require four years to achieve five kidding events and grow progeny out for performance recording. The final twelve months will be used for data analysis and adoption activities.

Breeds and numbers. Up to 1,000 breeding does will be joined 5 times in a self-replacing style breeding nucleus. The initial 1,000 breeding does will as near as possible equally representing the following breeds.

1) Rangeland goat population that have been sourced from multiple wild-harvest depots
2) High Boer content
3) High Kalahari Red content

Three breeds of bucks will be mated via artificial insemination and then back up syndicate mated in a self-replacing style reference population over the 4 years. Both purebred and crossbred

(including reciprocal crosses) matings will be undertaken. Link sires to the KIDPLAN database will be used so all data can be used in future KIDPLAN analyses.

Does born in the project will be first eligible for mating at eight months of age. Female progeny will only be culled from the project for one of the following reasons:

1) Animal ethics issue where a physical and health affliction affects the animal's state of health
2) If a doe is scanned empty after two consecutive mating events
3) If a doe is unsuccessful in raising kids at two consecutive events

Traits recorded including genomics. Traits measured on project progeny are defined in Table 1. All parents and progeny in the project will be genotyped on Neogen's 70k goat specific panel via a tissue sample unit. This will allow pedigree to be assigned. Furthermore, genomic testing of each project animal will facilitate genomic based analysis including genetic parameter estimation, genome wide association studies, and estimation of breed composition and heterosis.

Table 1. List of traits to be measured on experimental animals. Wt: weight

Growth	Birth & Reproduction	Carcase & EQ	Hard to Measure	Others
Weaning Wt	Conception	Fat Depth	Faecal egg count[1]	Temperament
Post-weaning Wt	Litter size	Eye muscle depth		Structure
Yearling Wt	Kids weaned	Condition score		Body condition score
Adult Wt	Udder score			Horn Score
				Coat colour

[1]Where enough phenotypic variation is available

Sire selection. Sires will be used via artificial insemination and natural mating. Artificial insemination sires will be nominated by industry for a fee like the Merino Central Test Sire Evaluation (Swan *et al*. 1998) systems. Nominated bucks will be accepted according to their influence in industry and/or pedigree supplied and/or genetic diversity and/or a breeder seeking a genetic links to the KIDPLAN database to begin submitting performance records. Eligibility for inclusion in artificial insemination will require bucks who are currently in KIDPLAN and/or sires or sons of sires who have contributed significantly to the goatmeat population. This will provide sire linkage between databases. In addition, naturally mated back-up bucks will be purchased by NSW DPI from key industry seedstock herds according to selection criterion similar to that adopted for the selection of AI sires. Sire purchasing will also strive to capture as much of the goat meat population's genetic diversity. Given there is little pedigree recorded in meat goats, the project accepts it will not capture all the diversity of the goat meat population. However, it will be a foundation block to build on over time, like the beginnings of the Sheep CRC Information Nucleus Flock (van der Werf *et al*. 2010). As the project progresses, more sophisticated approaches to sire selection can be used such as optimisation of current and future contributions using optimal contribution methods (Wray and Goddard 1994).

Base dam selection. Base dams will be sourced from commercial breeders who can provide as high a content of each breed (Rangeland, Kalahari Red, Boer) as possible. The project will aim to source from no more than three properties each. If a depth of pedigree can be obtained (e.g. sires of the sourced females are genotyped to provide sire pedigree), this would be advantageous. Prior to

the project beginning, dams will be given time to kid any potential existing pregnancies. This is necessary given many goat producers have little control of bucks (owned or feral entering properties) mating does.

Statistical analysis. Univariate animal models for single and/or repeated measures will be fitted using linear mixed model equations to do genetic parameter estimation of each trait. Genomic relationships will then be added to further refine estimations where breed proportions and heterosis can be accounted for.

Once univariate models are finalised, multi-trait analysis will be undertaken to better understand genetic relationships among traits.

Furthermore, genomic information will facilitate genome wide association (GWAS) analysis to investigate genetic markers that have large phenotypic effects such as horns, coat colour, muscling and potentially ovulation rate.

A feasibility study will also be conducted to examine whether data from this reference population will be suitable to become part of the KIDPLAN database. If successful, the KIDPLAN database would be expected to grow by 80% through this project, thereby providing key genetic links for existing and new studs and breeds into the KIDPLAN analysis. It will be key to providing a foundation to improve and update the KIDPLAN analysis plus adding new traits and industry relevant indexes.

CONCLUSION

The Measured Goats in the Rangelands project will form a valuable resource population for the growing goat meat industry. The project will introduce new breeds Kalahari Red and wild "Rangeland" to the KIDPLAN database as well as providing a well-structured genomic reference At the time of writing this paper, the project is at the stage of sourcing females and sires.

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