



A. ADMINISTRATIVE DATA

Institution:

Principal investigator:

Mailing address:

Phone:

Fax:

E-mail:

Project title: Genomic, meat yield, carcass quality and economic profiles of smallholder village goat populations of South Africa, Botswana and Zimbabwe:
Opportunities of optimal production under low input production systems

A list the names of all individuals and identify key personnel [e.g., co-investigator(s)], providing their department, telephone, and e-mail must accompany the samples and animals:

Full names	Affiliation/Institute	Country	Expertise/Role	Email address	Sub-committee
Dr Khanyisile Hadebe	Agricultural Research Council	South Africa	Principal Investigator	MdladlaK@arc.agric.za	Genomics/Meat Science
Dr Ennet Mpholisa	Agricultural Research Council	South Africa	Principal Collaborator	MoholisaE1@arc.agric.za	Genomics/Meat Science
Dr Kenneth Nhundu	Agricultural Research Council	South Africa	Collaborator	NhunduK@arc.agric.za	Economics
Dr Kgantjie Moloto	Agricultural Research Council	South Africa	Collaborator	MolotoK@arc.agric.za	Genomics/Meat Science
Ms Whitney Matli	Agricultural Research Council	South Africa	Junior Economist	MatliW@arc.agric.za	Economics
Dr Manana Mamabolo	Agricultural Research Council	South Africa	Economist/Project Implementation in Economics	ranchom@arc.agric.za	Economics
DR Kenneth Nhundu	Agricultural Research Council	South Africa	Economist/Project Implementation in Economics	nhunduk@arc.agric.za	Economics
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Professor Tinyiko Edward Halimani	University of Zimbabwe	Zimbabwe	Principal Collaborator	tinyiko.halimani@gmail.com	Genomics/Meat Science
Dr Plaxedis I. Zvinorova Chimboza	University of Zimbabwe	Zimbabwe	Collaborator	ivy.zvinorova@gmail.com	Genomics/Meat Science
Dr Phetogo I Monau	Botswana University of Agriculture and Natural Resources	Botswana	Collaborator	pmonau@buan.ac.bw	Genomics/Meat Science
Professor Shalaulani James Nsoso	Botswana University of Agriculture and Natural Resources (BUAN)	Botswana	Principal Collaborator	sinsoso@buan.ac.bw snsnsoso9@gmail.com	Leader
Dr Kethusegile Raphaka	Director for Animal Production and Health at the National Agricultural Research and Development Institute (NARDI)	Botswana	Collaborator	kethusegile@nardi.org.bw	Genomics/Meat Science
Dr Sinalo Mani	Agricultural Research Council	South Africa	Genomics	ManiS@arc.agric.za	Genomics/Meat Science
Mr Frans Seolwana	Agricultural Research Council	South Africa	ARC Animal Health Technician	SeolwanaF@arc.agric.za	Genomics/Meat Science (Animal Technician)
Dr Molebeledi D. Mareko	Botswana University of Agriculture and Natural Resources (BUAN)	Botswana	Collaborator	mmareko@buan.ac.bw	Genomics/Meat Science
Dr Keneilwe Kgosikoma	Botswana University of Agriculture and Natural Resources (BUAN)	Botswana	Collaborator	kkgosikoma@buan.ac.bw	Economics
Prof Edward Mutandwa	University of Zimbabwe	Zimbabwe	Collaborator	mutandwa.edward@gmail.com	Economics

B. BACKGOURND AND STUDY OBJECTIVES

Conservation, sustainable utilization and economic viability of indigenous goats are key issues for resource-poor farming communities that rely on them for food security, social, economic, and cultural functions, especially in the context of climate change, high unemployment rate and emerging diseases. The Southern African Development Community (SADC) has a rich and diverse goat population estimated at 38 million [1]. Sources indicate that South Africa, Zimbabwe and Botswana respectively have more than 6 million, 3,4 million and 1,4million goats in the smallholder sector. The extensive nature of the smallholder sector means they are not buffered from the environmental selective pressures. It is hypothesized that that the animals carry unique genes for adaptation to extreme environmental conditions, which translates into unique phenotypic diversities as well as their ability to thrive in low input production environments. These attributes makes them suitable to support marginalized rural low-income households, therefore a possible pathway for rural development and sustainable livelihoods.

Despite the three countries being major goat producers, the amount of goat meat that commercially produced and consumed is often low and limited to commercial meat-type goats i.e. Boer. For instance in South Africa, only 0.5% is slaughtered in the commercial sector with an estimated 39 008 Kgs exported in 2016 [2]). The low goat meat offtake is attributed to: (a) majority of the goats being produced in the smallholder sector where the genetics and genetic potential is poorly characterized and understood and therefore productivity and offtake is low; (b) low meat yield and poor carcass quality of the meat that is due to both the genetics and production methods (c) low-input and unoptimized production system that makes the enterprise not economically viable. Furthermore, markets for goats and goat products are poorly developed, resulting in mismatched demand and supply. Such a status calls for further improvements and interventions in the smallholder goat value chain to improve on both productivity levels and offtake.

The project aims to increase sustainable production, value addition, marketing and consumption of goats, for improved food and nutrition security and reduced poverty through multi-disciplinary research and development interventions that will be achieved through knowledge on the full value chain profile of the smallholder goat sector in Botswana, South Africa and Zimbabwe. In addition, the study intends to develop and establish genomic and economic decision tools to support development of smallholder goat value chains in the three and other countries in the region to broaden the commercial demand.

Specific objectives:

1. To investigate the genomic architecture and genetic potential of indigenous goat populations of Botswana, South Africa and Zimbabwe using the Illumina Goat 65K Genotyping Bead Chip.
2. To build a profile on the meat yield and carcass quality traits of indigenous goats of Botswana, South Africa and Zimbabwe

3. To build a profile on the rumen microbiome structure of indigenous goats of Botswana, South Africa and Zimbabwe
4. To conduct a value chain analysis economic viability scenario analysis and potential for intra-regional trade of the smallholder goat system in the three countries and identify barriers and opportunities for upscaling production and consumption.

C. ANIMAL REQUIREMENTS

Genus: *[e.g., Mus]*

Species: *[e.g., musculus]*

Strain, subspecies,
or breed: *[e.g., C57BL/6]*

Common
name: *[e.g., Black6]*

Approximate age, weight or
size:

Sex:

Bacteriological status: *[e.g., germfree (axenic), defined flora (gnotobiotic), specific pathogen free (SPF), conventional]*

Viral status: *[e.g., simian immunodeficiency virus, simian retrovirus]*

Source(s): *[e.g., name of vendor or breeder, or bred in-house]*

Primary origin/location(s): *[Facility manager must certify in Section S that facility has the resource capability to support the study. If animals will be housed in lab or anywhere else outside central facility for more than 12 hours, provide building and room number.]*

Location(s) where samples will
be processed:

Number of animals to be
used:

Year

Year

Year

1:

2:

3:

Total number of animals to be
used:

D. DESCRIPTION OF EXPERIMENTAL DESIGN AND ANIMAL PROCEDURES

Include the adhere to the standardized SOPs for compliance on the following, if applicable:

- **Animal identification methods** *[e.g., ear tags, tattoos, collar, cage card, implant, etc.].*
- **Method of transport**
- **Methods of restraint** *[e.g., restraint chairs, collars, vests, harnesses, slings, etc.].*
Describe how animals are restrained for routine procedures like blood withdrawals. Prolonged restraint must be justified with appropriate oversight to ensure it is minimally distressing. Describe any sedation, acclimation or training to be used.
- **Ear tissue biopsy** *[site, and methodology].*
- **Food or fluid restriction** If food, or fluid, or both food and fluid, will be restricted, describe method for assessing the health and wellbeing of the animals. *[Amount earned during testing and amount freely given must be recorded and assessed to assure proper nutrition.]* If you are seeking a departure from the recommendations of the Guide, provide a scientific justification.
- **Other potential stressors** *[e.g., noxious stimuli, environmental stress]* **and procedures to monitor and minimize distress.**
- **Experimental endpoint criteria** *[e.g., tumor size, percentage body weight gain or loss, inability to eat or drink, behavioral abnormalities, clinical symptomatology, or signs of toxicity]* must be specified. List the criteria that will be used to determine when euthanasia is to be performed. Death as an endpoint must be scientifically justified.
- **Veterinary care** Indicate the plan of action in case of animal illness *[e.g., initiate treatment, call investigator prior to initiating treatment, euthanize].*

Details of Veterinarian involved in the study:

Vet full names	Institute	Country	Registration body/Practice Number	Contacts

E. BIOLOGICAL MATERIAL/ANIMAL PRODUCTS FOR COLLECTION IN ANIMALS

[e.g., blood, faecal, etc.]

1. Specify Material:

2. Source:

Material Sterile or Inactive:

Yes

☐

No

☐

3. I certify that the samples taken will be used for the purpose of the research only. To the best of my knowledge the material remains uncontaminated with pathogens.

Initials of Principal Investigator

F. TRANSPORTATION OF SAMPLES

Transportation of biological samples must conform to all institutional guidelines/policies and regulations of Botswana, South Africa and Zimbabwe, where applicable. Samples must be labelled and accompanied by the sample sheet with the details of the animal samples.

- If samples will be transported on public roads or out of state, attach SOP that will be used to comply within and between country regulations.
- If samples will be transported between facilities, attach SOP that will be used.
- If animals will be transported within a facility, include the route and elevator(s) that will be used.

G. ANIMAL RESTRAINING DURING SAMPLING

The animal will be restrained by straddling it, placing knees behind the shoulders of the animal and backing the animal into a wall to control the hindquarters. The use of appropriate restraint method will ensure will cause minimal distress and can be conducted quickly and safely.

H. PHENOTYPIC CHARACTERISATION

Briefly explain the aim of the study and why the study is important to human or animal health, the advancement of knowledge, or the good of society in language that a layperson can understand. Please comment on whether the study unnecessarily duplicates other studies.

PHOTOGRAPH



Shot 1: Left side of goat.

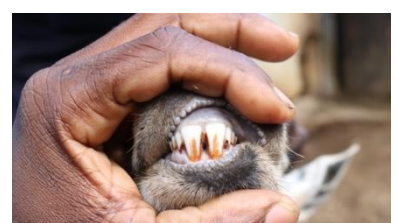
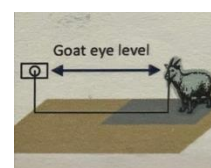
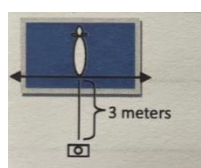
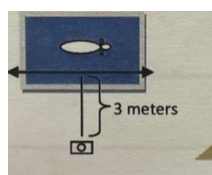


Shot 2: Front side of goat.



Shot 3: Right side of goat.

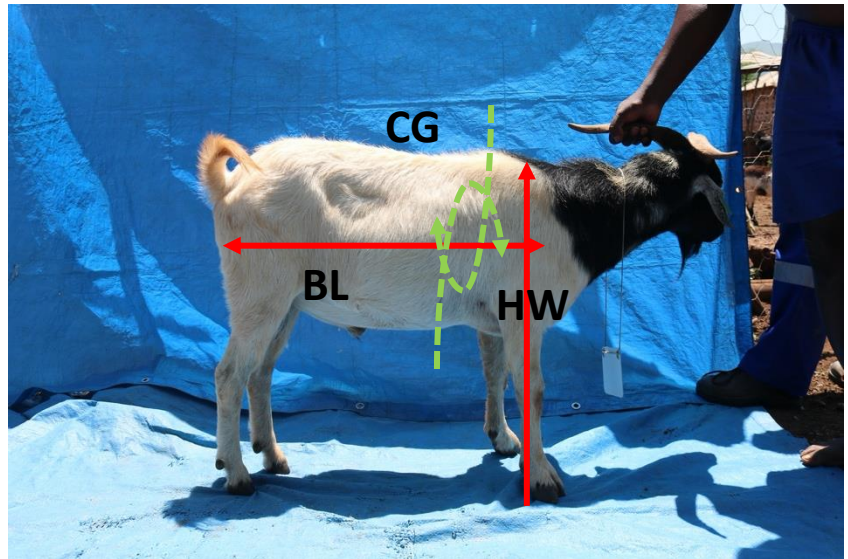
Camera position



BODY LINEAR MEASUREMENTS



SB: Width of points of shoulder bones in front.



BL (length): point to shoulder to pin bone (pins=point bones on either side of anus); CG (chest girth): body circumference at the heart, just behind the elbows; HW (height): front hoof to point of withers (top of shoulder blades).

BODY WEIGHT



Measure the animal body weight using a weight band by wrapping the weight band directly behind the shoulder blade, down the fore-ribs, under the body behind the elbow and all the way around to the point behind the shoulder blade, then overlap the ends of the weight band on top, on the goat's spine to read the value.

SCROTUM CIRCUMFERENCE



Measure scrotal circumference (SC) with a flexible tape measure from the bottom of the scrotum to the point of greatest diameter of the scrotal sac.

I. BIOLOGICAL SAMPLE COLLECTION

- Hygiene is always important when collecting ear tissue samples from your animals or tagging your animals to reduce the risk of infection.
- Tools should be cleaned before and after use.
- Store tissue applicator in a clean airtight container.
- Always clean the area on the animal to be applicated or tagged before the process begins.
- After tissue sample collection or tagging, check the tagged area regularly to ensure that the area is not infected.
- *Rubbing alcohol or a disinfectant should be used to clean the tools and the site on the animal to be tagged/ applicated.*

Considerations

- The least invasive tissue collection method available, i.e., the method causing the least discomfort to the animals, should be selected.
- The selection of the tissue collection method should take into consideration the age of the animals at the time of tissue collection.

EAR TISSUE SAMPLING

Procedures

Loading the tissue applicator (gun)

- Load the gun: Ensure the tube retainer at the base of the applicator gun is open.
- Insert the punch into the tissue applicator.
- Carefully squeeze the applicator handles together, guiding the punch tip into place if necessary.
- When fully seated the gun bolt will rest flush against the red plastic clip.
- Release the handle and remove the red plastic clip by pulling it outward.

Taking the sample

- Firmly restrain the goat, allowing access to the ears. Wipe down the ear area with 70% alcohol to clean and rub the numbing cream such as Lidocaine/prilocaine cream on the area to pierce.
- Slide the gun over the ear and position the cutter approximately 25 mm from the edge of the ear, taking care to avoid any obvious veins and ridges.
- Squeeze handles together to take a sample and then release to free the ear. Try to do this in one swift, fluid, motion. Move with the animal and don't fight its movements.
- The tissue punch will yield a sample of tissue approximately 1-2 mm in diameter.
- Remove the tissue punch from the device and check that sampling has been successful.
- Remove the used cutter from the applicator by pulling the handles apart. This will loosen the cutter. Discard safely.
- Disinfect the ear using sterile gauze and Betadine to prevent infection. Wipe dry. Discard into the biohazard disposable bucket.
- Disinfect the tissue applicator between animals with 70% alcohol.
- Label and place the tissue punch inside the storage box. Make sure the sample ID is the same as in the sample sheet.

The animals will be returned to the pen or other holding place for a few minutes to monitor bleeding and other stress-related behaviours. The farmer will report to the researchers and local animals health if further action is required.

Illustration below:

Loading the Tissue Applicator



Remove a TSU Punch from the packaging. Punches should be assembled as one piece: if they have come apart, reassemble.



Ensure the tube retainer at the base of the applicator gun is open. Push the retainer clip to open.



Insert the punch into the tissue applicator as shown. Release clip to lock punch into the device.



Carefully squeeze the applicator handles together, guiding the punch tip into place if necessary. When fully seated the gun bolt will rest tightly against the red plastic clip.



Release the handle.



Remove the red plastic clip by pulling it outward. Take care not to cut finger on the metal cutter, it is very sharp.

The applicator is now loaded and ready to take a sample. All parts are for one-off use only. Do not re-use metal cutters.

Taking the Sample



Squeeze handles together to take a sample and then release to free the ear. Try to do this in one swift, fluid, motion. Move with the animal and don't fight its movements



Note: The red plunger is visible in used punches.



Slide the gun over the ear, and position the cutter approximately 2.5cm from the edge of the ear, taking care to avoid any obvious veins and ridges.



Squeeze handles together to take a sample and then release to free the ear. Try to do this in one swift, fluid, motion. Move with the animal and don't fight its movements.

Check that sampling has been successful. If not, discard the sample and re-sample with a new punch.

Once the tissue sample has been extracted, care should be taken to store the product at room temperature. The best results are obtained when the samples are analyzed within one year after the sample collection.

HAIR SAMPLE

- Use fingers or pliers to grasp approximately 8-10 hairs close to the skin and pull. **Pull** (do NOT cut) hair strands. Examine the end of hair strands for presence of root bulbs. **Hair roots are necessary for DNA testing.** If the majority of hair strands lack the root bulbs, discard hair and start again.
- Repeat until you have approximately 20-30 hairs with root follicles attached.
- Place the 20-30 hairs with root follicles attached in the envelope and seal with the animal's ID written on the envelope.
- Repeat steps 1-4 for each additional animal being sampled.

Note:

- Hair should be dry.
- If hair has excess dirt and debris, please brush out if possible before pulling hairs for sample.
- **Do not cut the hair!** The roots contain the DNA for testing.
- When sampling several animals in the same session, make sure that there are no hair strands in your hands to reduce the possibility of sample contamination. Clean hands and/or pliers if possible.

FECAL SAMPLE

- This procedure may only be performed by or under the supervision of operators trained in the technique.

- The procedure requires an assistant to restrain the animal and another one to access the rectum of the animal.
- Insert a lubricated finger into the rectum and massaging until the external sphincter relaxes to collect the samples. Use a new glove for each sample to avoid cross contamination.
- Place the sample in the container with saline and label accordingly with animal ID and collection date.
- Samples should be packed in a cool box for transportation to the laboratory.

PACKAGING AND LABELLING BIOLOGICAL SAMPLE

- Label an envelope with the following details:
 - Animal ID
 - Farmer Initials and Surname
 - Address up to village
 - GPS coordinates
- Place the tissue samples in the TSU storage 96 well and parafilm seal the storage unit.
- Ensure the samples are kept at or below room temperature during storage and transportation.

J. TRANSPORTATION OF ANIMALS

Transportation of animals must conform to all institutional guidelines/policies and federal regulations. Country permits must accompany the animals. Please ensure that the Veterinarian responsible for each country is present for inspection at all points required.

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Tear off slip

Each animal for slaughter must have the following data

Animal ID	Origin	Owner	Purchase date	Purchase price	Vet check	Transport date	Age	Weight	SB	BL	CG	HW	PB	SC	BW

SB: Width of points of shoulder bones in front.

BL (body length): point to shoulder to pin bone (pins=point bones on either side of anus)

CG (chest girth): body circumference at the heart, just behind the elbows.

HW (height): front hoof to point of withers (top of shoulder blades)

PB (width of pin bones): width between rear bones at either side of the anus.

SC (scrotum circumference): measure from the bottom of the scrotum to the point of greatest diameter of the scrotal sac.

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