



# African Goat Improvement Network (AGIN): genetic and phenotypic characterization of populations to prioritize conservation and production efforts for small-holder farmers in sub-Saharan Africa



Mary E. Hannon and Heather J. Huson, PhD  
Cornell University College of Agriculture and Life Sciences  
Department of Animal Science

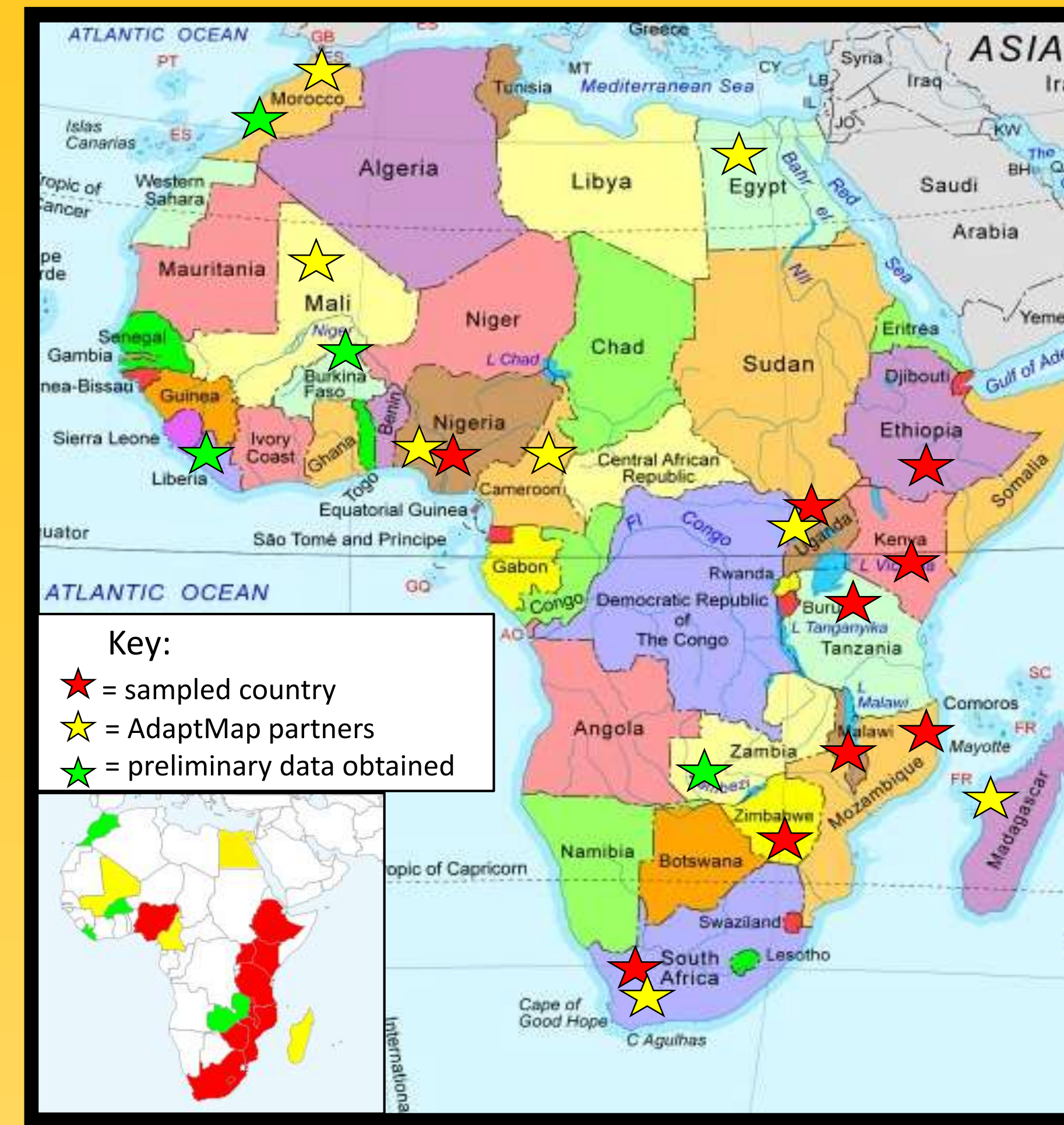
AGIN collaboration funded by USAID Feed the Future Initiative

**Project objective:** To improve goat productivity for African small-holder farmers by initiating genetic improvement and overall performance and productivity through enhanced breeding programs to help meet the demands of local food security.

## Overview of Methods:

- Collect phenotypic and genotypic data using standardized USDA sampling protocols (Figure 1)
  - Phenotypic information –
    - Geographical Information Systems (GIS) data
    - Breed
    - Photo Characterization
    - Age
    - Body measurements (height, weight, length, chest girth, width at pin bones, width at shoulders)
    - Anecdotal & historical observations
  - Genotypic information –
    - Blood or tissue sample analyzed using 50K goat beadchip and whole genome sequencing
- Map data collection sites (Figures 2 and 3). Obtain weather information using online records from stations near each sampling site.
- Analyze and compare results, looking for patterns and correlations in genotypes, phenotypes and environmental conditions (Table 1)

Figure 3: Current and future sampling sites



## Current Status:

Genotypic and phenotypic data are being processed (Table 1, Figures 4, 5 and 6) with new collaborators continuing to add data. Currently, we are analyzing body measurement data (Table 1, Figure 4) and collecting weather records for comparison to genotypic data (Figure 5) to identify trends and correlations between climate and genetic selection in rural areas of Africa. Principle Component tests have been used to provide preliminary breakdowns of genetic variation showing breed alignment with geographical origins (Figure 5).

Figure 4: Graphical data of sample populations within Uganda and Ethiopia with additional samples of two breeds from each of these countries (Abergelle and Gumez for Ethiopia; Mubende and Kigezi for Uganda)

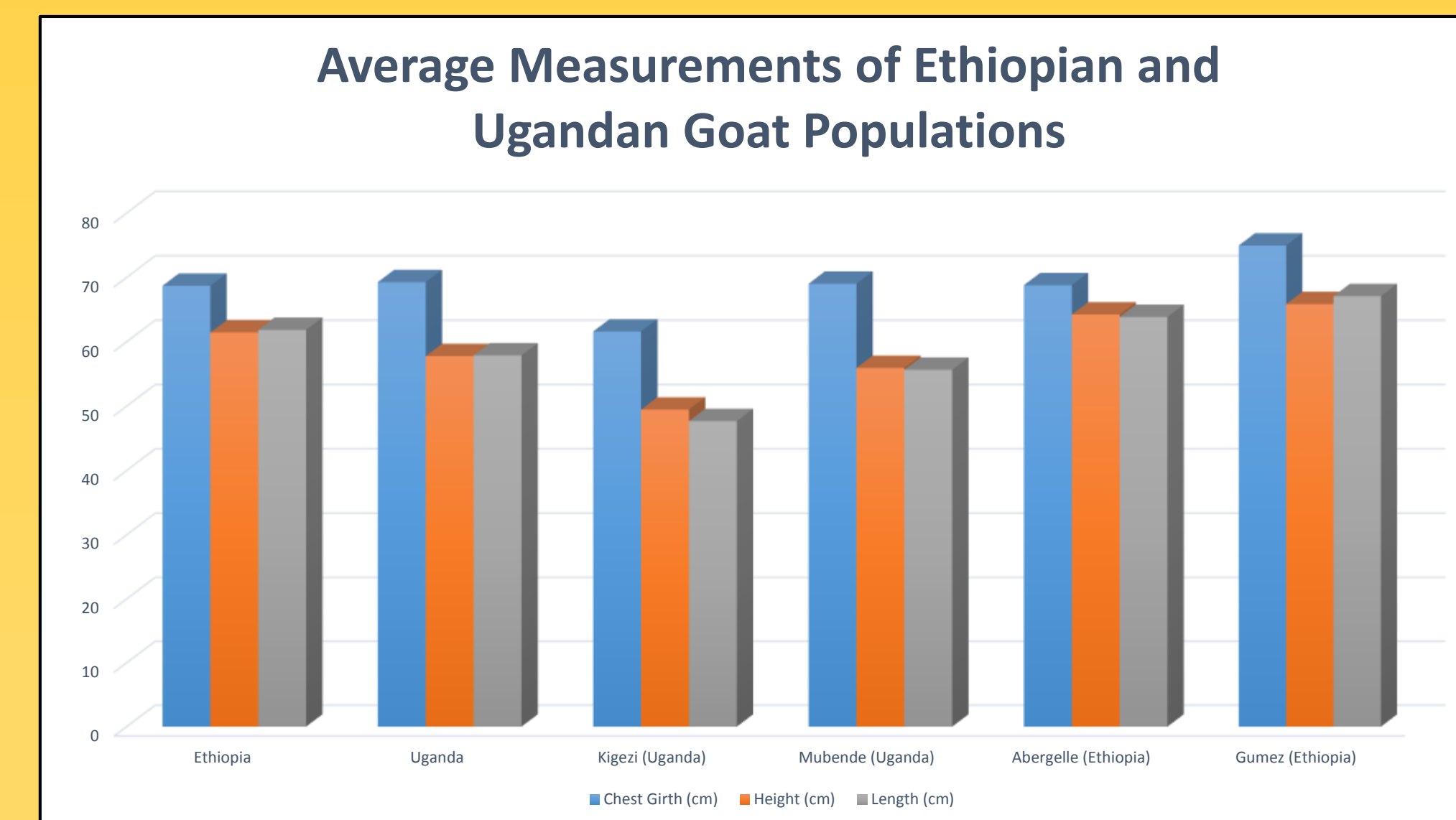


Figure 5: PC1 vs PC2 for goats from different countries

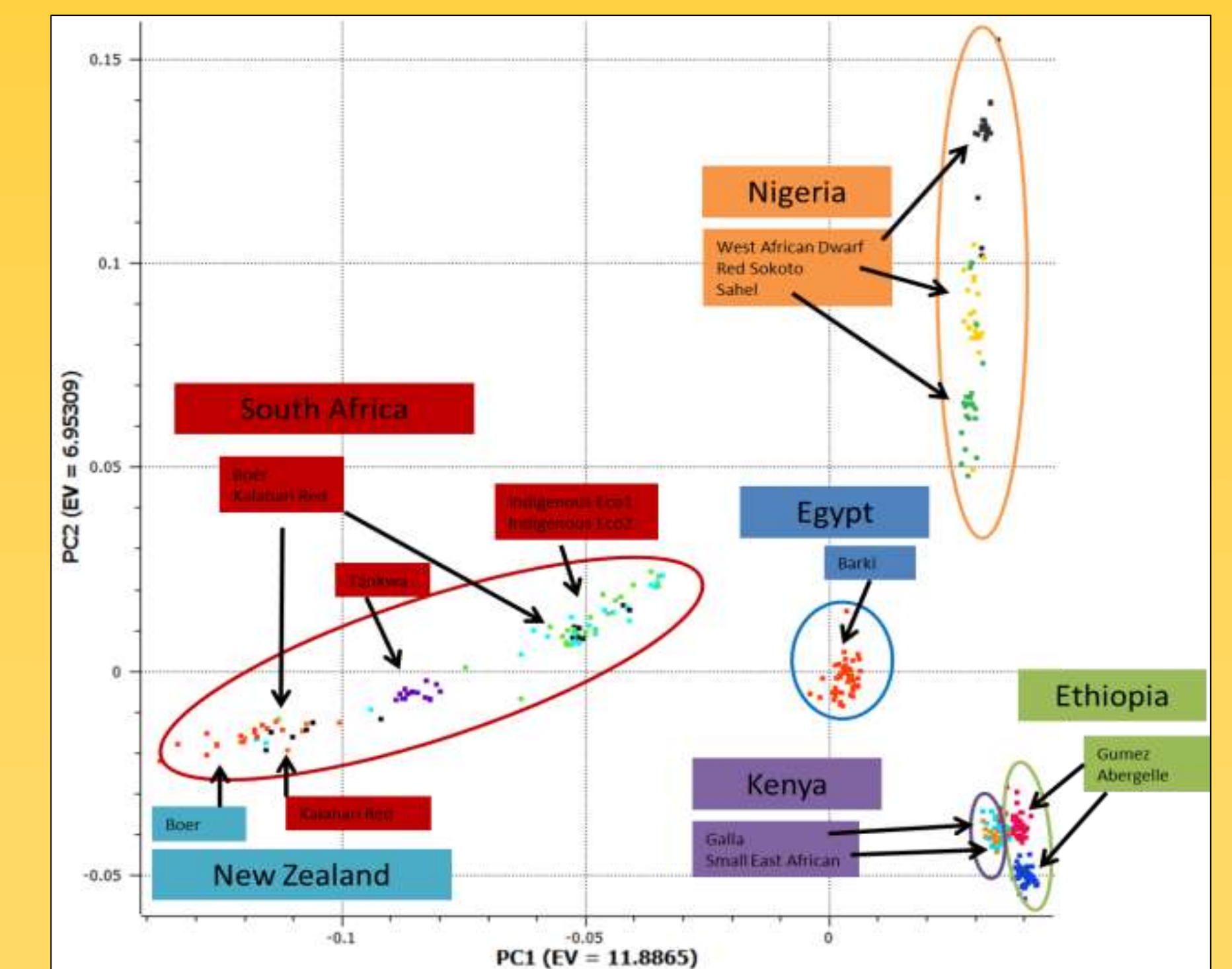
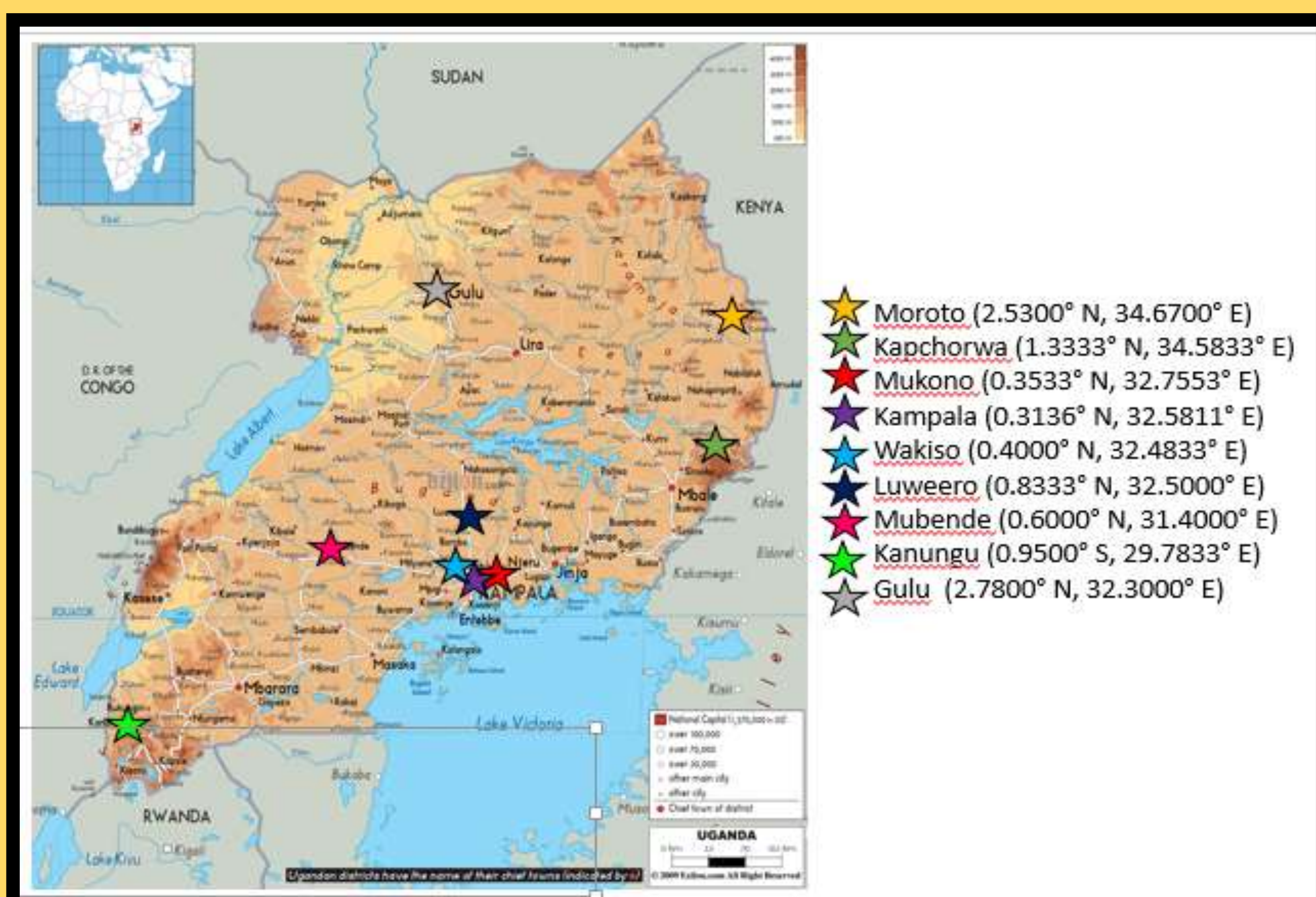


Figure 1: a) body measurements, b) body measurements, c) obtaining and recording tissue samples for DNA analysis



Figure 2: Mapped sites of data collection in Uganda



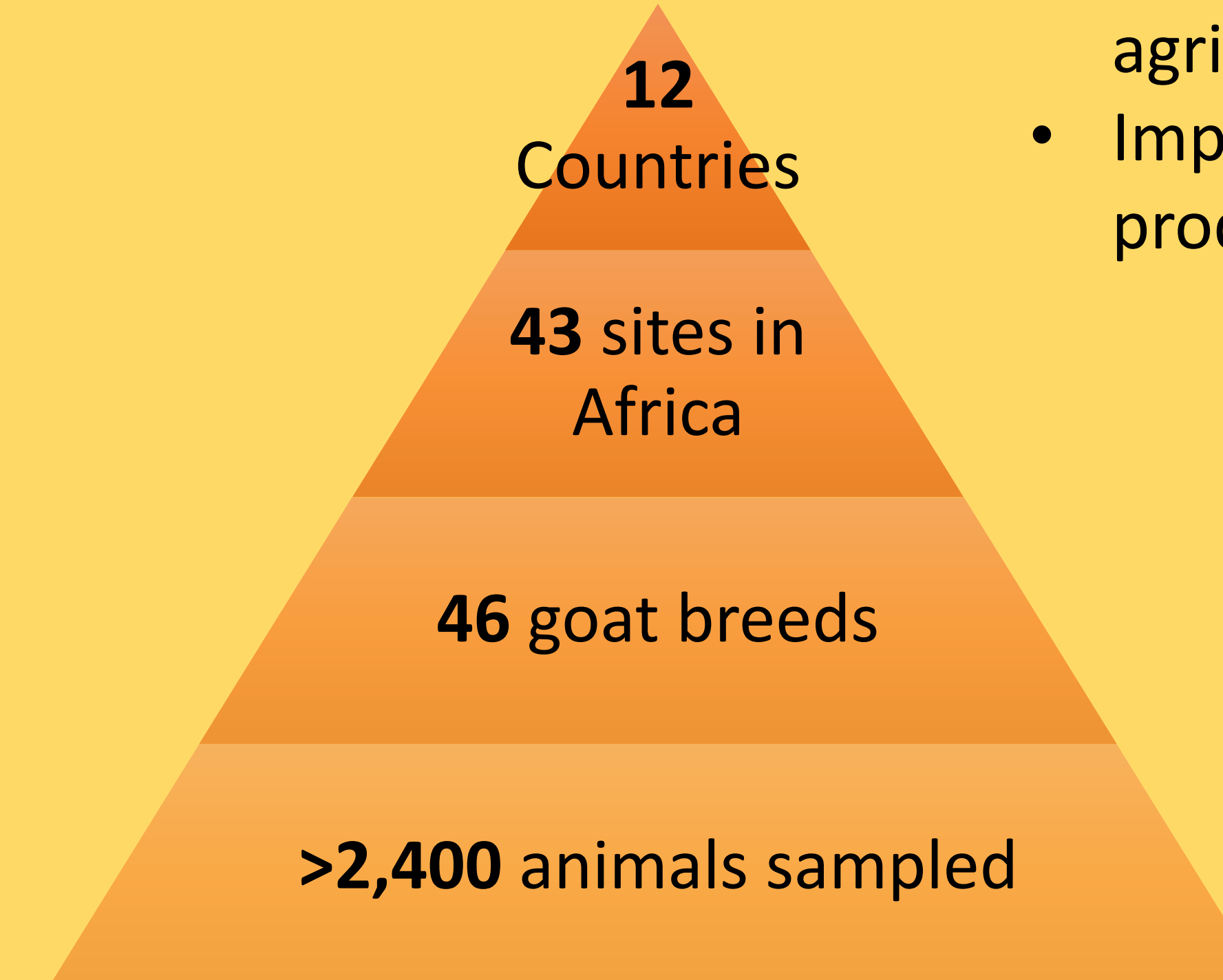
Sample Size	Country	Sex	Breed	Measurement Calculation	Chest Girth	Height	Length
247 goats	Uganda	70 M	All	Average	69.27	57.76	57.88
				StDev	11.10	8.22	9.53
				Max	104.00	85.00	81.00
				Min	33.00	29.00	23.00
46 goats	Uganda	14 M	Mubende	Average	69.02	55.94	55.64
				StDev	11.55	8.77	9.57
				Max	104.00	85.00	71.00
				Min	47.00	31.00	37.00
64 goats	Ethiopia	12 M	Abergelle	Average	68.79	64.23	63.86
				StDev	4.92	3.55	3.85
				Max	82.5	75	73
				Min	56	57	56
54 goats	Ethiopia	53 F	Gumez	Average	74.95	65.85	67.08
				StDev	7.95	5.96	7.5
				Max	86.5	74	75
				Min	42.5	42	35

Table 1: Mean, standard deviation, maximum and minimum values for all of Uganda, and breakdowns by breed for Mubende, Abergelle and Gumez.

Figure 7: African goats



Figure 6: Sample breakdown



## Discussion: Generations of indigenous breeding programs have caused vast phenotypic variation in goats across Africa (Figure 7)

- Analyzing data and genotypes will enhance understanding of the goat genome
- Association of geographic origins, phenotype, genotype, production and climate patterns to identify distinct goat populations for conservation and production
- Collaboration with targeted countries (USAID Feed the Future priority nations), and international institutions for agricultural development
- Implement programs to increase conservation, productivity and food security
  - Increase small-holder producer understanding of animal husbandry & self-sustaining community based breeding programs
  - Identify genetic mechanisms of African goat adaptation & production
  - Develop low cost genomic assays for use in selective breeding programs