Performance of Dairy Goat Genotypes in different Production Systems in Kenya

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Abstract

Dairy goat population in Kenya is estimated to be 175,000 heads which mainly consist of exotic breeds such as Toggenburg, Anglo-Nubian, German Alpines, Saanen, Boer and their crosses with indigenous goats. Genetic improvement efforts have mainly been focused on crossbreeding between the exotic breeds and local populations to improve both milk and meat. Previous crossbreeding programmes were initiated by interest groups such as Non-Governmental Organizations. Knowledge on productivity for different dairy goat genotypes is, however, still limited. The aim of this study was to document performance of dairy goat genotypes in different production systems. A baseline study was conducted in Homa Bay, Nyeri and Meru Counties which were the entry points of Saanen, Alpine and Toggenburg dairy goats in Kenya. A structured questionnaire was administered to a total of 147 household farms. The three genotypes per County with combinations of 30 households with Saanen, 58 Alpine and 59 Toggenburg were randomly sampled from Homa Bay, Nyeri and Meru Counties respectively. Data analysis were performed using SAS v2008 software. The results showed that all households in the three Counties practiced semi-intensive production system. The mean flock size was 4.5 ± 3.5, 5.2 ±2.4 and 6.9±3.2 per household for Saanen, Alpine and Toggenburg respectively. The average milk production per doe/day was 1.70±0.13 L, 1.83 ±0.12L and 2.52±0.18L for Toggenburg, Alpine and Saanen, respectively. Overall, age at first service, age at weaning and kidding interval for does were 1.1 years, 3.3 months, and 9.1 months respectively. The results from the study revealed the need for further research on profitability analysis per genotype.

Keywords: Dairy goat, Genotype, Kenya, Performance, Production system

Introduction

Goats form important sources of food and nutritional security through supply of milk and meat, income generation through sale of surplus stock and insurance against unforeseen risks and other non-tangible cultural values (Ogola *et al.* 2010b; Herrero *et al.* 2013; Mbuku *et al.* 2015). Recent studies have also shown that goats farming could be one of the alternative climate-smart agricultural practices that could build farmers resilience to climate change-related challenges (Ojango *et al.* 2016) through programmes such as nutrient recycling using goat manure on smallholder farming systems. The diminishing land sizes in the medium to high potential areas as a result of human population pressure and climate change related challenges is a trigger for alternative farming practices such as intensive dairy goat production that offer more multi-functionality, flexibility and adaptability to varied production conditions (Scarpa *et al.* 2003).

Goat population in Kenya is estimated to be about 27 million heads distributed in all the agro-ecological zones (FAO 2016). The dairy goat population is estimated at 175,000 heads (Shivairo *et al.* 2013) which consist of mainly exotic breeds such as Toggenburg, Anglo-Nubian, German Alpines, Saanen, Boer and their crosses with indigenous goats (Ahuya *et al.* 2005; Krause 2006; Bett *et al.* 2007).

In Kenya, medium and high rainfall

regions of Central, Eastern, Rift Valley, Nyanza and Coast province are the main dairy goat production areas (Bett 2009; Ogola *et al.* 2010a). They are kept in different production systems based on agro-ecological zones and management regimes. These include; smallholder low-potential (SLP), smallholder medium- potential (SMP) and small holder high-potential (SHP) (Bett *et al.* 2007; Shivairo *et al.* 2013). These production systems are distinguished by extensive, semi intensive and intensive management practices respectively. At present, however there is virtually no data on productive and reproductive performances of dairy goats in different production systems. The aim of the study was therefore, to characterize exotic dairy goat production systems and performance for different genotypes.

Materials and Methods

Study area

The study was conducted from August to September, 2018 in three Counties – namely Nyeri (Mukurweini Sub-County), Meru (Central Imenti Sub-County) and Homa Bay (Homa Bay town) located in the Central, Eastern and Western regions of Kenya, respectively (Figure 1). Mukurweini lies in the Upper midlands (UM2), also known as the main coffee Zone, receives 950-1500mm of mean annual rainfall and is 1460-1710 meters above sea level. Central Imenti is in the upper highlands (UH), which has an average precipitation of 800-2600 mm annually, temperatures of between 17.4-14.9oC. The altitude ranges between 1830-2210m above sea level. Homa Bay town lies in the lower midlands (LM2). The areas were selected because these were the entry points of different exotic dairy goats in Kenya.

Data collection

Dairy goat farmers sample size was determined as describe by Yamane (1967) with 5% level of precision as follows:

$$n = \frac{N}{1 + N(e)^2}$$

where; n is Sample size, N is Population size, e=Level of precision (5%)

Household sample size per County (Table 1) was proportionally distributed among number of dairy goat farmer groups in each

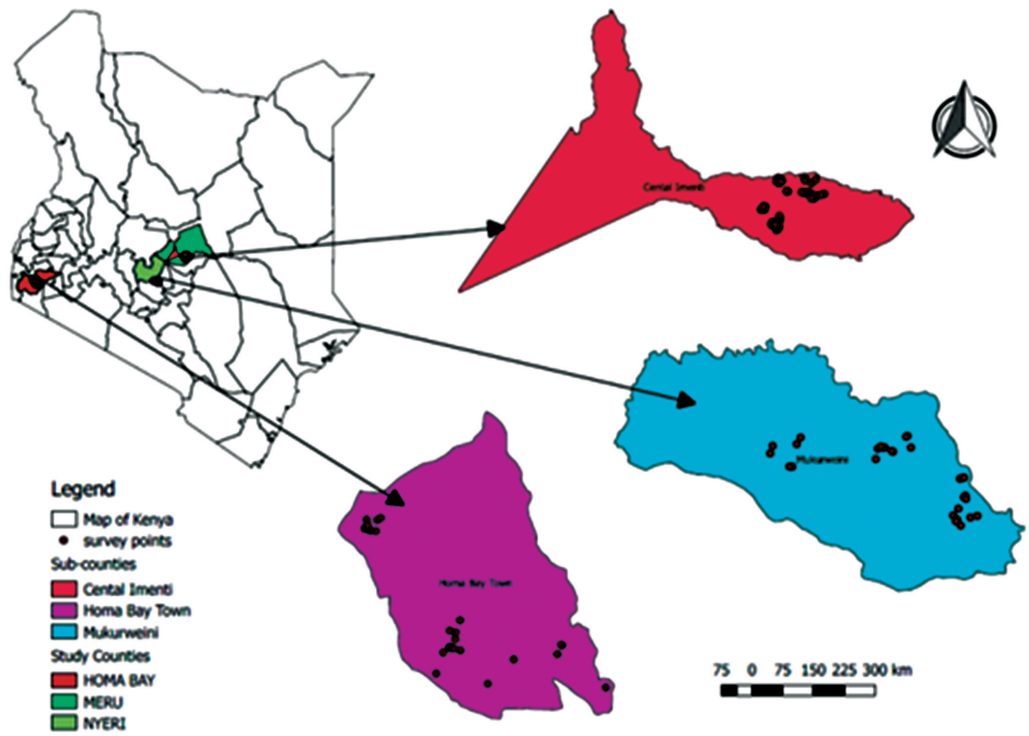

Figure 1: Map of Kenya showing area sampled within the selected sub counties

County. Within farmer groups, household were randomly sampled with the help from Dairy Goat Breeders Association per County. Dairy goat keeping households were purposively selected based on the following criteria: being a member of dairy goat farmer group, owns at least a mature does which matches the genotype of specific County.

Table 1: Genotype, number of dairy goat farmer groups, and households sampled per County

County	Genotype	No of dairy goat farmer groups	Households sampled
Homabay	Saanen	4	30
Nyeri	Alpine	3	58
Meru	Toggenburg	3	59
Total		**10**	**147**

Structured questionnaires were administered to selected dairy goat farmers by use of Open Data Kit (ODK) tool. Topics covered included; livestock ownership, dairy goat breed, reasons for keeping dairy goats, flock structure, performance (milk yield, age at first kidding, lactation length, birth weight, age at weaning), breeding and management practices. Enumerators were trained and questionnaires pre-tested before survey was conducted.

Data analysis

Data was analyzed using PROC GLM of SAS v2008 to generate descriptive statistics and analysis of Variance. Tukey's range test was used to determine which means were significantly different from each other.

Results

Farm characteristics

Most (61%) of dairy goat farmers in three counties were small scale subsistence. The study revealed that farmers from the three counties kept mixed livestock species, which included goats, chicken, cattle, pigs and rabbits. Dairy goats were ranked the most important (64%) livestock kept, followed by cattle (43%) in all the counties. Overall, the average number of cattle heads, sheep, goats and chicken per household were 3.7±3.6, 4.3±4.9, 5.5±3.2 and 15.0±15.1 respectively. In all the Counties, 60% of the households kept dairy goats under intensive systems while the remaining 40% raised them under semi-intensive system. However, 72% of Alpine farmers interviewed practiced intensive production system. The main mode of goat housing was structure with walls and roof (shed) which was reported by more than 79% of the respondents.

Flock structure management

The mean flock size was 4.5 ± 3.50, 5.2±2.44 and 6.9±3.27 for Saanen, Alpine and Toggenburg respectively. There was no significant difference between the average flock size of Saanen and Alpine. The minimum number of goats across genotypes was one with maximum of 13, 14 and 15 for Alpine, Saanen and Toggenburg, respectively. The flock structure revealed that number of does

Table 2: Average number of dairy goats with different categories sex/age class per genotype

Sex/Age class	Genotype		
	Saanen (N=30)	Toggenburg (N=58)	Alpine (N=57)
Does (>1 year)	2.4±1.9	3.3±1.7	2.6±1.3
Bucks (>1 Year)	1.5±0.7	1.5±1.1	1.4±0.6
Doelings (8 months to year)	1.3±0.5	2.2±1.7	1.6±1.0
Bucklings (8 months to 1 year)	1.5±0.7	2±1.1	1.4±0.5
Weaners (4months to 8 months)	2.0±1.3	2.4±1.5	1.7±1.3
Kids (<4 months)	1.2±0.4	1.7±1.1	2.1±1.2

N=Number of households, ±SD= Standard deviation

were higher compared to the numbers of other sex/age classes for all genotypes. The average number of Saanen kids were relatively small (1) compared to those of Alpine (2) and Toggenburg (2). The ratio of breeding buck to does was 1:2 for all the genotypes.

Genotype and breeding

Dairy goat farmers interviewed highly (96%) preferred to keep exotic than crosses and locals breeds. The main reason for this preference was because of high milk production for those genotypes (64%). Within the genotype, about 56, 62 and 84% Alpine, Toggenburg and Saanen farmers, respectively, preferred exotic breeds because of milk production. However, 13, 38 and 41% of Saanen, Toggenburg and Alpine farmers respectively, favoured exotic breeds due to high price of breeding flock.

In terms of productivity lifetime, about 64% of farmers maintained a buck for breeding in the flock for more than one year. About 28% of farmers in all Counties maintained buck for only one year. Breeding bucks and does were from different sources as indicated in Table 3.

Breeding bucks and does were from different sources as indicated in Table 3. About 0.7% only of Saanen farmers reported to purchase breeding buck from other smallholder/friend/neighbour. Hiring of breeding male (used with some form of payment) was reported by 30 %. 31% and 49% of Saanen Alpine and Toggenburg farmers, respectively. The leading source of breeding does was within flock selection as recorded by 82% of farmers across the three genotypes. About 2% of the farmers' purchase breeding doe from other smallholder/friend/neighbour. Purchase of breeding doe from a livestock market in the neighborhoods was reported by 0.7% farmers.

Reproduction and production performance

The average reproduction and production performance of different dairy goat genotypes as reported by respondents are shown in Table 4. The average age at first mating for male goat

Table 3: Source for breeding bucks and does per genotype

Source of breeding buck	Genotype			
	Saanen (N=30)	Toggenburg (N=53)	Alpine (N=58)	Total (N=141)
Use the buck that belong to the dairy goat farmers group	46.7	50.9	65.5	56.0
Hire of breeding male (used with some form of payment)	30.0	49.1	31.0	37.6
Borrow breeding male (used for free)	23.3	0	5.2	7.1
Use best buck from own herd	16.7	0	0	3.5
Purchase of breeding buck from dairy goat breeders Association / commercial dairy goat farm	6.7	0	1.7	2.1
Purchase of breeding buck from other smallholder/friend/neighbour	3.3	0	0	0.7
Source of breeding doe				
Priority is given to the best doe in my herd	80.0	78.5	93.1	82.2
Purchase of breeding doe from dairy goats breeders association / commercial dairy goats farm	10	12.5	5.2	9
Purchase of breeding doe from other smallholder/friend/neighbour	6.7	0	1.7	2.1
Purchase of breeding doe from a livestock market in the neighborhood	3.3	0	0	0.7

was 1.46±0.84 years. There was no significant difference between Saanen and Toggenburg on average age at first mating. Average age at first service for Toggenburg female goats was lower than the other two genotypes ($p<0.05$). All male genotypes observed the same average age at weaning significantly ($p<0.05$). Saanen female recorded significantly more months on average kidding interval and lactation length than other two genotypes ($p<0.05$). Female average lifespan was the same for all genotypes recording 5.98±2.28 years on overall. Average weight at birth for male and female was 2.88±0.63 and 2.55±0.49 kg, respectively, which there was no significant difference between the genotypes. Saanen produced significantly more milk per doe/day than the other genotypes ($p<0.05$). There was no significant difference in milk production per doe per day between Toggenburg and Alpine.

Table 4: Average reproduction and production performance for different genotypes

Trait	Genotype			
	Saanen	**Toggenburg**	**Alpine**	**Overall**
Male				
Age at first mating (years)	1.61a±1.41	1.68^{a}±0.39	1.24^{b}±0.35	1.46±0.84
Weight at birth (Kg)	2.50^{a}± 0.71	3.00^{a}±0.35	3.00^{a}±0.76	2.88±0.63
Age at weaning (Months)	3.85^{a}±1.90	3.42^{a}±0.87	3.40^{a}±0.57	3.48±1.03
Females				
Age at first service (years)	1.08^{b}±0.25	1.47^{a}±0.34	1.15^{b}±0.21	1.27±0.32
Weight at birth (Kg)	2.33^{a}±0.44	2.65^{a}±0.49	2.55^{a}±0.50	2.55±0.49
Age at weaning (Months)	3.04^{a}±0.88	3.47^{a}±0.93	3.35^{a}±0.55	3.34±0.79
Kidding interval (Months)	11.08^{a}±4.50	8.67^{b}±1.29	8.48^{b}±1.24	9.09±2.50
Lactation length (Months)	8.39^{a}±3.12	6.55^{b}±1.14	6.55^{b}±1.59	6.92±2.00
Lifespan (years)	8.19^{a}±2.51	6.23^{a}±2.22	5.10^{a}±1.71	5.98±2.28
Milk yield (Liters)	2.53^{a}±0.18	1.70^{b}±0.13	1.83^{b}±0.12	2.02±0.35

^{ab} *Means in the same row with different superscript are significantly different ($p<0.05$)*

Discussion

Farm characteristic

Small scale subsistence type of farming practiced across the Counties favoured keeping of dairy goats. This is due to their small body size, flexible feeding habits and short generation intervals. Goats are suited to farming systems where land sizes are limited, and contribute to nutrient recycling for other farm enterprises through manure (Ogola *et al.* 2010a; Herrero *et al.* 2013).

Flock structure management

Average flock size was relatively higher for Toggenburg compared with other genotypes. This may perhaps be for the reason that average farm size in Meru is higher than other Counties and also semi intensive production system practiced favored keeping of more goats. However, less number recorded for Saanen kids compared to other genotypes, might be as a result of poor management of flock leading to high mortality of kids and also long kidding interval observed. The reduction of bucks from buckling for Toggenburg genotype could be the presence of market for breeding buckling to neighbours and other counties.

Genotype and breeding

Preference of exotic to crosses and indigenous genotypes was because of milk production for home consumption and income generation mainly through sale of milk. This is in line with other studies reported earlier (Ogola *et al.* 2010a). This was expected because milk production was the breeding goal according to Non-Governmental Organizations

that introduced dairy goats to the study areas. However, due to lack of market for milk, farmers shifted breeding goal to sale of breeding flock especially Alpine farmers. This has resulted to almost 100% consumption of milk produced or leaving kids to suckle without specific age of weaning for faster growth. Dairy goat farmers were all under dairy goat breeders association, therefore, they followed rules and regulation set by associations on breeding especially using breeding buck that belong to association at a fee (Ahuya *et al.* 2001).

Production and reproduction performance

On average, milk production observed for the genotypes in this study was different from other studies earlier reported (Valencia *et al.* 2007; Ahuya *et al.* 2009; Norris *et al.* 2011; Jackson *et al.* 2012; Marete *et al.* 2014). In this study, average daily milk production for Toggenburg, Alpine and Saanen was 1.7, 1.83 and 2.53 Liters/doe/day, while a study done in South Africa the yield was 0.56, 0.75, and 1.45, respectively (Norris *et al.* 2011). According to British Goat Society, (https://www.britishgoatsociety.com) Toggenburg, British Alpine and Saanen produces 3.61, 4.09 and 4.2 liters/doe/day, respectively. These genotypes have been selected for milk production in temperate climates and the poor milk production reported in this study is a clear sign that their full genetic potential for milk production in tropical climates has not been expressed.

Toggenburg and Alpine kidding interval was relatively shorter than what was earlier reported by other studies (Ahuya *et al.* 2009; Jackson *et al.* 2012; Marete *et al.* 2014). Saanen has both long kidding interval and lactation length compared to other genotypes and therefore this explains the longer the lactation length the stretched kidding interval. In this study, less birth weight was observed for all the genotypes compared to other studies in the tropics (Valencia *et al.* 2007; McManus *et al.* 2008; Ahuya *et al.* 2009; Marete *et al.* 2014).

Conclusion

The current study revealed that most dairy goat breeds in Kenya are kept under intensive production system. The production and reproduction performance of the various dairy goat breeds varies although their genetic potential of each breed seem not to have been realized. Therefore, there is need for more research on profitability for each breed when they are reared in intensive system in different ecological zones. Further studies are needed to ascertain the genetic composition of the various dairy goat breeds because some farmers were sourcing breeding does/ bucks from the market notwithstanding the genetic make-up of the goats. To avoid inbreeding, the dairy goat farmer groups need to be strengthened through the Dairy Goat Breeders Associations for better dairy goat management.

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