

# Husbandry and Productivity of Red Maasai Sheep in Arumeru and Monduli Districts in Tanzania

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## ABSTRACT

This study was undertaken to describe the husbandry practices and productivity of the Red Maasai sheep in Arumeru and Moduli districts in Tanzania. Sixty three farmers from each of the two districts were interviewed. Data were analysed using SPSS computer package. All farmers (100%) practice an extensive production system where sheep graze together with cattle and goats. The majority (61.9%) of the farmers use communal land to graze their animals, and children are the main source (69.0%) of labour. Almost half (50.8%) of the farmers indicated to supplement their sheep with mainly (65.6%) maize bran. Identified constraints to production were diseases, drought, lack of capital, poor markets and extension services, thefts, and predators. A plastic apron was found to be an effective indigenous technique to control mating and practice seasonal breeding. Age at first lambing for the majority of Red Maasai sheep was 13 to 18 months and lambing intervals of 12 to 18 months. Most sheep lambed between October and January. Twinning cases were few (15.9%) indicating a low twinning rate in the population. Breeding rams were selected within flocks, and many farmers (95.2%) preferred seasonal breeding to allow ewes to lamb in the wet season. Disposals were done to get income, remove infertile ewes, and slaughter for food and rituals. Generally, the productivity of Red Maasai sheep was low due to poor husbandry practices. It was concluded that improved management was likely to enhance sustainable production and conserve the breed.

**Keywords:** Disposals, production system, productivity, Red Maasai sheep, Reproduction.

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## I. INTRODUCTION

Domestic sheep, like other small ruminants, are kept in Tanzania and other countries because they are a convenient way of converting poor quality forages into mutton, milk, wool, and manure [1]. They also provide income, insurance against crop failure, and a means of rural employment to resource poor farmers [2]-[5]. Sheep of different sorts are found in diverse areas of the world because they have biological mechanisms that make them adaptable to such environmental variations [6].

Sheep have some virtues that are not possessed by cattle. They have adapted to survive and produce under diverse environmental conditions [2]-[3], [7]-[8]. Sheep are reared in a variety of management systems, as they respond well to improved systems [3]. They are resistant to diseases and have low requirements for feed and water [9]. Sheep have a high incidence of multiple births and short reproductive cycles [4], [10].

The small size of sheep has merits in their agility to graze on steep slopes [3]-[4], [10]. They are easily managed by family labour, especially women and children with low costs of production [3]-[4]. In the Maasai community fat and mutton are given to lactating mothers, patients, and special guests [4]. Keeping sheep and consumption of mutton are free from cultural barriers [3].

Red Maasai sheep are a local mutton breed in some parts of Kenya, including Kajiado and Naivasha, and Arusha region of Tanzania. They are trypanotolerant and resistant to *Haemonchus contortus*. The breed is at a risk of being discriminated against since it has been neglected by researchers and extension agents. It is being managed under poor husbandry practices and indiscriminate crossbreeding is taking place often replaced by exotic breeds [7]. High mortality, low productivity, and low genetic potential can be the major cause of low multiplication and off-take rates of local sheep [11].

Unlike other livestock species, the sheep population in Tanzania has not been increasing for almost a decade. The country has 33.9 million cattle, 24.5 million goats and 8.5 million sheep, 1.9 million pigs, and 87.7 million poultry [12]. According to the same report, the contribution of sheep husbandry to household income generation in the country is the least, only 1% as compared to other livestock species, with chickens 53%, cattle (32%), goats (10%) and pigs (4%). Thus, it was necessary to conduct this study to see what could be done to increase the productivity of sheep in Tanzania. Reasons for flock decline could be due to low lambing rates, high mortality, and infertility due to poor feeding regimes, among other reasons.

The current study was aimed at describing the husbandry and productivity of Red Maasai sheep in Arusha region and herd dynamics of Red Maasai sheep. Others were to study

reproduction and production characteristics of local sheep in Arusha region including indigenous knowledge of livestock keepers and to identify constraints facing Red Maasai sheep productivity in the study area.

## II. MATERIALS AND METHODS

### A. Description of Study Area

The study was conducted in Arumeru and Monduli districts of Arusha region in Tanzania (Fig. 1). Three wards were chosen from each of the districts, where three villages from each ward were randomly selected. From each village seven households keeping Red Maasai sheep were interviewed, making a sample size of 126 respondents. Information on sheep husbandry and productivity was collected using a structured questionnaire and informal discussions with selected farmers. Participatory Rapid Appraisal (PRA) was used to capture indigenous knowledge of farmers regarding husbandry, productivity parameters as well and selection.

### B. Final Stage Data Analysis and Handling

Questionnaire data were coded and entered into a spreadsheet for analysis. The frequency procedure of Statistical Package for Social Science-SPSS, version 16.0 for windows was used. Frequencies and percentages were used to summarize the information from questionnaires. Simple frequency procedure was used where respondents had to give only one answer, while multiple response procedures were employed where respondents gave more than one answer.

## III. RESULTS AND DISCUSSION

### A. Social Economic Status of Sheep Farmers

Results on socio-status of farmers are presented in Table I. Most households that participated in the study were male-headed. This is common to Maasai society that wealth is owned by men with exceptions for widowed and divorced women. Maasai senior men ("Makaa") have the mandate to sell and manage wealth from livestock. The results agree with [14] which reported that Maasai women manage animals, but rarely own them. It is also known that, in Maasai society animals belong to men while woman owns cooking pots and calabashes. However, Maasai women play a central role in the management of animals and the transfer of assets. Women are not involved in decision making regarding the sale, slaughter, or castration of animals.

The majority of farmers in the study area were literate with primary school education, with few possessing secondary and informal education, and the rest had no education at all. This means that most farmers can read and understand published materials on livestock management. Most elders had informal or no education, but had accumulated indigenous knowledge on sheep production. Comoro *et al.* [14] documented that, some of the Maasai in Mbarali consider education of their children as an important need. The exposure to education has caused changes in the traditional way of life in terms of habits and lifestyle. In view of the continued shrinking of grazing land, some educated "Moran" (young circumcised men) prefer smaller herds, looking for more productivity [14].

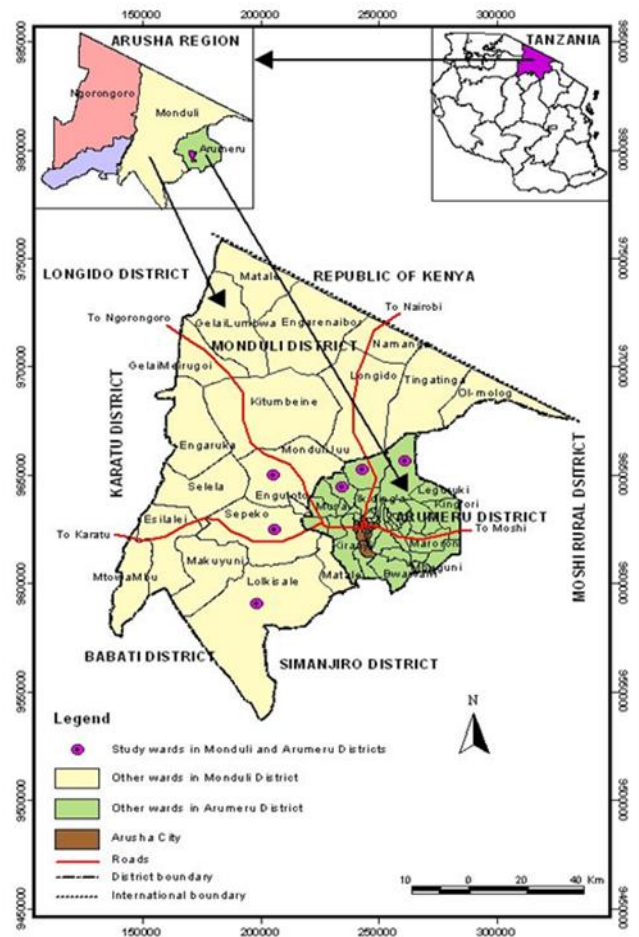


Fig. 1. Map of Arumeru and Monduli districts showing the study areas.

### B. The Roles of Sheep to the Maasai Community

Multiple responses in Table II indicate that sheep are kept by Maasai people for income generation, source of food, payment of school fees, and social issues including bride price, cultural celebrations, ritual sacrifices, church related fiesta, and circumcision ceremonies. In Maasai community sheep fat and mutton are special diets for lactating women, sick persons, circumcised ladies and boys locally known as ("layoni") and for special guests. Sheep also provide a source of employment to households, used as a live bank and insurance, prestige, and a source of manure. The roles of keeping sheep in Maasai community are similar to those reported by various authors including Dorji *et al.* [15] and Adogla-Bessa *et al.* [4]. Despite the merits sheep provide, their population has not increased as compared to other livestock species for almost a decade [16]. This implies that sheep are unseen as a valuable commodity that may provide wealth and food security to farmers in Tanzania.

### C. Sheep Production Systems

All farmers (100%) in the two districts practice an extensive production system, where sheep graze together with goats and cattle. This is due to inadequate pasture and water for animals attributed to drought and overgrazing. Diverse types of livestock species are kept together with sheep to serve farmers against risks like floods, droughts, diseases, and predation which may wipe out some livestock. Previous studies [17] support the current results that, sheep are kept extensively together with other livestock species.

Pastoral production systems are mostly extensive, using marginal lands in arid zones [14].

Grazing and animal care were mainly reported to be taken by children (69.1%) while to a minor extent husbands (29.4%) were involved and rarely hired labour (1.6%) were reported (Table III). In Maasai society, labour shortage is an emerging problem as children who were previously involved in taking care of sheep are now attending school. The same has been observed by Wanjala *et al.* [18] in Norak, Kenya. Therefore ‘Morans’ who are the overall animal caretakers and supervisors of young boys (‘layoni’) are becoming overworked. However, hired labourers are occasionally used, but they cannot be trusted with very large herds.

The majority (91.3%) of farmers confine their animals at night in open kraals (Figure 2) to protect them from wild animals and thefts (Table III). A Few (8.7%) households do not have kraals and hence their animals sleep around their homesteads subjecting them to colds, thefts, and predation. Similar findings were reported by Arora *et al.* [17] on Ganjam sheep that were housed in open sheds adjacent to owners’ houses. The results also agree with Gatenby [3] that, sheep are housed to protect them against predators and thefts.

#### D. Feeding Management

Farmers (50.8%) reported supplementing their sheep after grazing, whereas the rest (49.2%) did not supplement due to the high costs of concentrates, lack of knowledge, and unavailability of concentrates. Where supplementation was done, feed stuff used was mainly maize bran (65.5% of respondents). Other feed ingredients were mineral salts, oil seed cakes, tree pods, leaves, and molasses which were rarely used (Table IV). Similar results were reported in Bhutan that, sheep grazed on pastures with no supplementation other than salts [15].

Watering frequency was reported to vary with season of the year. During the rainy season, sheep drink water once per week, while in the dry season twice or very often whereas some farmers reported no water was supplied (Table IV). Sheep can tolerate water shortage for longer periods than cattle and pigs, although water requirements vary depending on the size of the animal, feed dry matter, physiological state, production level, ambient temperature, and relative humidity [10]. During the rainy season, sheep are sent to drink water once per week but in the dry season, they drink twice per week or very often. Sheep are a suitable livestock species in droughty areas. Adogla-Bessa *et al.* [4] reported similar

findings that, sheep demand less water than cattle, especially if forages do not have very high dry matter content. Therefore, sheep will require less cost in terms of water requirements.

In this study, the time spent by sheep for grazing ranged from five to twelve hours (Table IV). The majority (84.2%) of farmers graze their sheep for eight to ten hours per day. The grazing time in the two districts is in line with earlier findings published by Charray *et al.* [10] on WAD sheep that, at least eight hours of grazing were recommended for sheep, however ten hours per day of grazing provides optimum DM intake. The observation by Mandal *et al.* [19] reported a bit similar data that, Muzaffarnagari sheep in India were grazing for eight to nine hours on common grazing land. Elsewhere, Ganjam sheep in Eastern India were reported to graze for about 9 hours a day [17] which is also supported by Gatenby [3] who recommended a minimum grazing time of eight hours per day. Grazing time is therefore influenced by pasture quantity and quality, such that, animals graze for a longer time in poor quality forages to obtain the required daily intake. The time needed for grazing depends on the vegetation quantity and quality [3]. Therefore, in a poor quality pasture with minimum supplementation, animals should maintain longer grazing time to allow selectivity of quality forages for increased feed intake and productivity.

TABLE I: HOUSEHOLDS’ SOCIO STATUS IN THE TWO DISTRICTS

Item	Arumeru		Monduli	
	n	%	n	%
Total	63	100	63	100
<i>Gender</i>				
Males	57	90.5	61	96.8
Females	6	9.5	2	3.2
<i>Education level</i>				
Primary education	35	55.6	36	57.1
Secondary education	4	6.3	5	8.0
College education	2	3.2	0	0
Informal education	5	7.9	12	19.0
No education	17	27.0	10	15.9

TABLE II: PURPOSES OF KEEPING SHEEP IN THE DISTRICTS STUDIED

Purpose	Arumeru		Monduli	
	n	%	n	%
Income generation	62	22.5	63	25.4
Source of food	63	22.8	63	25.4
School fees	37	13.4	17	6.9
Social issues	49	17.8	54	21.8
Self-employment	21	7.6	16	6.5
Prestige	31	11.2	29	11.7
Manure	13	4.7	6	2.3



Common kraal used to house sheep at Monduli Juu village



An improved kraal with enclosure for sheep at Ilkuroti village

Fig. 2. Housing systems for sheep production in Maasai community.

TABLE III: PRODUCTION SYSTEM FOR SHEEP KEEPING

Item	Arumeru		Monduli	
	n	%	n	%
<i>When the farmer started keeping sheep</i>				
1960–1970	8	12.7	5	7.9
1971–1980	27	42.9	23	36.5
1981–1990	16	25.4	17	27.0
1991 to present	12	19.0	18	28.6
<i>Land ownership</i>				
Individual	33	52.4	47	74.6
Communal	30	47.6	16	25.4
<i>Source of labour</i>				
Children	43	68.2	44	69.9
Husband	18	28.6	19	30.1
Hired labour	2	3.2	0	0
<i>Grazing system</i>				
Communal	34	54.0	44	69.8
Public	23	36.5	18	28.6
Individual	6	9.5	1	1.6
<i>Housing system</i>				
Free range	6	9.5	5	7.9
Confined kraal	57	90.5	58	92.1

TABLE IV: FREQUENCY DISTRIBUTION FOR FEEDING AND WATERING MANAGEMENT

Aspect	Arumeru		Monduli	
	n	%	n	%
<i>Feeding status</i>				
Supplementing	34	54.0	30	47.6
No supplementation	29	46.0	33	52.4
<i>Feed stuff used for supplementation</i>				
Maize bran	29	85.2	13	43.3
Mineral salts only	0	0	4	13.3
Oil seed cakes	1	3.0	0	0
Tree pods and leaves	1	3.0	5	16.7
Maize bran, crop residues and molasses	3	8.8	8	26.7
<i>Watering frequency</i>				
Once/week	39	61.9	38	60.3
Twice /week	13	20.6	11	17.5
Very often	7	11.1	13	20.6
Not at all	4	6.4	1	1.6
<i>Time spent for grazing</i>				
5 to 7 hours	8	12.7	3	4.8
8 to 10 hours	46	73.0	60	95.2
11 to 12 hours	9	14.3	0	0

### E. Constraints Facing Sheep Production in Maasai Community

Sheep farming is mired by a number of constraints (Table V). The case of grazing constraints, include drought, poor pasture quality and availability (quantity), bush encroachment, parasites, and overgrazing. On the other hand, productivity problems reported were lack of capital, drought, inadequate market services, inadequate extension and veterinary services, shortage of labour, diseases, thefts, and predators. Sheep mortality is mainly caused by drought and diseases and to a lesser extent, long grazing distances and predation were also reported to cause mortality.

Drought has been a serious limitation to livestock production in the study area since it results in scarce and poor quality pastures as well as a shortage of drinking water to sheep. Therefore, many sheep deaths were reported to be caused by drought allied problems. A study by Sahana *et al.* [20] found similar problems that, mortality for adult Garole sheep was higher during summer than during winter and rainy seasons. Adogla-Bessa *et al.* [4] reported that drought had led to a shortage and low quality pastures, low feed intake, and reduced productivity due to mineral deficiencies and poor

water access. According to Comoro *et al.* [14], climate change, especially the shortage of rain, has an immediate effect on pasture and water availability. Major losses occur during the dry season due to the poor health of the animals. Likewise, conception and fertility rates are adversely affected by drought leading to low lambing rates, slow growth rates, and late maturity. Bush encroachment has prevented the regrowth of pastures and enhanced the loss of palatable pasture species. Since farmers solely graze their sheep on natural forages, bush encroachment increases pasture scarcity and affects productivity.

The lack of market services for sheep and their products affects income generation and lowers selling prices. In Arumeru and Monduli districts they reported to have few livestock auction markets. A study by Aphunu and Okoedo-Okoje [21] indicated an irregular demand for small ruminants' products, was probably caused by a lack of market.

Shortage of extension services is mainly due to few livestock extension officers being employed in villages. Most farmers in the study area treat their animals with natural herbs due to a lack of technical knowledge on sheep diseases. Aphunu and Okoedo-Okoje [21] described production constraints as a result of poor veterinary and extension services, high costs for veterinary drugs and vaccines, and inadequate information on improved management practices.

Lack of capital was reported to affect sheep productivity, in terms of inadequate money for purchasing feed ingredients, paying veterinary services, and paying hired labour. Aphunu and Okoedo-Okoje [21] have stated financial constraints to limit the costs of housing constructions and herd expansion.

Labour shortage is a serious problem in Maasai society nowadays as young boys and girls attend schools. This has a negative consequence on sheep productivity. Sheep require a considerably longer grazing and watering time to get enough pasture and water for maintenance, growth, and production. Comoro *et al.* [14] had similar findings that, children who attend school do not like livestock management activities. Therefore, farmers have to hire labour or reduce number of livestock. Aphunu and Okoedo-Okoje [21] have stated unavailability of labour is one of the serious problems affecting sheep production.

The main causes of death to sheep include drought, diseases, animals walking long distances searching for pastures, and predation (Table VI). The highest mortality was reported from June to September for both districts, whereas the least mortality was from February to May. The period marked with highest mortality is the dry season, which predisposes the sheep to inadequacy forages and water scarcity. Animals lose weight and become more susceptible to infections. Similar findings were reported by Tembely *et al.* [22] on native lambs in the sub-humid environment in Mali, marked with highest rate of mortality in June/July.

### F. Diseases Management and Control Measures

Both internal and external parasites have been main threats to sheep productivity in the two districts (Table VII). Farmers in the study area deworm their sheep after every three months but fewer farmers deworm their sheep at irregular intervals. A review by Kurwijila and Kifaro [9] supports these findings that, sheep are more susceptible to internal parasites than

other domestic animals. Another place noted that during the rainy seasons, Garole sheep were more susceptible to worms and diarrhea [20]. A previous study by Kusiluka and Kamarage [11] revealed helminthosis as the major cause of mortality and suboptimal productivity in goats and sheep in traditional farming systems in sub-Saharan countries. In the humid climate of West Indies, where the density of sheep is high, sheep were reported to show tolerance to round worms [3]. Previous works [23], [11] have reported that, Red Maasai sheep are resistant to *Haemonchus contortus* infection when compared to Dorper, Blackheaded Somali, and Romney Marsh sheep breeds.

Tick-borne diseases common in the study area were reported to be heart water and anaplasmosis, which are caused by protozoan parasites carried by ticks. Farmers were reported to control them mainly by hand spraying while fewer farmers used plunge dips. Although trypanosomosis is a common disease in sheep and other livestock, Red Maasai sheep are said to be trypanotolerant. A review by Kurwijila and Kifaro [9] also pinpointed that, sheep are affected by trypanosomiasis particularly those caused by *Trypanosoma congolense* and *T. vivax*. Other research findings have also documented that, Red Maasai sheep are trypanotolerant [13], [7]. The work published by Charray *et al.* [10] and another one by Kurwijila and Kifaro [9] are in line with the findings for the control of external parasites. For improvement in production, farmers should make sure they use the right methods and effective chemicals to control parasites.

Although some farmers do not vaccinate their sheep, some vaccinated them against anthrax, black quarter, and foot and mouth disease (FMD). Some farmers reported to vaccinate their animals twice per year, but others were not sure while others vaccinated on irregular basis. For this matter, vaccination programs have not been successfully done in Maasai society because of their migratory farming practices.

TABLE V: GRAZING AND PRODUCTIVITY PROBLEMS IN SHEEP

Item	PRODUCTION			
	Arumeru		Monduli	
	n	%	n	%
<i>Grazing problems</i>				
Drought	58	32.8	52	32.1
Poor pasture quality and quantity	59	33.3	51	31.4
Prey and predators	11	6.2	10	6.2
Bush encroachment	3	1.7	5	3.1
Parasites	40	22.6	12	7.4
Overgrazing	6	3.4	32	19.8
<i>Productivity problems</i>				
Insufficiency of capital	13	6.9	6	3.8
Drought	50	26.6	53	33.8
Inadequate market services	7	3.7	5	3.2
Inadequate extension and veterinary services	7	3.7	6	3.8
Labour shortage	7	3.7	1	0.6
Low technical know how	12	6.4	15	9.6
Diseases	54	28.7	62	39.5
Thefts	8	4.3	3	1.9
Predators	30	16.0	6	3.8

TABLE VI: CAUSES AND OCCURRENCE OF MORTALITY RATES BY SEASONS OF THE YEAR

Item	Arumeru		Monduli	
	Frequency	Percentage	Frequency	Percentage
<i>Causes of mortality</i>				
Drought	58	48.3	58	43.6
Diseases	43	35.8	55	41.4
Long distance for grazing	10	8.3	8	6.0
Predators	9	7.5	12	9.0
<i>Occurrence of mortality rates</i>				
June to September	35	54.7	49	77.8
October to January	15	23.4	13	20.6
February and May	14	21.9	1	1.6

TABLE VII: COMMON SHEEP DISEASES AND THEIR CONTROL MEASURES IN THE STUDY AREA

Disease	Arumeru		Monduli	
	n	%	n	%
Lumpy skin disease	18	10.8	9	4.2
Foot and Mouth Disease	4	2.4	2	0.9
Mange	7	4.2	8	3.7
Worms	35	21.1	32	14.9
Diarrhoea	12	7.2	32	14.9
Anthrax	8	4.8	26	12.1
Anaplasmosis	18	10.8	36	16.7
Red eye disease	3	1.8	4	1.9
Heart water	22	13.3	32	14.9
Plant poisoning	6	3.6	6	2.8
Pneumonia	33	20	28	13.0
<i>Vaccination type:</i>				
Anthrax and Black quarter	31	70.5	38	92.7
Foot and Mouth Disease	13	29.5	3	7.3
<i>Vaccination frequency:</i>				
Once per year	31	49.2	38	60.3
Irregular	32	50.8	25	39.7
<i>Endoparasites control:</i>				
Regular deworming	39	61.9	39	61.9
Strategic deworming	2	3.2	1	1.6
Irregular deworming	22	34.9	23	36.5
<i>Ectoparasites control:</i>				
Plunge dip	2	3.2	3	4.7
Hand spraying	61	96.8	60	95.3

### G. Productivity of Red Maasai Sheep

The age at first lambing had a big variation, with some sheep starting lambing too early while others started too late (Table VIII). The variation from 12 months to 24 months may be due to environmental differences. Feeding regime and climatic conditions may cause variations in age at first lambing. The figures obtained are close to those by Mandal *et al.* [19] and Karunanithi *et al.* [14] on Muzaffarnagari sheep and Mecheri sheep which altogether reported to start lambing at the age of  $17.4 \pm 0.17$  months. The authors also stated that the age at first lambing under the controlled breeding programme was higher than those mated at the farmer level without controlled breeding. The high frequency of lambing from October to January (66.7%) is likely due to enough pasture and drinking water in these months (rain season). These results agreed with Karunanithi *et al.* [14] on Mecheri ewes in Tamil Nadu which were mated from June to November to coincide with lambing months when the area

receives maximum rainfall.

The lambing intervals ranged from 6 to 18 months (Table VIII), which are within the average lambing interval for Muzaffarnagari sheep (399±54.9 days) reported by Mandal *et al.* [19]. A study by Karunanithi *et al.* [14] reported a shorter mean lambing interval of 226±0.7 days for Mecheri sheep, which is within the lowest range for Red Maasai sheep (6 to 11 months). The short lambing intervals imply that Red Maasai sheep have high reproductive efficiency as they can lamb twice per year and thus increase the number of offspring and flock size.

Most Red Maasai sheep were born single while a few were twins (Table VIII). The majority of farmers reported a very low twinning rate of 10 to 20% and some reported a medium twinning rate of 30 to 50% of their sheep, while very few farmers reported a twinning rate of 60 to 80%. The low twinning rate may be due to nutritional deficiencies and low genetic potential of the local stock. The figures observed in the study are higher than that in a previous [19] finding which was 1-2% for Muzaffarnagari sheep. A higher sheep twinning rate (70%) was reported by Sahana *et al.* [20]. The low twinning rate in this study implies a slow multiplication rate for sheep. The variation in productivity between twin and single-bearing ewes and their lambs can be minimized by adequate nutrition in late pregnancy and in early lactation.

TABLE VIII: PRODUCTIVITY PERFORMANCE OF RED MAASAI SHEEP IN ARUMERU AND MONDULI

Parameter	Arumeru		Monduli	
	n	%	n	%
<i>Age at first lambing</i>				
12 months	15	23.8	21	33.3
13-18 months	29	46.0	39	61.9
19-24 months	19	30.2	3	4.8
<i>Lambing seasons</i>				
October to January	54	85.7	30	47.62
February to May	8	12.7	29	46.03
June to September	1	1.6	4	6.35
<i>Lambing interval</i>				
6-11 months	30	47.6	31	49.2
12-18 months	33	52.4	32	50.8
<i>Twinning status</i>				
Singles	49	77.8	57	90.5
Twins	14	22.2	6	9.5
<i>Twinning rate (%)</i>				
10 to 20	26	53.1	21	36.8
30 to 50	17	34.7	30	52.7
60 to 80	6	12.2	6	10.5
<i>Source of breeding ram</i>				
Within the flock	44	69.8	48	76.2
From neighbour	10	15.9	8	12.7
Purchased	9	14.3	7	11.1
<i>Seasonal breeding:</i>				
Practicing	62	98.4	58	92.1
Not practicing	1	1.6	5	7.9
<i>Methods of controlling breeding</i>				
A special apron to rams	29	46.0	53	84.1
Rams separated from ewes	34	54.0	10	15.9

Most (73.0%) farmers breed their sheep by mating ewes with the best rams raised and selected from their flocks. Others (14.3%) hire rams from neighbours or purchase (12.7%) them from markets. A previous study by Mandal *et al.* [19] also reported the use of natural breeding for Muzaffarnagari sheep. In that case, rams and ewes were housed and grazed together with no controlled mating being

practiced at farmers' level. Seasonal breeding is practiced by farmers in the two districts to let lambing happen in the rainy season when forages and water are plenty.

Inbreeding is a serious threat to animal genetic diversity and is very common under extensive production systems. The use of plastic apron (Fig. 3) in Maasai society is a technology commonly applied to control breeding by ensuring the use of desired rams. Sheep are allowed to mate in order to lamb during the period of plenty of forage and drinking water. These findings are similar to Wanjala *et al.* [18] and Comoro *et al.* [14] publications on indigenous techniques used to control the breeding and seasonal mating of sheep and goats by Maasai. The practice has the advantages of improving performance, reducing deaths due to drought stress, and enabling lambs to have plenty of colostrum and milk.

#### H. Herd Dynamics

Most farmers acquired their initial sheep stock through inheritance, bride price, or as gifts (Table IX) in the Maasai society keeping sheep is a traditional duty. The major forms of sheep exits were sales, mortality, being culled, slaughtered, and diverse social uses.

The flock trend is generally declining (Table IX) which is possibly due to climate change, poor feeding management, and disease control, among other reasons. A study by Mandal *et al.* [19] reported a severe decline in the population of Muzaffarnagari sheep crosses which were stated to be caused by poor adaptability to the prevailing environments resulting in high morbidity and mortality. The decrease in sheep population may be caused by farmers' deliberate effort to integrate livestock keeping with crop farming.

Generally, more sheep were sold in Monduli than in Arumeru districts. During emergencies like drought and extremities of low productivity, sheep are sold to remain with a manageable flock size. In another study Arora *et al.* [17], Ganjam sheep were disposed of by selling rams for breeding and other needs.

The highest mortality is exhibited among male lambs followed by female lambs in Monduli; whereas the lowest mortality was reported in Arumeru. This means lambs are more susceptible to diseases and mortality than adults. The findings agree with Kusiluka and Kambarage [11] who noted lambs and kids are more susceptible to worm burden than adults and this is probably because adults are more resistant to worm infestation than lambs.

Culling was done to eliminate sheep with low fertility, those too old, and those with poor health conditions. The majority of mature males in Monduli were culled, whereas the productive age groups were retained for the sustainability of the flocks. The findings are similar to a past study [13] where ewes were culled because of udder problems and low milk yield.

More mature males from Monduli were reported to be slaughtered followed by mature females from Arumeru. Males were mostly slaughtered because only a few were required for breeding purposes and the rest were slaughtered for food security and ritual sacrifices. Sheep with low production performance were also culled from the flock.

Sheep were also reported to be disposed of for social reasons and presents (gifts) during the marriage, bride price, church-related fiesta, rituals, and cultural ceremonies such as



A plastic apron on rams at Losinoni village in Arumeru district



A plastic apron on rams at Lengijave in Arumeru district

Fig. 3. The use of plastic apron to control breeding of sheep.

TABLE IV: HERD DYNAMICS OF SHEEP IN THE MAASAI COMMUNITY

Item	Arumeru		Monduli		Overall	
	n	%	n	%	n	%
<i>Sources and reasons of inflow</i>						
Purchase by cash	4	6.4	10	15.9	14	11.1
Purchase, bride price and gifts	30	47.5	2	3.3	32	25.4
Inherited	27	42.9	18	52.3	45	35.7
Bride price and gifts	2	3.2	33	28.5	35	27.8
<i>Forms /reasons of outflow (exit)</i>						
<i>Reasons for selling</i>						
Low productivity of sheep	34	31.5	9	10.5	43	22.2
To obtain income	52	48.1	59	68.6	111	57.2
Excessive drought	22	20.4	18	20.9	40	20.6
<i>Reasons for culling:</i>						
Low fertility	29	35.4	33	49.3	62	41.6
Aged sheep	31	37.8	23	34.3	54	36.2
Disease conditions	22	26.8	11	16.4	33	22.2
<i>Reasons for slaughter</i>						
Food	52	76.3	60	67.4	112	69.1
Ritual sacrifice	21	23.7	29	32.6	50	30.9
<i>Social reasons and gift</i>						
Church related fiesta	19	48.7	7	8.5	26	21.5
Ritual sacrifices	13	33.4	39	47.6	52	43.0
Maasai cultural ceremonies	7	17.9	36	43.9	43	35.5
<i>Flocks trend</i>						
Increasing	21	33.3	11	17.5	32	25.4
Decreasing	31	49.3	26	41.3	57	45.3
Stable	4	6.3	6	9.5	10	7.9
Fluctuating	7	11.1	20	31.7	27	21.4

circumcision and celebrations after harvests. More mature males were disposed of for social reasons, followed by male growers, retaining the most productive age categories.

#### IV. CONCLUSION

Local sheep in the two districts are kept under an extensive production system with minimum improved management practices. As a result, their productivity is rather low. This has been attributed to a number of factors such as diseases, climate change, poor feeding regime and farmers' dynamic production objectives to suit modern lifestyles. Improvement in the management system, particularly feeding would enhance the sustainable productivity of Red Maasai sheep.

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#### CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

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