ANALYSIS OF FARMING SYSTEMS INVOLVING KANGAYAM BREED OF CATTLE

By

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THESIS

Submitted in partial fulfilment of the
requirement for the degree

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
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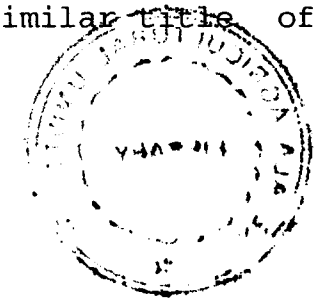
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy, Thrissur

1995

DECLARATION

I hereby declare that the thesis entitled **"ANALYSIS OF FARMING SYSTEMS INVOLVING KANGAYAM BREED OF CATTLE"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.



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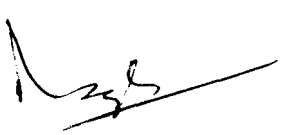

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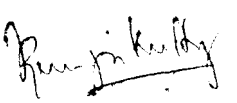

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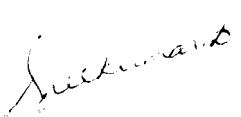

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N. KUMARAVELU

Dedicated to my Parents,

Teachers and Farmers

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Introduction

1. INTRODUCTION

In its evolution, civilization has witnessed man passing on a part of his burden to the animal to pursue his cultural and spiritual interests. Draught Animal Power (DAP) forms an inseparable component of the integrated crop-livestock production system. Seventy four million bullocks and 8 million buffaloes make available 40 million HP energy worth Rs.10,000 crores.

Kangayam is one of the major draught breeds of cattle of India, which derives its name from its native tract Kangayam, an area of Periyar district of Tamil Nadu. The pressing needs for food production necessiating a hardy type of cattle to tackle the various agricultural operations under difficult circumstances, probably led to the evolution of this hardy breed of cattle. Much importance was not attached for milch characteristics probably due to the fact that the greater demand was for motive power. Bullocks of Kangayam breed contribute substantially to the agricultural power and rural transport needs of South India.

Apart from this, the breed of cattle is closely associated with the tradition and culture of South India. Kangayam cattle centered activities like cattle racing and

cattle fairs are important events for the rural community of the region.

No comprehensive evaluation of the breed from a farming systems context has been reported so far. The complex relationships between the operator, animal, soil, climate and crop are difficult to simulate at research stations and hence, conducting such trials in farmer's field condition is more appropriate. Moreover, such studies can throw light on the role of Kangayam sub-system within the overall agricultural production system and its interaction with other sub-systems. The study was therefore taken up with the objectives of documenting the existing practices of procurement, management, breeding, utilization and disposal of Kangayam cattle in a farming systems context. The animal, as a component of the system was characterised with respect to conformation, morphological traits and work performance.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Management practices

2.1.1 Selection

There are only very few documentations about the selection of draught animals.

Apart from physical appearance and body conformation, farmers consider good whorls of hair or lucky marks on the skin as important criteria in the selection of indigenous cattle (Sreekumar, 1993). Gunn (1909) and Littlewood (1936) have described various marks on the skin considered by farmers as lucky or unlucky after describing the physical characteristics of the native cattle breeds of South India.

As indicated by an FAO study (FAO, 1972) bullock, as a draught animal, must be powerful, compact and sturdy with well developed muscles, particularly those of back and hind quarters. Its legs must be strong and short. The chest must be ample and deep. It must have strong hooves.

Chantalakhana (1981) reported that the villagers in Thailand, Indonesia and Phillipines traditionally selected their work animals according to the size and height preferably from the age group of 2.5 to 3 years.

Reh (1982) considered the presence of hump desirable, while Goe (1983) suggested that it was not necessary.

Starkey (1984) suggested that wherever possible the use of locally adapted breeds is to be preferred as draught cattle.

Upadhyay (1989) reported that in choosing a draught animal, emphasis should be placed on the body dimensions, conformation, physiological and functional capacities required during work. He observed that farmers generally looked into the size, height, general body condition, hair whirlings, placement of legs and style of walking.

Mishra and Nayak (1991) documented that factors like better height, young age, native breed, excellent outlook, absence of body deformities, white coat colour, normal temperament, free walk with long strides, adequate training in work, absence of any vice and favourable season for field operations raised the value of draught cattle in the state of Orissa.

Sreekumar (1993) reported that the major criteria regarding selection of work bullocks by the rural farmers of Kerala were physical appearance of the animal, age, body condition, conformation, whirling patterns of hair, temperament and the animals' price. Over and above these factors, farmers

also gave preference to psychological attributes like single colour, set pattern and appealing shape of the horns.

Reddy et al. (1994) observed that the selection of crossbred bullocks around Bangalore (Karnataka) and Palakkad (Kerala) were based on general appearance, body conformation and position of hair whorls. Temperament was not considered important as most of them were docile.

2.1.2 Feeding management

Gunn (1909), Littlewood (1936), Pattabhiraman (1958) and Narayanan and Dabadghao (1972) have given a clear picture about feeding practices of Kangayam calves, cows, bulls and bullocks. Pastures containing, 'Kolukattai' (Cenchrus ciliaris) grass, legume 'Phaseolus trilobus' and white babul (Acacia albawillow) trees seen abdundantly in their native tract form major source of herbage for them. Amble and Krishnan (1960) have reported the feeding practices of stock comprising various age groups of Kangayam cattle at Hosur cattle farm.

FAO (1972) stated that the theoretical requirements of working cattle for energy are approximately ten times the energy requirements for work output.

Williamson and Payne (1978) stated that working cattle should always have access to a mineral ration.

In South-East Asian countries, during the dry season, after rice and other crops have been harvested, buffaloes and cattle were allowed to graze on rice stubbles, corn stovers, weeds and other crop wastes. During the rainy season when fields are being cultivated, most animals were tied around households and rice straw was given as the major feed stuff (Chantalakhana, 1981).

The reports vary with regard to the effect of work on feed intake of bovines. Appreciable increase in feed intake was observed when the work periods were short (Wachirapakron and Wanapat, 1989) and when the animals were worked at cooler environments (Bakrie et al., 1989). Baumaulin and Ffoulkes (1988) reported that there was no change in feed intake due to work while a reduction in feed intake was observed by Thomas and Pearson (1986), Sreekumar and Thomas (1990) and Anil (1994).

Lawrence (1985) in a review on the nutrient requirements of bullocks stated that there seemed to be very little requirement for extra protein during work and the most extra requirement for draught animals was energy.

Gincy et al. (1988) observed that feeding of draught animals differed from cows and female buffaloes in Kerala. Draught animals were kept on low feed intake at rest which

comprised only straw, rice bran, a little grass and water. On days of work, as a special diet they received boiled paddy upto a kilogram per day. In some areas, draught animals were fed tamarind seed powder as a special diet as the farmers felt it gave strength. During off season, they were taken out for grazing.

George and Nair (1990) reported that in Kerala the average consumption of paddy straw/day was higher in the case of working bullocks followed by cows in milk, dry cows, heifers and young female stock in that order.

Sreekumar (1993) reported that paddy straw was the only roughage fed to the bullocks and the most popular concentrate ingredient was par-boiled rice bran in rural Kerala. The bullocks were provided with adequate dry matter and energy on both work and idle days whereas most of the farmers fed only less than required amount of digestible crude protein.

2.1.3 Housing management

FAO (1972) stated that a draught bullock required a rectangular space of about 1.50 m width and length according to the size of the animal, i.e., an average of 2.0 to 2.5 m^2.

Williamson and Payne (1978) suggested that working cattle must always have access to shade while not working.

Kumar and Sastry (1989) in a survey of housing practices of bullocks in Western Haryana found that majority (74%) of the bullock keepers were not keeping their bullocks at a particular place all the time, but kept them at different locations in combination, i.e., in the open, under the tree, in shed and in paddock as per necessity arising out of the diurnal and seasonal conditions. Majority of the bullock keepers housed their bullocks along with buffaloes.

Wells (1985) stated that adequate housing without over crowding and avoidance of extremes of temperature was important to limit stress on working animals.

Sreekumar (1993) observed that in rural Kerala majority of the farmers provided Kutcha type of housing to their bullocks with locally available materials. Such houses had coconut leaf or paddy straw thatched roofs and stone paved, plank laid (palm/coconut), concrete or mud floors.

2.1.4 Health care management

Pattabhiraman (1958) and Amble and Krishnan (1960) documented the disease incidence of Kangayam cattle at Hosur cattle farm.

FAO (1972), Williamson and Payne (1978) and Reh (1982) reported that the common health problems affecting draught

animals were injuries. The types of injuries to which draught animals were subjected to included bruising or open wounds caused by beatings or undue pulling on the nose ring/rope, sores caused by badly fitting harness, discomfort from stones and earth becoming stuck or caked in the cloven hoof and chronic irritation from head ropes predisposing to horn cancer.

Kumar et al. (1974) in a study on the incidence of Brucellosis in bulls and bullocks in Tamil Nadu from 1955 to 1974 found that the incidence in non-descript bullocks and bulls were much higher than in breeding bulls. Majority of the affected bullocks (77%) suffered from arthritis of knee joint.

Starkey (1985) stated that there were no distinct diseases associated with draught animals, apart from harnessing sores. The stress of work could make worse problems which might otherwise be minor.

Partoutoma et al. (1985) reviewed diseases affecting draught power of large ruminants and horses in Indonesia.

In a study on health practices of draught animals in Hisar district (Haryana) Gulati et al. (1988) found that yoke gall, string hault and trauma were the common health problems affecting draught animals. They found that sixty four per cent

of the farmers in the region got their bullocks vaccinated against H.S. and FMD.

Sreekumar (1993) in a survey on the health care management practices of draught animals in rural Kerala indicated that the common health problems of the bullocks were lameness and foot lesions/injury, anorexia, pyrexia, bloat, yoke injury and Foot and Mouth disease.

Reddy et al. (1994) reported that the farmers around Bangalore (Karnataka) and Palakkad (Kerala) were aware of the need for vaccination against common infectious diseases but only 30 per cent got their bullocks vaccinated against FMD and all the animals were vaccinated against Rinderpest.

2.2 Utilization pattern

India has the largest population of draught animals with most of the power requirements for agriculture being provided by animals working for 45 to 230 days in a year depending upon the size of the land holding (Pathak and Gill, 1984 and Ramaswamy, 1987).

Ramaswamy (1985) reported that draught animals were put to use in India for less than half the time in a year, with the

result that a potential of about 35 million horse power remained idle.

In a survey conducted during 1985-87 at the seven centres of the animal energy project, Srivastava and Ojha (1987) found out the annual utilization of DAP as follows:

1.	Villages near Bhopal	:	281 hours (bullocks)
2.	Villages near Raichur	:	828 hours (bullocks)
3.	Villages near Ludhiana	:	795 hours (bullocks)
4.	Allahabad	:	275 hours (bullocks)
5.	Pantnagar	:	480 hours (buffaloes)
6.	Udaipur	:	1220 hours (camels)
7.	Rewari	:	523 hours (bullocks), 499 hours (camels)

One complete year of survey of bullock utilization in Nabibagh, Palasi and Islamnagar villages near Bhopal by Dubey (1987) revealed higher utilization of bullocks during the months from June to November. On an average, in these villages a pair of bullocks was used for 238.76 to 319.30 hours.

Varma and Verma (1987) reported that the annual use of small, medium and heavy sized bullocks were about 425, 550 and 700 hours respectively in Eastern Uttar Pradesh. The estimated

working days of draught animals in a year were about 100 to 150 days.

George and Nair (1990) observed that the decline in the availability of draught animal has contributed to increased utilization of draught animals and development of a bullock rental market.

Kaushik et al. (1991) reported that on an average, bullocks were used for 129 days in a year in Haryana.

In a study on farm draught power in Northern-Central Himalayas, Tripathi (1991) found that the utilization of bullock power was 28.08, 18.23 and 20 per cent of the total availability on high hills, middle hills and valley farms respectively.

Singh (1993) reported that the availability of bullocks in Gujarat was 1.79 per farm at the overall level and 1.31, 1.83 and 2.21 on small, medium and large size farms respectively. The total utilization was only 52, 51.2 and 100 pair days respectively.

Sreekumar (1993) observed that in Kerala a pair of bullocks was used for 775.85 hours during a year in the plains of Palakkad and 288.78 hours in the Wayanad plateau.

Reddy et al. (1994) in a study on utilization pattern of crossbred bullocks at a few locations around Bangalore and Kerala (Palakkad and Munnar) reported that the utilization in Kerala and around Bangalore amounted to about 775 hours in a year.

2.3 Work performance

2.3.1 Speed

Singh et al. (1970) observed the speed of walking in Sahiwal bullocks during disc ploughing, harrowing and tilling to be 2.21, 1.98 and 2.21 km/hour respectively.

Williamson and Payne (1975) reported that work bullocks had an average rate of movement of 0.88 to 1.2 m/sec.

In a study to evaluate the work performance of cross-bred bullocks, Rao and Upadhyay (1984) observed that they ploughed 2800, 2600 and 3100 sq.m area in 6 hours during summer, hot-humid and winter seasons respectively.

Nagpaul et al. (1984) found that the distance covered in one hour of carting on village roads averaged 2638 and 2682 meters for crossbred and local Hariana cattle respectively in

summer. The corresponding distance covered in winter were 2230 and 2645 meters.

Sreekumar and Thomas (1990) observed that during dryland ploughing Kangayam bullocks walked at a speed of 1.24 m/sec compared to 1.05 m/sec by crossbred bullocks. Kangayam bullocks ploughed more area (426 sq. metres per hour) than crossbred bullocks (364 sq. metres per hour).

Anil (1994) reported that Kangayam bullocks walked with a speed of 1.13 m/sec during dryland ploughing and 0.98 m/sec during wetland ploughing. In dryland ploughing Kangayam bullocks covered an area of 701.5 sq.m/h as compared to 625.0 sq.m/h in wetland ploughing.

2.3.2 Physiological responses

In planning physiological studies of draught animals it is important to link such experiments with observations of actual draught animal production systems. As it was difficult to simulate actual field conditions on research stations, conducting experiments on farmer's animals appeared to give more realistic results (Pearson, 1985).

Significant increase in the respiratory rate, pulse rate and rectal temperature was reported by Adkine et al. (1977) in

Deoni, Red-Kandhari and Holstein x Deoni cross bred cattle; Maurya and Devadattam (1982) in Jersey x Red-Sindhi crossbred bullocks; Maurya (1982) in Jersey x Red Sindhi crossbred and Khillari bullocks; Upadhyay and Madan (1985) in Holstein x Hariana crossbred bullocks while performing carting operations.

While ploughing, similar increase in the above parameters was observed in Jersey x Sahiwal crossbred bullocks (Rao and Upadhyay, 1984); Red-Dane x Sahiwal, Malvi and indigenous bullocks (Rautaray, 1986); Holstein-Friesian and Jersey crosses with local bullocks (Bhosrekar and Mangurkar, 1989) Jersey x Red-Sindhi crossbred and Kangayam bullocks (Sreekumar and Thomas, 1990) and Kangayam and Surti buffalo bullocks (Anil, 1994). It was noted that the increase of these parameters was significantly more in crossbred bullocks than indigenous bullocks.

2.3.3 Draughtability

Devadattam and Maurya (1978) while studying the draughtability of Hariana bullocks observed that the optimum draft for an average pair of Hariana bullocks was 60 kg.

Upadhyay and Madan (1985) conducted trials with four Hariana and four HF x Hariana crossbred bullocks and found that

the Hariana produced a higher horse power than the crossbred bullocks (0.52 Vs 0.44).

Rautaray (1986) reported the average power output of bullocks to be varying from 0.4 to 0.65 hp on black soil.

Bhosrekar and Mangurkar (1990) while comparing the draughtability of Holstein crossbred bullocks with local non-descript bullocks indicated that power expressed as horse power per kg metabolic body size was higher for local cattle (0.32 and 0.31 in the morning and evening respectively) than in 50 per cent Holstein (0.23 and 0.20) and 75 per cent Holstein (0.25 and 0.22).

Anil (1994) in a study on comparison of draught capacity of Kangayam bullocks and adult graded Surti buffalo bullocks reported that cattle and buffaloes developed horse power of 0.77 and 0.78 respectively during dry ploughing and 1.04 and 1.07 respectively during wet ploughing.

2.4 Morphological characteristics and body measurements

Gunn (1909), ICAR (1952) and Maule (1990) described body conformation and morphological characteristics of Kangayam breed of cattle.

Littlewood (1936), Joshi and Phillips (1953), Pattabhiraman (1958), Acharya and Bhat (1984) and Sreekumar (1993) have described physical characteristics and various body measurements of adult male and female cattle of Kangayam breed (Table 1). Kandasamyraja (1953) studied the physical measurements of Kangayam calves in relation to their growth at Palayakottai cattle farm.

Sreekumar (1993) indicated various body measurements and body weight of Kangayam type, Hallikar type and Non-descript bullocks of rural Kerala.

In different parts of India, various workers documented the physical traits of local cattle and buffalo breeds (Murari, 1959; Panda and Mishra, 1990; Sahoo and Mishra, 1990; Natarajan et al., 1992; Singh, 1992 and Vij et al., 1994)

Table 1. Body measurements of Kangayam cattle as reported by various workers

Sl. No.	Sex	Age (years)	Height behind hump	Body length	Chest girth	Length of the face	Length of horns	Shoulder width	Girth of forelimb		Girth of hind limb		Reference
									Shank region	Pastern region	Shank region	Pastern region	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Bull	9	50"	56"	75.5"	21"	19.5"	-	-	-	-	-	( )
		7	51.5"	60"	78"	21"	14.5"	-	-	-	-	-	( )
		6	49.5"	53"	74.5"	21"	15.5"	-	-	-	-	-	( ) 1
		5	50"	56"	74"	20"	17"	-	-	-	-	-	( )
		4.5	52"	60"	77"	24"	16"	-	-	-	-	-	( )
2.	Cow	8.5	49"	50"	69"	18"	16.5"	-	-	-	-	-	( )
		8	48"	53"	65.7"	19"	17"	-	-	-	-	-	( )
		6.5	46"	50"	62"	19.5"	17.5"	-	-	-	-	-	( ) 1
		6	47"	51"	66"	19"	14.5"	-	-	-	-	-	( )
		5.5	46.5"	49"	62"	19"	14"	-	-	-	-	-	( )
3.	Male	1	43"	42"	51"	-	-	-	-	-	-	-	( )
		2	48"	48"	60"	-	-	-	-	-	-	-	( )
4.	Mature Bull		54"	63"	76"	-	-	-	-	-	-	-	( )
5.	Bullock		56"	64"	73"	-	-	-	-	-	-	-	( ) 2)

Contd.

Table 1 (Contd.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
6.	Cow	1	42"	42"	50"	-	-	-	-	-	-	-	( )
		2	46"	51"	57"	-	-	-	-	-	-	-	( ) 2
		3	48"	56"	67"	-	-	-	-	-	-	-	(
7.	Bull		52"	60.5"	76"	19"	15.5"	-	-	-	-	-	3
8.	Cow		47"	53"	64"	17.6"	16"	-	-	-	-	-	3
9.	Male		140 cm	100 cm	190 cm	-	-	-	-	-	-	-	4
10.	Female		140 cm	140 cm	179 cm	-	-	-	-	-	-	-	4
11.	Bullocks		128 cm	138 cm	167 cm	-	-	36.54cm	17.17cm	21.06cm	17.57cm	21.67cm	5

1. Littlewood (1936)
2. Joshi and Phillips (1953)
3. Pattabhiraman (1958)
4. Acharya and Bhat (1984)
5. Sreekumar (1993)

Materials and Methods

3. MATERIALS AND METHODS

The study involved documentation of the existing management practices, utilization pattern, work performance and physical characteristics and body measurements of Kangayam cattle in a farming system context under rural set up in the home tract of Kangayam in Tamil Nadu and adjoining Palakkad region of Kerala state.

3.1 Period and location of the study

The present study was conducted between June, 1994 and May, 1995. Geographically the home tract of Kangayam (Coimbatore/Periyar district) lies in north west of Tamil Nadu state at 11°N at latitude, and 77°E at longitude with a mean elevation of 426.8 m above MSL.

The adjoining Palakkad region of Kerala state is situated at 10°48" N at latitude and 76°12"E at longitude with a mean elevation of 150 m above MSL.

3.2 Selection of respondents

Selection of farmers was done purposively from the home tract of Kangayam cattle in Tamil Nadu and adjoining Palakkad region of Kerala state. Only those farmers owning Kangayam

cattle were included in the study. Sixteen villages were included from the Kangayam tract and eleven villages from adjoining Palakkad region of Kerala state. The total number of farmers included in the study was fifty five from each region. The names of villages included in the study are given in Appendix I.

3.3 Observations

3.3.1 Meteorological information

The meteorological data of the home tract of Kangayam were collected from Tamil Nadu Agricultural University, Coimbatore and that of Palakkad region were collected from Kerala Livestock Development Board, Dhoni (Palakkad district). Monthly averages of maximum and minimum temperature, relative humidity, hours of bright sunshine, and rainfall during the study period were collected.

3.3.2 Management practices

Information pertaining to the existing management practices of Kangayam cattle was collected with the help of a structured and pre-tested schedule (Appendix-II) and by direct observations.

The survey aimed at collecting information relating to size of land holding, livestock holding including bullocks and types of implements and accessories.

Information regarding procurement of bullocks was collected. It included the source of bullocks, selection attributes, their cost, source of finance, age at purchase and farmers preference in keeping bullocks.

The survey aimed at gathering information on husbandry practices followed in a farming system involving Kangayam breed of cattle. With respect to feeding and watering, type of feeding resources, source of roughages and concentrates, quantity and frequency of roughages and concentrates fed and frequency of watering during work and rest seasons were collected.

The details of age and methods of castration and training were collected. With respect to housing practices, information on type of housing and details of roof and floor were collected.

With respect to health care management of bullocks, details of washing, common health problems encountered, season and duration of suffering, nature of treatment and details of vaccinations were collected. In addition the details of frequency and cost of shoeing were also collected.

The survey also aimed at collecting information on utilization patterns of bullocks. Different operations performed and number of hours per day used for each operation

in a year, number of days per year for each operation, peak season of use, details of hiring out and age upto which bullocks were used for work and reasons for disposal were collected.

3.3.3 Work performance

Studies on the work performance of the bullocks consisted of on-farm trials in farmers' field. Ten pairs of Kangayam bullocks were included in the trial from each region. They were used for dry land ploughing for a period of four hours continuously on each day of work. Speed of walking, stride length and horse-power developed were studied. Physiological responses before work and immediately after work were recorded.

3.3.3.1 Speed of walking and stride length

The speed of walking of bullocks was calculated by measuring the time taken to traverse a particular distance. This was repeated four times and the mean of the observations was taken and compared.

Stride length was found out by counting the number of steps taken to traverse a known distance and dividing the distance with the number of strides taken. This was repeated four times in each case, and the mean of the four observations was taken as the particular stride length.

3.3.3.2 Physiological responses

Physiological responses in terms of respiratory rate, pulse rate and rectal temperature were recorded before the start of work and immediately after four hours of work. The respiratory rate was counted from flank movements. The pulse rate was taken under the root of the tail by feeling the number of beats from the coccygeal artery with the fingers for one minute. The rectal temperature of the bullocks was taken by inserting full length of a clinical thermometer in the rectum and holding its bulb against the rectal wall for about three minutes.

3.3.3.3 Draughtability

The horse power developed was measured with a dynamo meter using the modified technique of Maurya and Devadattam (1982). Dynamometer measured the pull in kilogram (kg) directly. Draft was calculated as pull in kg as measured in the dynamometer x Cos O, where O is the angle the beam makes with the horizontal ground while pulling. The horse power developed was estimated using the following equation:

$$\text{Horse power} = \frac{\text{Draft x speed/sec}}{75}$$

3.3.4 Morphological characteristics and body measurements

Body measurements and morphological characteristics of Kangayam cows and bullocks were documented by following the general procedure laid out by FAO (1986) with suitable modifications (Appendix III).

The body measurements were taken with a standard 300 cm measuring tape and measuring rod after making the animals stand on an even ground. The body measurements collected in centimetres were length of horn, circumference of horns at base, length of the ear, length of face from poll to upper edge of muzzle, height at withers, length of the body from point of shoulder to pin bones, chest girth behind the hump, length of the tail from the base to the start of the switch and length of the switch. The body measurements so obtained were then classified according to the age group of animals in both the regions and comparisons made.

3.3.5 Statistical analysis

Means and standard errors were calculated with the data collected. Comparisons were made by using 't' test. In general statistical procedures detailed by Snedecor and Cochran (1967) were followed.

Results

4. RESULTS

4.1 Management practices

4.1.1 Meteorological information

The average meteorological data of the study area has been presented in Table 2. Figure 1, 2, 3 and 4 give information on climatic variables for the study period (June, 1994 to May, 1995) at the two locations included in the investigation. Monthly minimum temperature ranged from 16.1°C to 23.8°C in Kangayam tract and from 20.5°C to 28.4°C in Palakkad region. Monthly maximum temperature ranged from 28.1°C to 35.7°C in Kangayam tract and between 25.9°C and 37.8°C in Palakkad region. It is evident from Fig.1 and Fig.2 that the months from February to May during which work performance trials were conducted, recorded highest maximum temperature.

The average relative humidity of Kangayam tract was 68 per cent compared to 87 per cent in the Palakkad region.

Mean hours of bright sunshine was 6.3 hours in both the study regions which ranged between 2.4 hours and 9.2 hours in Kangayam tract and 1.4 hours to 9.2 hours in Palakkad region.

Fig.1 WEATHER CHART FOR THE PERIOD JUNE 1994 TO MAY 1995 AT KANGAYAM TRACT

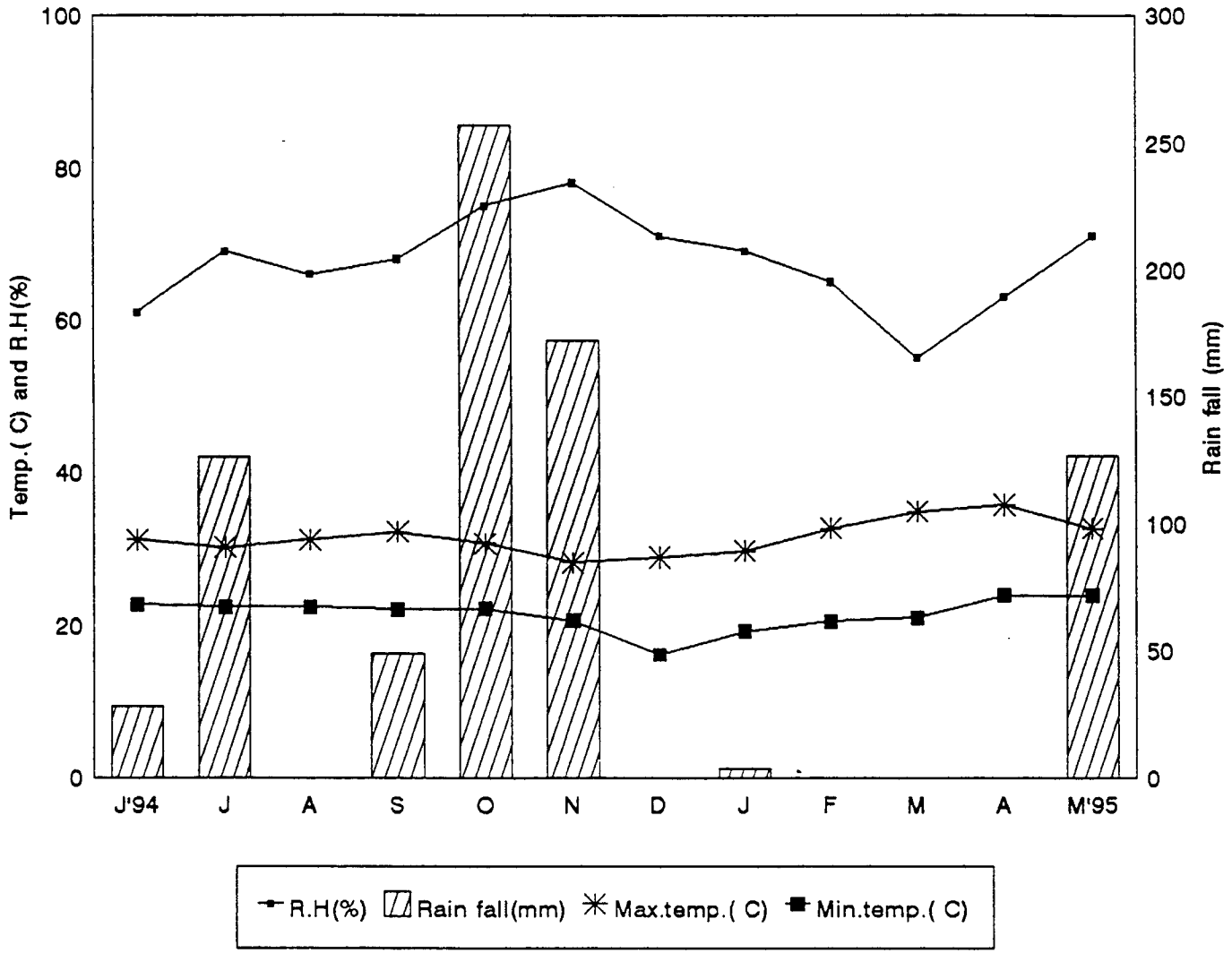


Fig.2 WEATHER CHART FOR THE PERIOD JUNE 1994 TO MAY 1995 AT PALAKKAD

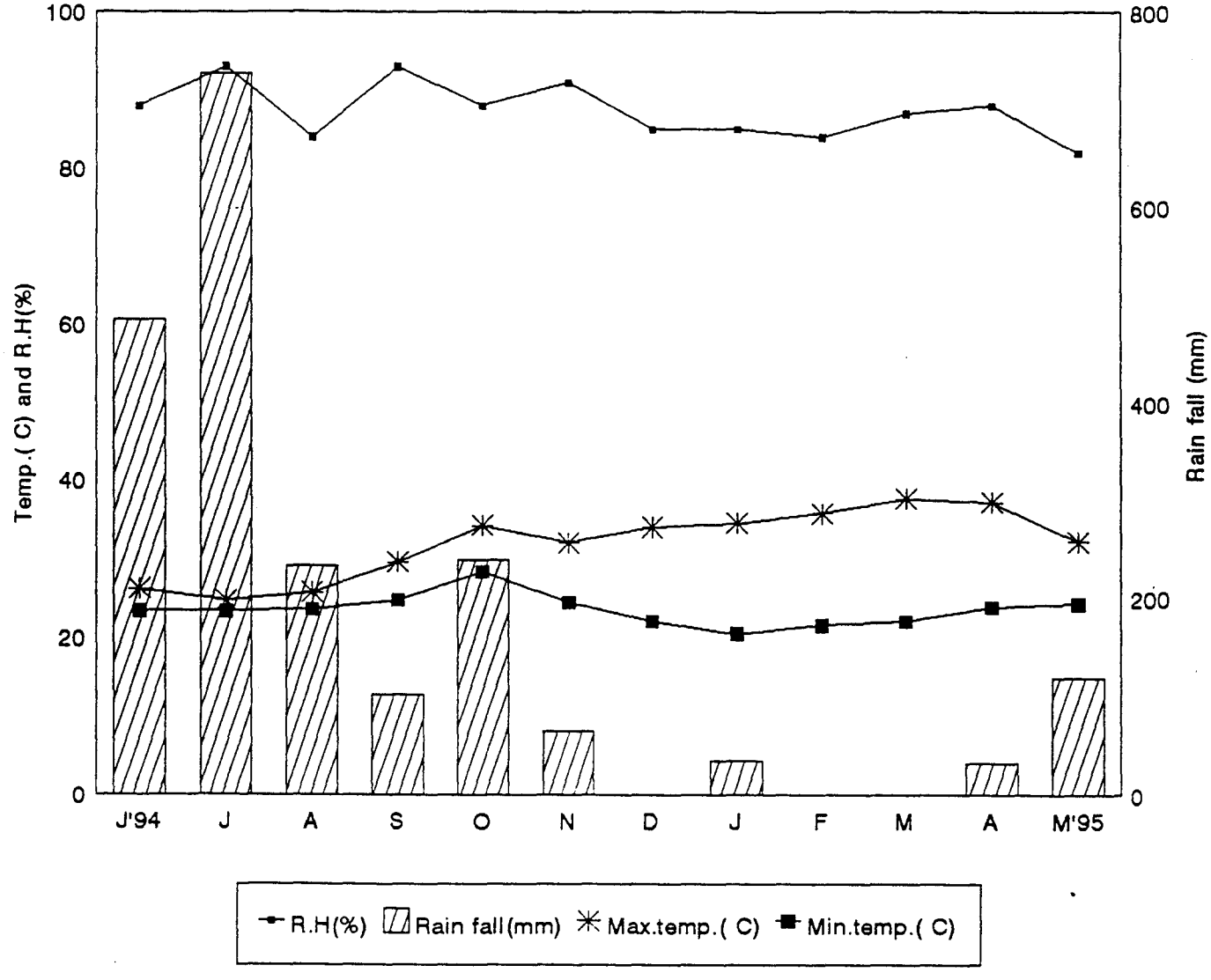


Fig.3 COMPARISION OF MEAN TEMPERATURE AND RELATIVE HUMIDITY IN TWO REGIONS

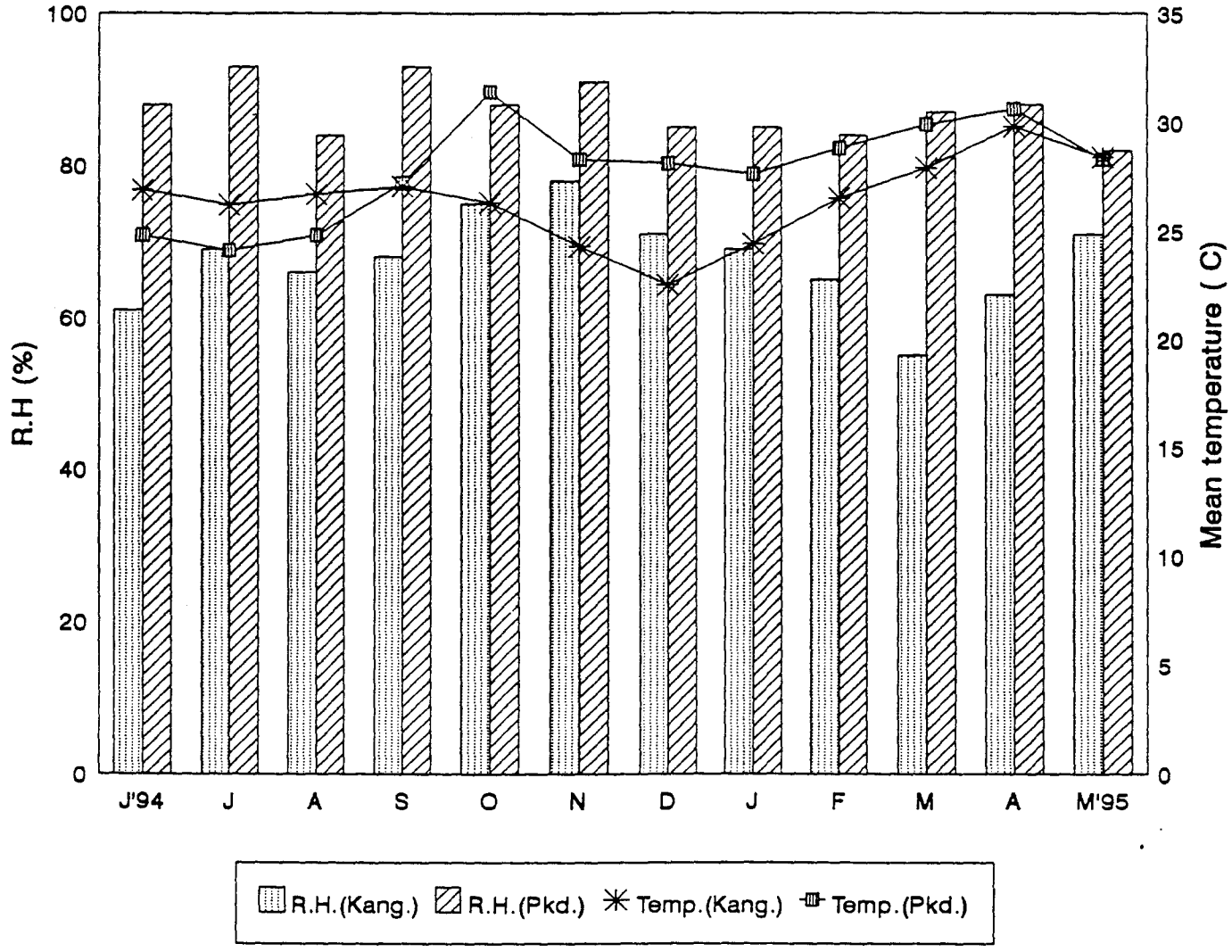
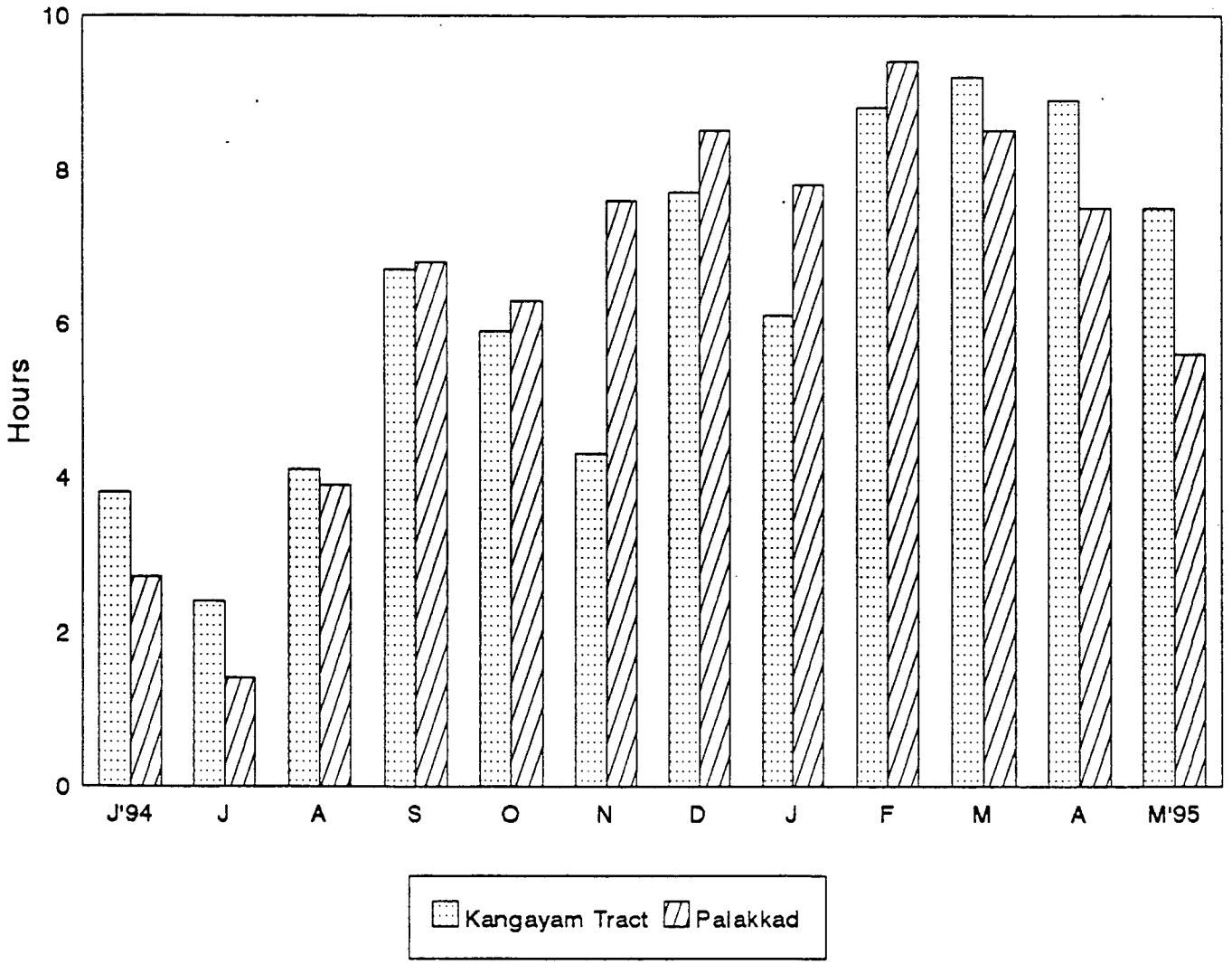


Fig.4 COMPARISION OF HOURS OF BRIGHT SUNSHINE IN TWO REGIONS



Average monthly rainfall was 63.4 mm in Kangayam tract and 170.9 mm in Palakkad region.

Table 2. Average monthly meteorological data of Kangayam tract and adjoining Palakkad region during the study period (June, 1994 to May, 1995)

Sl. No.	Parameters	Average	
		Kangayam	Palakkad
	Monthly averages of:		
1.	Maximum temperature (°C)	31.4	32.3
2.	Minimum temperature (°C)	21.3	23.6
3.	Relative humidity (%)	68.0	87.0
4.	Hours of bright sunshine (hrs)	6.3	6.3
5.	Rainfall (mm)	63.4	170.9

4.1.2 Land and livestock holdings of farmers

The details of land holdings of the farmers surveyed in the home tract of Kangayam and adjoining Palakkad district of Kerala are given in Table 3 and Fig.5.

Fig.5 LAND HOLDINGS OF FARMERS KEEPING DRAUGHT ANIMALS IN KANGAYAM TRACT AND ADJOINING PALAKKAD

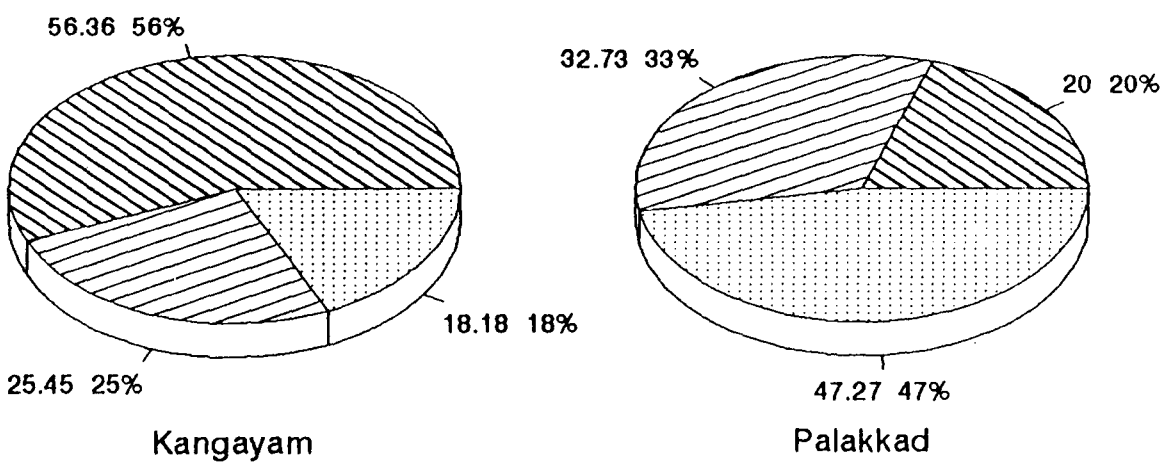


Table 3. Classification of farmers surveyed in the home tract of Kangayam and adjoining Palakkad district based on land holdings

Sl. No.	Type	Kangayam tract		Palakkad	
		n	%	n	%
1.	<2 ha	10	18.18	26	47.27
2.	2-4 ha	14	25.45	18	32.73
3.	>4 ha	31	56.36	11	20.00
		55	100	55	100

The size of land holdings was comparatively larger in the Kangayam region compared to the adjoining regions of Palakkad district, Kerala. While 56.36 per cent of the farmers surveyed in Kangayam region had a holding size above 4 ha, only 20 per cent in Palakkad region had similar holding size. The frequency of occurrence became less in the Kangayam tract as the area of farms became less. In contrast, in the adjoining Palakkad region of Kerala small sized farms predominated with holdings measuring less than 2 ha forming 47.27 per cent. In that region, the frequency of occurrence decreased as the farm size increased.

The mean land holding of farmers surveyed in the home tract of Kangayam was 4.24 $\pm$ 0.35 ha. The corresponding

figure for the farmers of Palakkad area was 2.95 ± 0.54 ha. Analysis by 'T' test indicated no significant difference between the mean land holdings of the farmers in both the regions.

The livestock holdings of farmers in the home tract of Kangayam and adjoining area of Palakkad is given in Table 4.

Table 4. Livestock kept in 55 bullock-keeping households in each region

Sl. No.	Type of livestock	Kangayam tract		Palakkad	
		n	%	n	%
1.	Cattle (adult female)	40	76.36	49	89.10
2.	Cattle (young stock)	13	26.64	15	27.27
3.	Buffalo (adult female)	21	38.18	7	12.73
4.	Goats (adult)	7	12.73	17	30.91
5.	Sheep (adult)	8	14.55	-	-
6.	Bullocks	55	100	55	100

4.1.3 Implements and accessories possessed by the bullock keeping households

The particulars regarding implements and accessories possessed by farmers in the two regions are presented in Table 5.

Table 5. Implements and accessories possessed by draught animal keeping households

Sl. No.	Items	Kangayam tract		Palakkad	
		n	%	n	%
A.	PLOUGHS				
1.	Indigenous	55	100	52	94.55
2.	Improved	-	-	1	1.82
3.	Nil	-	-	2	3.63
B.	CARTS				
1.	Indigenous	45	81.82	53	96.36
2.	Improved	6	10.91	1	1.82
3.	Indigenous + Improved	3	5.45	-	-
4.	Nil	1	1.82	1	1.82

All the farmers surveyed in the Kangayam tract possessed indigenous ploughs whereas majority of the farmers in the Palakkad region owned indigenous ploughs (94.55%). Of the farmers in Palakkad region, one farmer (1.82%) possessed improved plough and two farmers (3.63%) did not possess any plough.

Majority of the farmers in Kangayam tract (81.82%) and Palakkad (96.36%) owned indigenous carts. One farmer from Kangayam tract and adjoining Palakkad region (1.82%) did not possess any cart. Number of farmers owning improved cart was meagre in Palakkad region (1.82%). On the other hand, 10.91 per cent farmers in the Kangayam tract had improved carts and 5.45 per cent both improved and indigenous.

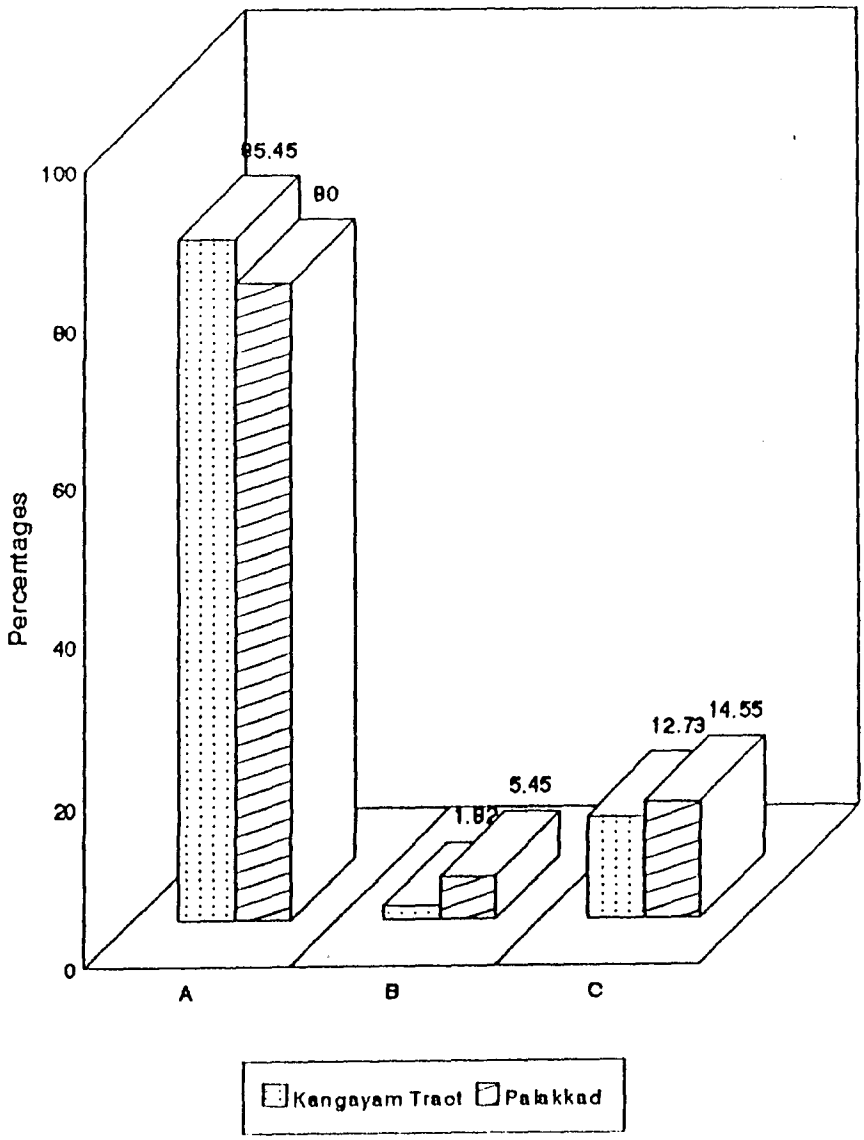
4.1.4 Farmer's preference with respect to duration of keeping bullocks

The preference of farmers with regard to duration of keeping bullocks ascertained through a questionnaire has been presented in Table 6 and Fig.6.

Table 6. Farmers preference with respect to duration of keeping bullocks

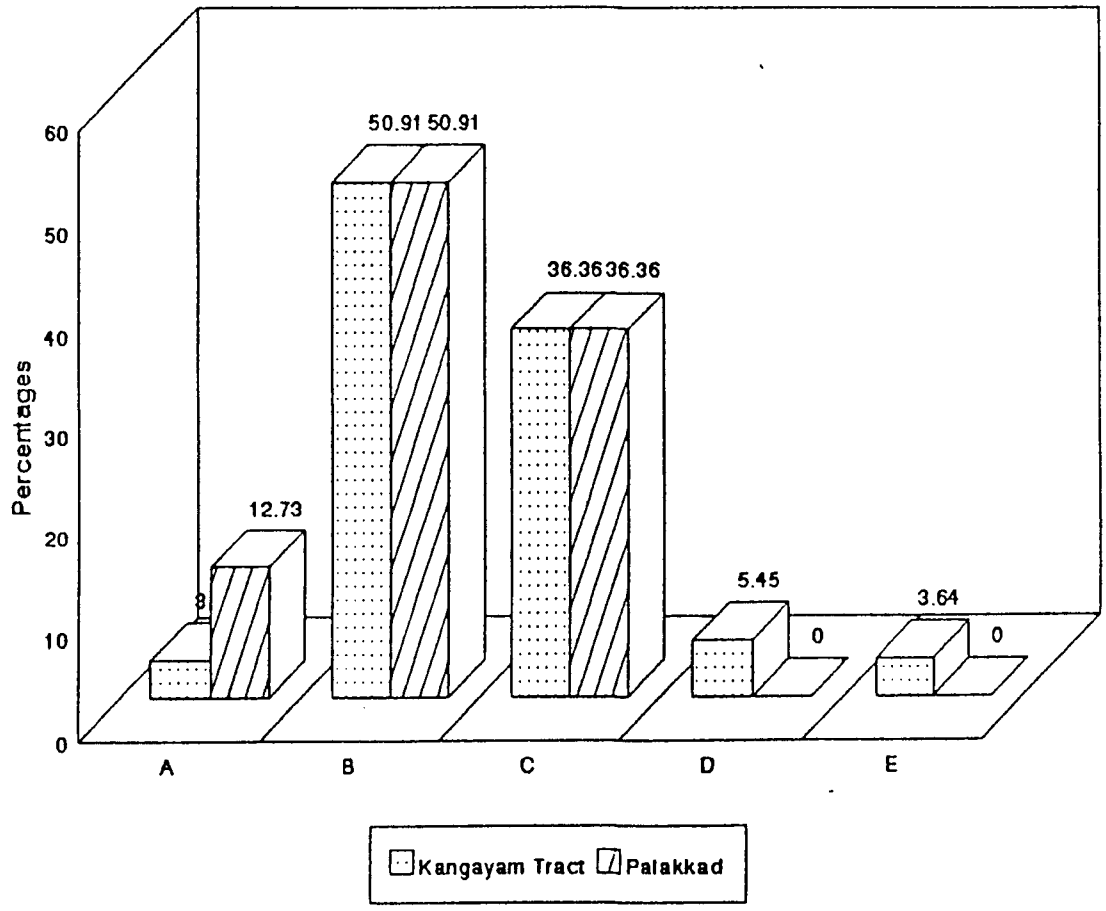
Sl. No.	Item	Kangayam tract		Palakkad	
		n	%	n	%
1.	Keep throughout the year	47	85.45	44	80.00
2.	Dispose after peak season	1	1.82	3	5.45
3.	Either keep or dispose after peak season	7	12.73	8	14.55
		55	100	55	100

Fig.6 FARMER'S PREFERENCE WITH RESPECT TO DURATION OF KEEPING BULLOCKS



A - Keep throughout the year
B - Dispose after peak season
C - Either keep or dispose after peak season

Fig.7 SOURCE OF PROCUREMENT OF KANGAYAM BULLOCKS



A - Own farm

B - Market/shandy

C - Other farmers

D - Other farmer + market

E - Own farm + market

Majority of the farmers in Kangayam tract and adjoining Palakkad area (85.45% and 80% respectively) preferred to keep the bullocks throughout the year. Those farmers preferring to dispose the bullocks once the peak season of work is over was meagre in both the regions, although slightly higher in Palakkad region. Proportion of farmers preferring to either keep or dispose was 12.73 per cent in Kangayam tract and 14.55 per cent in adjoining Palakkad region.

4.1.5 Source of obtaining bullocks

Information on source of obtaining bullocks is presented in Table 7 and Fig.7. Markets (Shandies/cattle fairs) and other farmers were the common sources of purchase of bullocks in both the regions. Very few farmers only raised their own replacements of bullocks in both the regions.

Table 7. Source of obtaining bullocks

Sl. No.	Source	Kangayam tract		Palakkad	
		n	%	n	%
1.	Own farm	2	3.64	7	12.73
2.	Market/shandy	28	50.91	28	50.91
3.	Other farmers	20	36.36	20	36.36
4.	Other farmer + market	3	5.45	-	-
5.	Own farm + market	2	3.64	-	-
		55	100	55	100

All the farmers surveyed in the Kanagayam tract purchased bullocks with their own financial resources whereas, in adjoining Palakkad region 92.73 per cent of the farmers purchased their bullocks with their own financial resources and 7.27 per cent of the farmers availed bank loans.

The mean cost of a pair of Kangayam bullocks in their home tract was Rs.10,927 $\pm$ 282.9 and in adjoining Palakkad region of Kerala Rs.7,855 $\pm$ 238.8. The cost of a pair of bullocks in both the regions differed significantly ($P \leq 0.05$).

The age at purchase of bullocks in Kangayam tract varied from 1 to 10 years with a mean age of 4.609 $\pm$ 0.337. On the other hand, in adjoining Palakkad region, the age at which farmers purchased their bullocks ranged from 2.5 to 10 years with a mean age of 5.173 $\pm$ 0.176. The mean age at purchase in both regions did not differ significantly.

Maximum number of farmers in Kangayam tract (18.18%) purchased their bullocks at 2.5 years of age followed by 4.5 years (16.36%). In adjoining Palakkad region, maximum number of farmers (29.09%) purchased their bullocks at 6 years of age followed by 4.5 years (21.81%).

4.1.6 Training

Majority of the farmers in both Kangayam tract (81.82%) and in adjoining Palakkad region (83.64%) purchased trained

bullocks. The proportion of farmers who purchased untrained bullocks and later imparted training was 18.18 per cent in Kangayam tract and 16.36 per cent in adjoining Palakkad region.

The method of training bullocks did not vary much in the two regions. Around 2-3 years of age, nose ropes are put on bullocks for better restraint. Two untrained bullocks or one untrained bullock along with a trained one were tied to a yoke and made to follow a pair of fully trained bullocks ploughing the field for about a week at the rate of one hour per day. After this, the plough was hitched to the yoke and a mild traction given for a few days. In due course the bullocks would be in a position to plough the soil.

Once the bullocks were trained for the above purpose, they could be easily put under training for carting. Here a pair of untrained animals are hitched to an empty cart and led through the road with one person sitting on the cart and another walking alongside the animals.

Some farmers attempted training to pull cart before being trained for ploughing. Here, one untrained bullock was hitched to a cart along with a trained one and led through the roads, with one man sitting on the cart and another walking alongside the bullocks. This exercise was carried out for at least a week at the rate of nearly 2 hours per day preferably during morning hours. Initially, the bullocks would be made to

haul carts with lesser load. After a month or so these bullocks would be trained for ploughing as described earlier.

Most of the farmers felt that kindness and patience were major considerations for successful training of bullocks.

During the initial phase of training, bullocks might develop injury on the neck region. Under such conditions, rest will be given for a few days. Application of common salt mixed with butter, tamarind leaves boiled in water, neem oil, charred paddy straw with coconut oil etc. over the sores were practised.

4.1.7 Selection criteria

Various attributes of the bullocks considered by the farmers in selecting bullocks, obtained through a questionnaire, are presented in Table 8.

Table 8. Attributes for selection of bullocks

Sl. No.	Attributes	Kangayam tract		Palakkad	
		n	%	n	%
1.	Physical appearance alone	0	0	5	9.09
2.	Physical appearance + whirling pattern of hair	34	61.82	42	76.36
3.	Physical appearance + temperament	0	0	1	1.82
4.	Physical appearance + whirling pattern of hair + temperament	21	38.18	7	12.73
		55	100	55	100

In Kangayam tract, 61.82 per cent of the farmers surveyed considered physical appearance along with whirling pattern of hair as the important attributes for selecting bullocks. In adjoining Palakkad region, nearly three-fourths of the farmers (76.36%) considered these attributes as important. Farmers looking into temperament along with physical appearance was none in Kangayam tract and was meagre (1.82%) in the adjoining region of Palakkad. The proportion of farmers who looked into physical appearance along with whirling of hair and temperament was 38.18 per cent in Kangayam tract and 12.73 per cent in adjoining Palakkad region. None of the farmers in Kangayam tract and a meagre proportion (9.09%) in Palakkad region considered physical appearance alone while selecting bullocks.

Farmers in both the regions considered various physical attributes while selecting bullocks. Majority of the farmers preferred grey coloured animals. Some also preferred to have a fawn colour or a fawn or black coloured animal paired with grey coloured one. Bullocks in the height range of 1.35-1.50 m were preferred by the farmers. They preferred well developed compact bullocks with well-sprung strong ribs, head held high with a slight depression on the forehead and almost straight face. A bullock with smoothly curving even horns with hard horn base was preferred. Thin horns are more preferred than heavier ones. Bullocks with bright and bulging eyes were preferred. A

bullock with black patch around the eye is considered to be highly vicious and hence less preferred. Similarly, a bullock with reddish conjunctiva is also considered to be highly temperamental and therefore discriminated against. Bullocks having white eye lashes, white hooves, white hairs on the switch and white muzzle are considered as of weak constitution and therefore less preferred. The farmers wanted their bullocks to have black muzzles without any white spots or specks in it. Tongues of pinkish colour with black spots were preferred. A bullock with a pale tongue is rated low.

Farmers liked the dewlap to be thin and of medium size and the naval flap and penis sheath tucked up and close to the body. According to the farmer's preference, skin should be thin, soft and pliable especially over the neck region. Medium sized humps, straight or slightly tilted towards left side were considered by farmers as good. A bullock with almost straight back and devoid of any curvature was preferred.

Bullocks with straight and thin tail with the switch in level of hock region were preferred, and tails with kinked look were not liked.

In farmers' conception, a good bullock should have straight and strong limbs, with black, even and round hooves. Legs should not splay or brush each other and dewclaw should not touch the ground while walking.

A bullock at the time of purchase should have cut either fourth pair or third pair of permanent incisors. A bullock which cuts only seven permanent incisors is considered unlucky and hence not preferred by the farmers. Molars should not have any sharp edges.

The farmers observe that a calm and quiet temperament is ideal for work bullocks as nervous excitable bullocks are difficult to handle and their work output is less.

In addition to the physical appearance, farmers in both the regions considered whirling patterns of hairs on the bullocks as a major criteria of selection. A whirl is a twist of hair on the body. A whirl just behind the poll, the one situated in line with the umbilicus on the line from the head to the tail on the back just behind the hump of the animal and the one on either side of the neck are considered lucky marks by the farmers while selecting their bullocks.

A whirl in between or just above the eyes, two whorls one over the other on the forehead, whorl on the fetlocks of either pair of legs, two ridges of hair on the back on either side of the middle line on the croup and a whorl on the inner side of the tail are considered unlucky marks on the bullocks, Hence animals with such whirling patterns were seldom selected by farmers.

4.1.8 Castration

The proportion of farmers who purchased entire bulls and later on castrated was similar in both Kangayam tract and the adjoining Palakkad region (16.36%). Rest of the farmers (83.64%) purchased castrated bullocks. Of the farmers in both the regions who castrated their animals after buying, only 11.11 per cent performed castration by country method and the rest (88.89%) sought the help of veterinary personnel for castrating with Burdizo castrator. In the home tract of Kangayam, castration is usually done on Sundays and Fridays in the months of January, February, July, August, September and November only.

After castration, ears were trimmed with a simple knife. Farmers felt that trimming of ears of bullocks gave an alert appearance to this breed. However, ear trimming is not practised on Kangayam cows and breeding bulls.

The age at which farmers castrated their bullocks varied from 2 to 2.5 years with mean of 2.150 $\pm$ 0.076 years in Kangayam tract, whereas in adjoining Palakkad region, it ranged from 1.5 to 2.5 years with a mean of 2.167 $\pm$ 0.144 years.

4.1.9 Feeding Management

The bullocks in the Kangayam tract and adjoining Palakkad region of Kerala generally sustain themselves on

Plate 1. A pair of Kangayam bullocks in front of the stacked hay of sorghum and Phaseolus trilobus (Naripayathankodi)

Plate 2. A typical Kangayam cow in a Kolukattai grass pasture in the native tract

locally available feed resources including crop residues, concentrates and agricultural by products (Table 9).

Table 9. Feed resources used for feeding bullocks in Kangayam tract and adjoining Palakkad region

Sl. No.	Type	Items
1.	Roughage	Paddy straw, sorghum straw, grazing in fallow lands, bunds of canals, pastures, maize straw, pearl millet straw
2.	Concentrate feed/ ingredients	Groundnut cake, coconut cake, cotton seed, paddy, horse gram, rice broken, sorghum, black gram and compound feed
3.	Crop residues	Ragi stalk, groundnut stalk, black gram hulls, horse gram hulls, soya hulls, stalk, hulls and pods, green gram hulls and sugarcane bagasse
4.	Agricultural by-products	Wheat bran, rice bran

In both the regions, bullocks were mostly stall-fed with some amount of grazing in fallow fields, bunds etc. In some localised areas of the home tract Kangayam bullocks were also grazed in fenced pasture lands of 'Kolukattai grass' (Cenchrus ciliaris).

During work days 25.45 per cent of the farmers in the home tract of Kangayam and 52.72 per cent of the farmers in the

adjoining region of Palakkad of Kerala grazed their bullocks. On an average, the bullocks were grazed for 2.00 ± 0.18 hours and 2.52 ± 0.15 hours in Kangayam tract and adjoining region of Palakkad respectively. On the other hand, during rest days, majority of the farmers in Kangayam tract (81.81%) and in adjoining Palakkad region (96.36%) grazed their bullocks. The mean duration of grazing during rest days was 6.22 ± 0.28 hours in Kangayam tract and 7.55 ± 0.25 hours in adjoining regions of Palakkad District.

The sources of different feed ingredients provided to bullocks in both the regions are presented in Table 10. All the farmers studied had their own source of roughage in both the areas. Majority of farmers in Kangayam tract (48.94%) depended on market/mills for concentrate feed ingredients whereas majority of the farmers in Palakkad region of Kerala (58.82%) had their own source.

Different roughage items fed to the bullocks and the proportion of farmers in both the regions feeding these items are presented in Table 11.

Table 10. Source of different feed ingredients provided to bullocks in Kangayam tract and Palakkad

Sl. No.	Source	Kangayam tract		Palakkad	
		n	%	n	%
A.	Roughage				
	1. Own	55	100	55	100
B.	Concentrate				
	1. Own	6	12.78	30	58.82
	2. Market/mill	23	48.94	4	7.84
	3. Own + Market/mill	18	38.28	17	33.33
		47	100	51	100

It is evident from Table 11 that sorghum straw was the major roughage item fed to bullocks in Kangayam tract followed by ground nut stalks and paddy straw. On the other hand paddy straw formed the major roughage ingredient provided to the bullocks in adjoining region of Palakkad followed by sorghum straw and groundnut stalks in that order.

Items such as Phaseolus trilobus stalk and pods, green gram stalk, finger millet straw and sugarcane bagasse were used for feeding bullocks only by farmers of the home tract of

Table 11. Proportion of farmers feeding different roughage ingredients to bullocks in Kangayam tract and Palakkad

Sl. No.	Source	Kangayam tract		Palakkad	
		n	%	n	%
1.	Paddy straw	26	47.27	51	92.73
2.	Sorghum straw	43	78.18	36	65.45
3.	Grass	9	16.36	15	27.27
4.	Ragi stalk	0	0	6	10.91
5.	Groundnut stalk	30	54.55	19	34.56
6.	Black gram hulls	0	0	7	12.73
7.	Horse gram hulls	1	1.82	6	10.91
8.	Bengal gram hulls	2	3.64	2	3.64
9.	Soya hulls	0	0	3	5.45
10.	Soya stalk	1	1.82	7	12.73
11.	Maize straw	5	9.09	1	1.82
12.	Phaseolus trilobus stalk + pods	7	12.73	0	0
13.	Green gram stalk	1	1.82	0	0
14.	Finger millet straw	3	5.45	0	0
15.	Sugarcane bagasse	4	7.27	0	0

Table 12. Proportion of farmers providing different feed ingredients to bullocks in Kangayam tract and Palakkad

Sl. No.	Item	Kangayam tract (n=47)		Palakkad (n=51)	
		n	%	n	%
1.	Rice bran	36	76.60	41	80.39
2.	Groundnut cake	10	21.28	13	25.49
3.	Coconut cake	0	0	7	13.73
4.	Boiled paddy	0	0	10	19.61
5.	Wheat bran	0	0	4	7.84
6.	Cotton seed	25	53.19	14	27.45
7.	Horse gram	7	14.89	3	5.88
8.	Rice broken/gruel	0	0	3	5.88
9.	Sorghum	1	2.13	0	0
10.	Black gram broken	3	6.38	0	0
11.	Compound feed	2	4.26	0	0

Kangayam. Soya hulls, black gram hulls and ragi stalks are provided to bullocks only by few farmers in Palakkad region.

Table 12 presents different concentrate feed ingredients fed to the bullocks and the proportion of farmers providing each of these items in the two regions.

In both the regions, rice bran formed the major concentrate feed ingredient, followed by cotton seed and then groundnut cake.

The frequency of feeding different roughages to the bullocks in the two regions is presented in Table 13. Majority of the farmers in Kangayam tract (36.36%) provided roughages 5 times a day during work days especially during the evening and night hours. In Palakkad, majority of the farmers (40%) provided roughages three times a day during work days. During rest days, 40 per cent of the farmers in Kangayam tract and 34.55 per cent of the farmers in adjoining Palakkad region provided roughages two times a day.

As far as concentrates are concerned almost all farmers in both the regions fed them two times a day during both work and rest days. The proportion of farmers feeding concentrate feed ingredients was more in Palakkad region (92.73%) than Kangayam tract (85.45%). During work days farmers fed concentrate ingredients immediately before and after work in

Table 13. Frequency of feeding different roughages to bullocks in Kangayam tract and Palakkad

Sl. No.	Frequency	During work				During rest			
		Kangayam tract		Palakkad		Kangayam tract		Palakkad	
		n	%	n	%	n	%	n	%
1.	1 time	0	0	0	0	0	0	18	32.73
2.	2 time	1	1.88	4	7.27	22	40.00	19	34.55
3.	3 time	14	25.45	22	40.00	16	29.09	9	16.36
4.	4 time	9	16.36	13	23.64	3	5.45	0	0
5.	5 time	20	36.36	12	21.82	3	5.45	0	0
6.	6 time	11	20.00	4	7.27	11	20.00	9	16.36
		55	100.00	55	100.00	55	100.00	55	100.00

Table 14. Frequency of watering bullocks in Kangayam tract and Palakkad

Sl. No.	Frequency	During work				During rest			
		Kangayam tract		Palakkad		Kangayam tract		Palakkad	
		n	%	n	%	n	%	n	%
1.	1 time	0	0	0	0	14	25.45	26	47.27
2.	2 time	19	34.55	23	41.82	33	60.00	24	43.64
3.	3 time	36	65.45	32	58.18	8	14.55	5	9.09
		55	100.00	55	100.00	55	100.00	55	100.00

both the regions. During working days farmers in the home tract of Kangayam, on an average, provided 3.77 ± 0.25 kg concentrate feed per pair per day. In Palakkad region also farmers fed their bullocks a similar amount of 3.77 ± 0.23 kg. On the other hand during rest days farmers provided 2.78 ± 0.17 kg and 2.43 ± 0.17 kg per pair per day in Kangayam tract and in adjoining Palakkad region respectively.

Frequency of watering bullocks in the two regions is presented in Table 14. During work days, majority of the farmers in the Kangayam tract (65.45%) and in adjoining Palakkad region (58.18%) provided water three times a day. On the other hand, during rest days majority of the farmers in Kangayam tract (60%) provided water two times a day and in adjoining Palakkad region (47.27%) only once a day.

4.1.10 Housing

The type of housing provided to bullocks varied among farmers. Majority of the farmers in Kangayam tract (81.82%) and in adjoining Palakkad region (63.64%) provided independent houses for bullocks. The proportion of farmers providing lean-to-type house was less in Kangayam tract (7.28%) when compared to adjoining Palakkad region (36.37%).

Among the farmers who provided housing, 63.26 per cent in Kangayam tract and 87.27 per cent in adjoining Palakkad

region provided 'Kutcha' type of houses and 36.73 per cent farmers in Kangayam tract and 12.73 per cent farmers in adjoining Palakkad region provided 'pucca' houses.

In the original home tract of Kangayam, some farmers did not provide any houses for their bullocks. Instead, during the months of April to August when there is heavy draft, they put up some sort of wind screens/barriers made of cotton stalks or woven coconut leaves in the open field. The animals are kept behind the screen in the open field.

Majority of the farmers in Kangayam tract (65.31%) and in adjoining Palakkad region (87.27%) provided thatched roofing and 32.65 per cent farmers in Kangayam tract and 12.73 per cent farmers in adjoining Palakkad region provided tiled roof. One farmer in Kangayam tract also used asbestos - cement sheets as roofing material.

The type of floor consisted of mud (81.63%), concrete (16.33%) and stone paved (2.04%) in Kangayam tract whereas in adjoining Palakkad region it consisted of mud (85.45%) and concrete (14.55%). Majority of the farmers surveyed in Kangayam tract (79.59%) and in adjoining Palakkad region (69.09%) housed their bullocks only during night time. The proportion of farmers who sheltered the animals during parts of the day also was of the order of 16.23 per cent in Kangayam tract and 27.27 per cent in adjoining Palakkad region.

4.1.11 Washing

All farmers surveyed in Kangayam tract and the adjoining Palakkad region who used their bullocks for wet ploughing invariably washed their animals daily after work. The frequency at which the bullocks were washed in Kangayam tract and adjoining Palakkad region is given in table 15.

Table 15. Frequency of washing bullocks

Sl. No.	Frequency of washing	Kangayam tract		Palakkad	
		n	%	n	%
1.	Daily	0	0	2	3.64
2.	Weekly once	14	25.45	20	36.36
3.	Fortnightly	8	14.55	7	12.73
4.	Monthly	14	25.45	8	14.55
5.	Once in two months	4	7.27	6	10.91
6.	As per convenience	15	27.27	12	21.81
		55	100.00	55	100.00

In Kangayam tract, larger percentage of the farmers reported that they washed their bullocks as per convenience (27.27%) whereas in adjoining Palakkad region more number of farmers (36.36%) washed their bullocks weekly once.

4.1.12 Shoeing

Majority of the farmers surveyed in Kangayam tract (92.72%) and adjoining Palakkad region (96.36%) shoed their bullocks. The frequency of shoeing bullocks is presented in Table 16.

Table 16. Frequency of shoeing bullocks in Kangayam tract and adjoining Palakkad region

Sl. No.	Frequency	Kangayam tract		Palakkad	
		n	%	n	%
1.	≤ 30 days	15	29.41	18	33.96
2.	31-60 days	28	54.90	19	35.85
3.	61-90 days	6	11.76	12	22.64
4.	> 91 days	2	3.92	4	7.55
		51	100.00	53	100.00

In Kangayam tract more than 50 per cent of the farmers (54.90%) shoed their bullocks at an interval of 31 to 60 days. In adjoining Palakkad region also major proportion of farmers (35.85%) shoed their bullocks at 31 to 60 days intervals. The mean cost of shoeing was Rs.69.71 ± 1.49 in Kangayam tract whereas in adjoining Palakkad region it was Rs.72.17 ± 1.11.

The mean cost of shoeing bullocks in the two regions studied did not differ significantly.

4.1.13 Health care

A large proportion of the farmers surveyed in Kangayam tract (41.82%) and in adjoining Palakkad region (50.99%) reported that they provided either household remedy or treatment from the veterinary hospital when the animals fell sick. In Kangayam tract, 26.64 per cent and in adjoining Palakkad region, 20 per cent of the farmers resorted to own treatment and 34.54 per cent of the farmers in the Kangayam tract and 29.09 per cent of the farmers in adjoining Palakkad region resorted to treatment from veterinary hospitals.

The common health problems of bullocks in the two regions studied were bloat, indigestion, hoof injury, yoke gall, lameness, bursitis, neck sore, hump sore, sprain, string hault, horn fracture, pyrexia, diarrhoea, ring worm infection, insect bite allergy, foot and mouth disease, ephemeral fever, Babesiosis, Actinomycosis and Actinobacillosis. Proportion of farmers who got their bullocks vaccinated in Kangayam tract was 60 per cent and in adjoining Palakkad region it was 63.64 per cent. The different diseases against which vaccinations were conducted and proportion of farmers availing the service are given in Table 17.

Table 17. Details of vaccination of bullocks in Kangayam tract and adjoining Palakkad region

Sl. No.	Disease	Kangayam tract		Palakkad	
		n	%	n	%
1.	FMD	10	30.30	4	11.63
2.	RP	7	21.21	19	54.29
3.	FMD + RP	12	36.36	7	20.00
4.	FMD + RP + HS	3	9.09	2	5.71
5.	FMD + RP + BQ	1	3.03	3	8.57
		33	100.00	35	100.00

4.1.14 Disposal pattern of bullocks

The maximum age upto which bullocks were worked ranged from 6 to 20 years with a mean of 14.55 ± 0.52 years in Kangayam tract. In adjoining Palakkad region it ranged from 10 to 20 years with a mean of 15.78 ± 0.42 years, which were not significantly different. The maximum age upto which bullocks were used for work as reported by farmers in Kangayam tract and in adjoining Palakkad region of Kerala is presented in Table 18.

Table 18. Age upto which bullocks were put to work (as reported by farmers)

Sl. No.	Age	Kangayam tract		Palakkad	
		n	%	n	%
1.	≤ 10 years	11	20.00	5	9.09
2.	11-15 years	28	50.91	21	38.18
3.	16-20 years	16	29.09	29	52.73
		55	100.00	55	100.00

Reasons for disposal of bullocks in Kangayam tract and in adjoining Palakkad region are presented in Table 19.

4.1.15 Utilization pattern of bullocks

Table 20 present information on the utilization pattern of bullocks. Part A of the table gives the mean hours per day and mean days per year for which the bullocks were used for various operations in the two regions. Part B of the table gives the overall yearly averages of utilization for ploughing and carting separately as well as the overall total.

All the farmers in both the regions used bullocks for preparing land for the cultivation of different crops. Bullocks were used for ploughing own land for cultivation at the rate of 7.71 ± 0.09 hours/day for an average of 68.85 ± 5.54 days in an

Table 19. Details of disposal of bullocks

Sl. No.	Reason	Kangayam tract		Palakkad	
		n	%	n	%
1.	Old age	37	67.26	25	45.45
2.	Highly temperamental	1	1.82	-	-
3.	Old age + highly temperamental	6	10.91	2	3.64
4.	Old age + season over	2	3.64	11	20.00
5.	Old age + disease + highly temperamental	2	3.64	-	-
6.	Old age + want of money + temperamental	1	1.82	-	-
7.	Old age + disease	1	1.82	7	12.73
8.	Old age + pair died	3	5.45	5	9.09
9.	Old age + want of money	1	1.82	5	9.09
10.	Disease + season over	1	1.82	-	-
		55	100.00	55	100.00

year in the Kangayam tract. In the adjoining Palakkad region, bullocks were used for 54.30 ± 3.87 days at an average rate of 7.60 ± 0.13 hours/day. The number of hours/day used for ploughing own land and the number of days on which the animals were used per year did not differ significantly between the two regions. The bullocks were hired out for ploughing at the rate of 8.00 hours/day in both the regions. On an average they were hired out for 25.26 ± 2.74 days in Kangayam tract and 26.25 ± 3.75 days in Palakkad region. There were no significant differences between regions in this respect.

Out of the 55 households, 50 in Kangayam tract and 54 in Palakkad region used the bullocks for their own carting work. In Kangayam tract for this purpose the farmers used the bullocks on an average 91.80 ± 5.94 days in an year at the rate of 5.92 ± 0.26 hours/day. In Palakkad region they used on an average 77.22 ± 5.22 days at the rate of 5.20 ± 0.14 hours/day. Fifteen farmers in Kangayam tract and 16 in Palakkad region hired out their bullocks for carting work. In the former, the duration of hire averaged 6.53 ± 0.36 hours whereas in the latter case 7.31 ± 0.41 hours/day. The average number of days on which the bullocks were hired out for carting in Kangayam tract averaged 74.00 ± 10.98 days in an year as against 72.81 ± 7.55 days in Palakkad region. The duration of carting as well as number of days used for carting whether for own purposes or for hiring out, did not differ significantly between the two regions.

Table 20. Utilization pattern of bullocks in home tract of Kangayam and adjoining Palakkad region

Part A

Sl. No.	Activity	Kangayam tract			Palakkad		
		n	Mean hours/ day	Mean days/ year	n	Mean hours/ day	Mean days/ year
1.	Ploughing (own land)	55	7.71± 0.09	68.85± 5.54	55	7.60± 0.13	54.30± 3.87
2.	Ploughing (hire out)	8	8.00± 0.00	25.62± 2.74	4	8.00± 0.00	26.25± 3.75
3.	Carting (own)	50	5.52± 0.26	91.80± 5.94	54	5.20± 0.14	77.22± 5.22
4.	Carting (hire out)	15	6.53± 0.36	74.00± 10.98	16	7.31± 0.41	72.81± 7.55
5.	Threshing	9	4.00± 0.00	5.88± 1.92	38	3.34± 0.19	7.03± 0.97
6.	Logging	-	-	-	1	4.00	60.00

Part B

Sl. No.	Activity	Kangayam tract			Palakkad		
		n	Mean hours/ year	Mean days/ year	n	Mean hours/ year	Mean days/ year
1.	Overall mean ploughing	55	558.20± 39.44	72.58± 5.17	55	426.03± 28.38	56.21± 3.73
2.	Overall mean carting	54	583.29± 47.76	108.47± 7.42	54	548.96± 50.54	99.79± 7.92
3.	Overall annual utilization	55	1129.90± 59.45	175.29± 9.18	55	988.56± 46.41	155.34± 8.53

Only nine farmers out of 55 in the Kangayam tract used their bullocks for threshing work which averaged 4 hours/day and 5.58 ± 1.92 days in an year. On the other hand in the adjoining Palakkad region 38 farmers out of 55 used their bullocks for threshing work at the rate of 3.34 ± 0.19 hours/day for 7.03 ± 0.97 days in an year.

One farmer in Palakkad area hired out his bullocks for logging timber at the rate of 4 hours/day for 60 days in an year.

Part B of table 20 depicts the yearly overall utilization of the bullocks for the various purposes. In the Kangayam region bullocks were used for ploughing work for an average 72.58 ± 5.93 days in an year. On an average they were used for ploughing for a total of 558.20 ± 45.11 hours in an year. The corresponding figures for bullocks in the Palakkad region were 56.21 ± 3.89 days and 426.03 ± 27.18 hours.

The farmers in the Kangayam tract put their bullocks to carting work for an average 108.47 ± 7.42 days in an year, whereas in Palakkad region they were used for 99.79 ± 7.92 days for carting only. The total hours for which the bullocks in the Kangayam region were put to carting work averaged 583.29 ± 47.76 hours in an year as against 548.96 ± 50.54 hours per year in the Palakkad region.

The overall annual utilization of bullocks for various purposes in the Kangayam tract averaged 1129.90 ± 59.45 hours/year and 175.29 ± 9.18 days in an year. The corresponding figures for the bullocks in the Palakkad region were 988.56 ± 46.41 hours/year and 155.34 ± 8.53 days/year.

4.2 Work performance

4.2.1 Speed of walking and stride length

The mean speed of walking of bullocks during dry land ploughing in the Kangayam tract and adjoining Palakkad region are presented in Table 21 and Fig.8.

Table 21. Mean speed of walking of bullocks while ploughing dry land

Sl. No.	Parameters	Kangayam tract		Palakkad	
		n	Mean ± SE	n	Mean ± SE
1.	Initial speed (m/sec)	10	1.249±0.395	10	1.066±0.349
2.	Final speed (m/sec)	10	0.992±0.314	10	0.997±0.315
3.	Overall speed (m/sec)	10	1.114±0.028	10	1.052±0.130

Fig.8 INITIAL AND FINAL SPEED OF WALKING OF KANGAYAM BULLOCKS WHILE DRY PLOUGHING

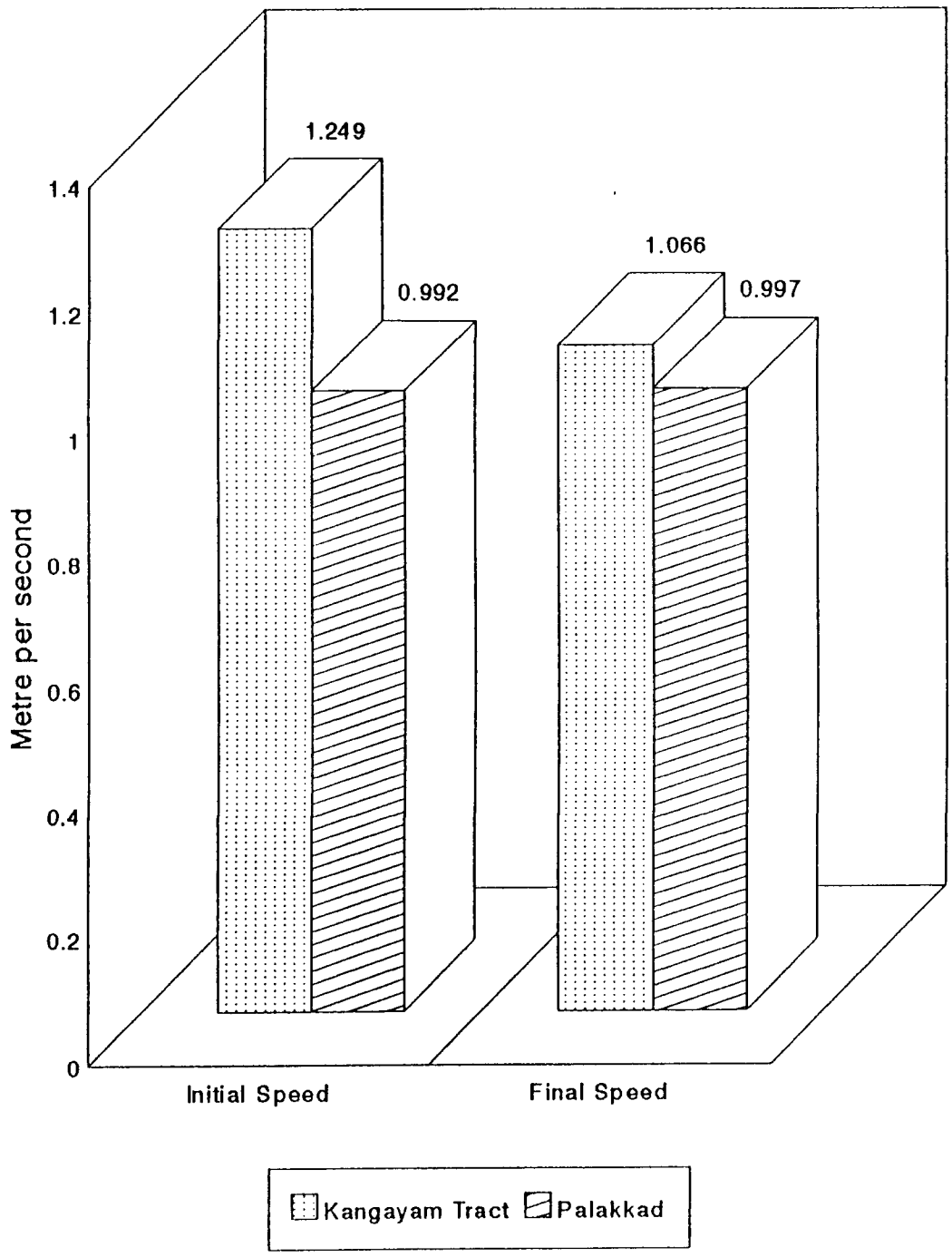
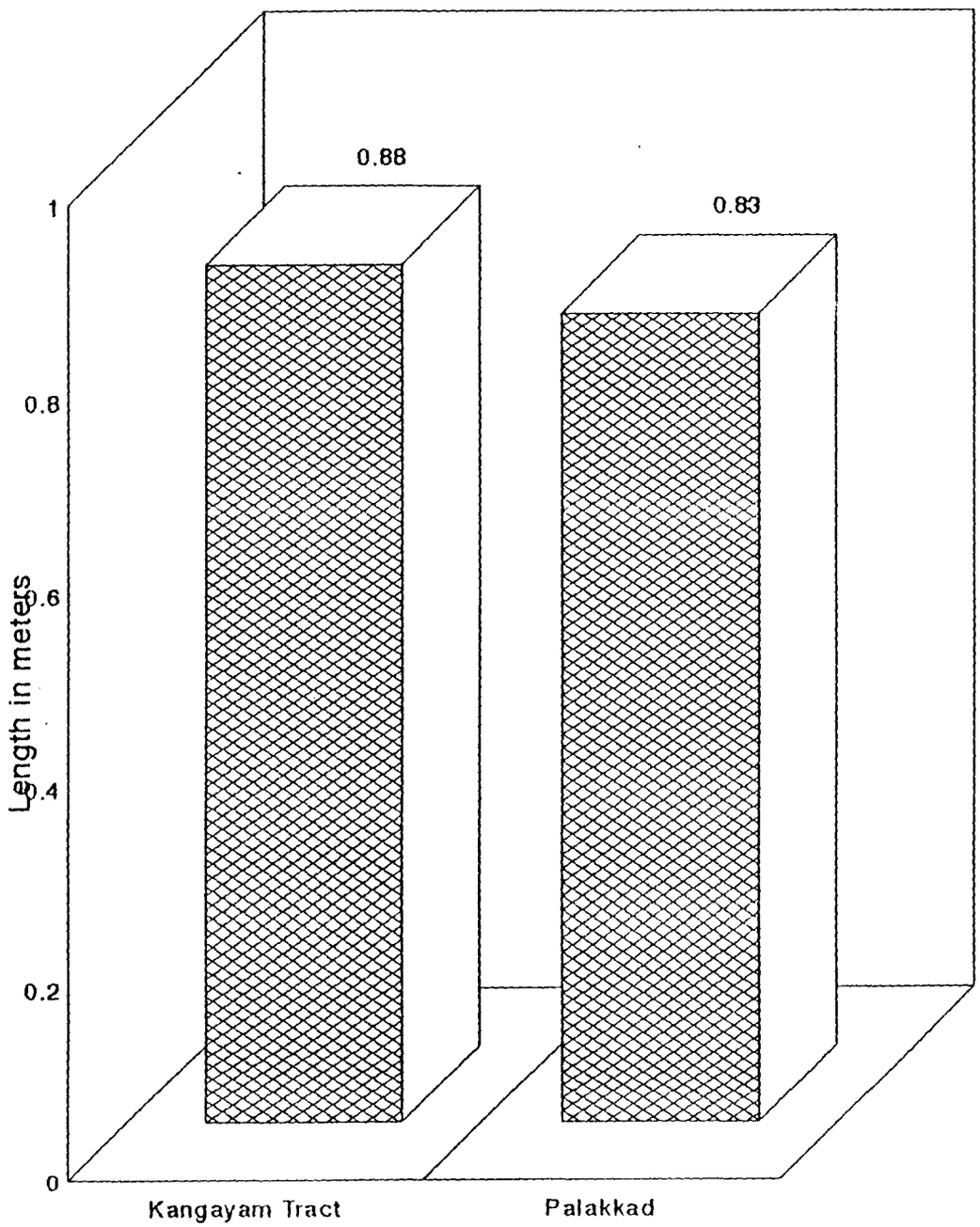


Fig.9 MEAN STRIDE LENGTH OF KANGAYAM BULLOCKS WHILE DRY LAND PLOUGHING



The mean initial speed of walking of bullocks was significantly ($P \leq 0.05$) higher in Kangayam tract when compared to Palakkad area. The final speed (towards the end of 4 hours of work) was however, similar in both the regions.

There has been a significant ($P \leq 0.05$) reduction in the speed of walking from the initial value as a result of 4 hours of work in both the regions. The decline in speed from the initial value was 20.53 per cent in the home tract of Kangayam whereas in the adjoining Palakkad region only 9.89 per cent.

The mean stride length of bullocks in the Kangayam tract and adjoining Palakkad region was 0.88 ± 0.02 m and 0.80 ± 0.01 m respectively (Fig.9). The stride length did not differ significantly between the regions.

4.2.2 Physiological responses

The mean values of respiratory rate, pulse rate and rectal temperature of bullocks immediately before and after work in both the regions are presented in Table 22 and Fig.10, 11 and 12.

Table 22. Physiological responses of bullocks immediately before and after work in the Kangayam tract and Palakkad region

Sl. No.	Parameters	Before work		After work	
		Kangayam tract	Palakkad	Kangayam tract	Palakkad
1.	Respiratory rate (per min)	20.80± 0.99	23.30± 1.09	50.60± 2.76	41.50± 1.82
2.	Pulse rate (per min)	64.40± 1.73	65.80± 2.64	98.20± 1.89	96.90± 1.76
3.	Rectal temperature (C)	38.16± 0.18	38.00± 0.15	39.68± 0.17	39.33± 0.12

In the home tract of Kangayam the mean respiratory rate of bullocks was 20.80 ± 0.99 before work and 50.60 ± 2.76 after work. On the other hand, in the adjoining Palakkad area the mean respiratory rates before and after work were 23.30 ± 1.09 and 41.50 ± 1.82 respectively.

The respiratory rate increased significantly ($P \leq 0.05$) in both the regions as a result of 4 hours of dry-land-ploughing. Between regions, there was no significant difference in the respiratory rate recorded before the start of work, whereas, the respiratory rate towards the end of work was significantly different ($P \leq 0.05$).

Fig.10 EFFECT OF DRY LAND PLOUGHING ON RESPIRATORY RATE IN KANGAYAM BULLOCKS

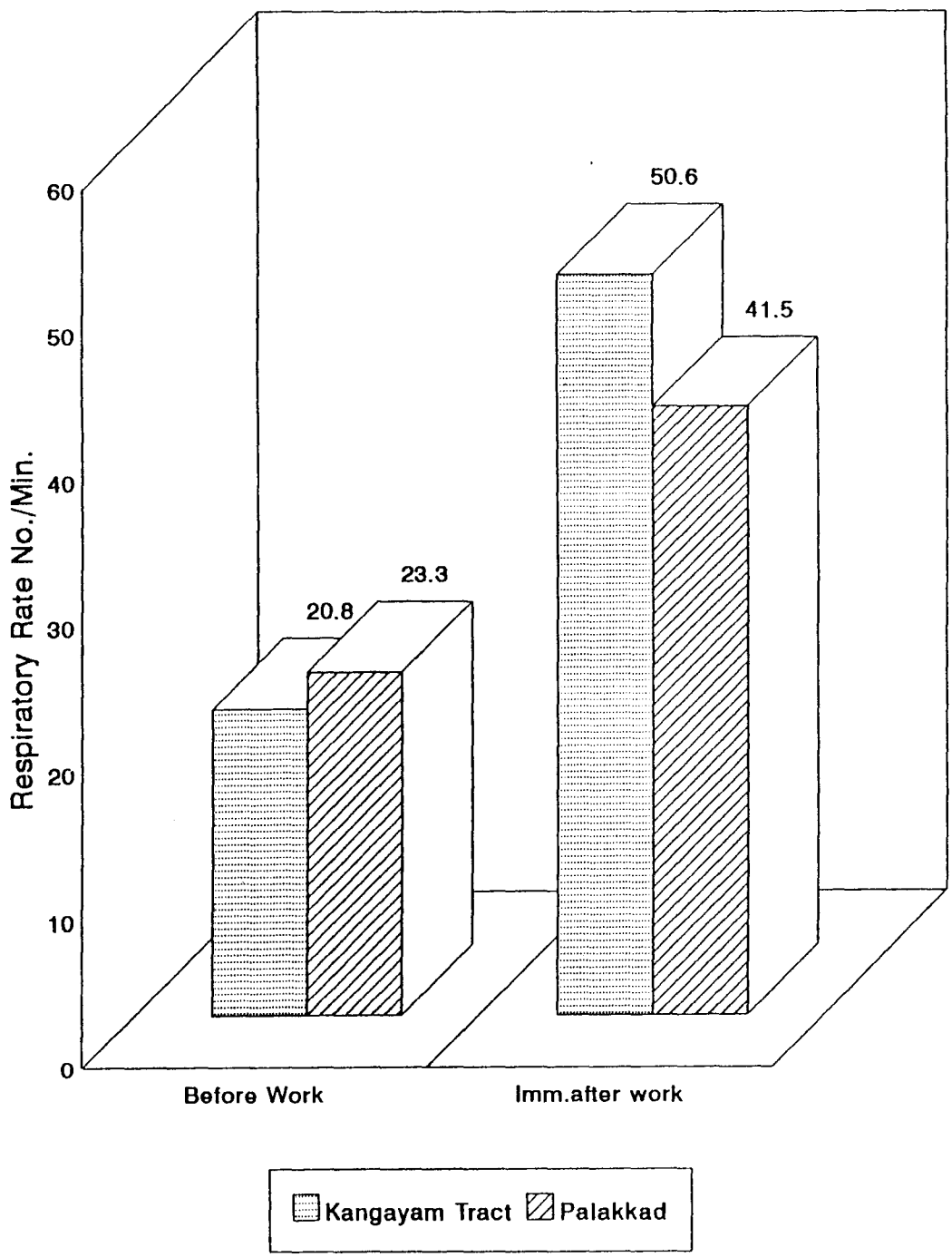


Fig.11 EFFECT OF DRY LAND PLOUGHING ON PULSE RATE IN KANGAYAM BULLOCKS

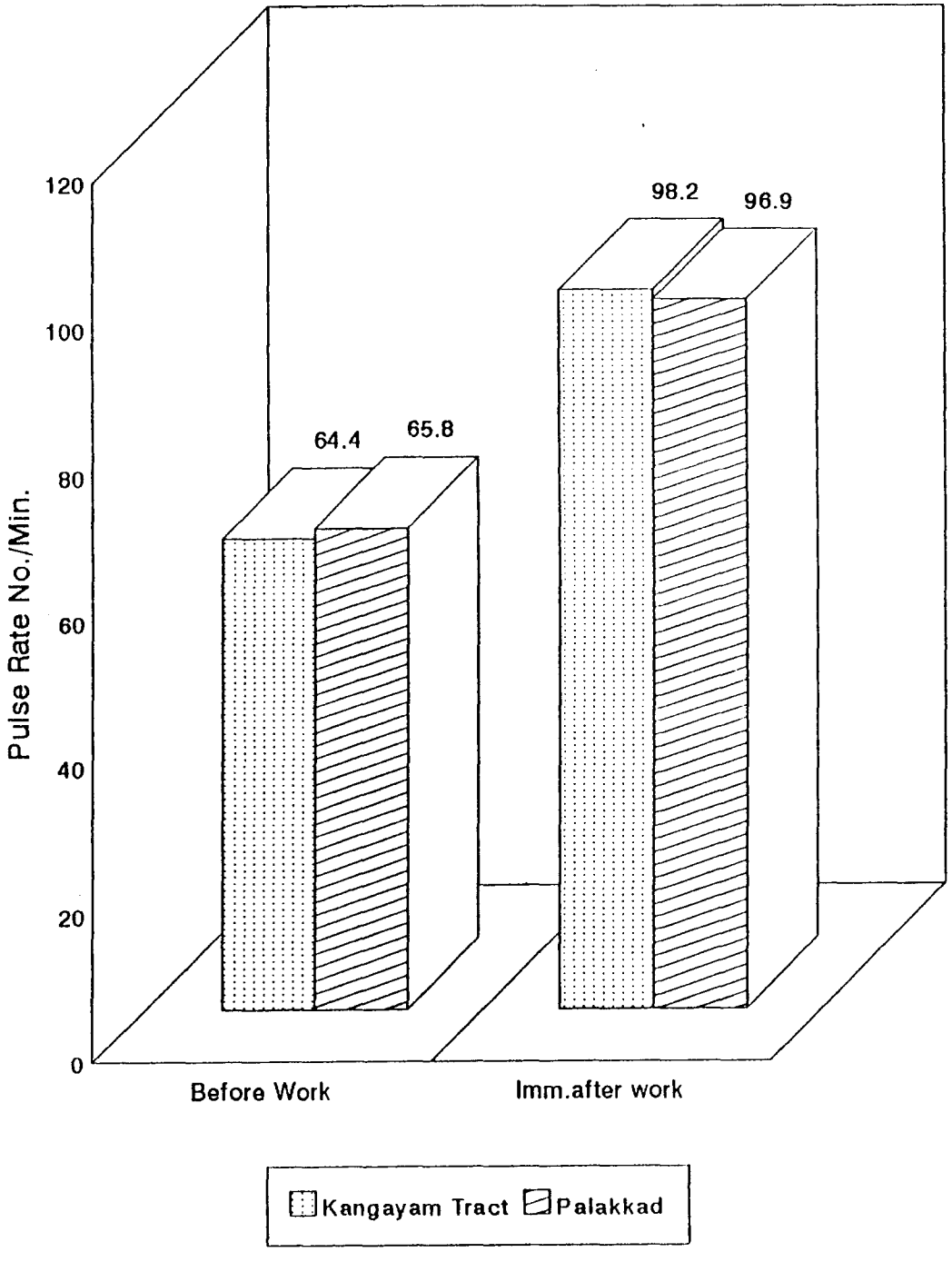
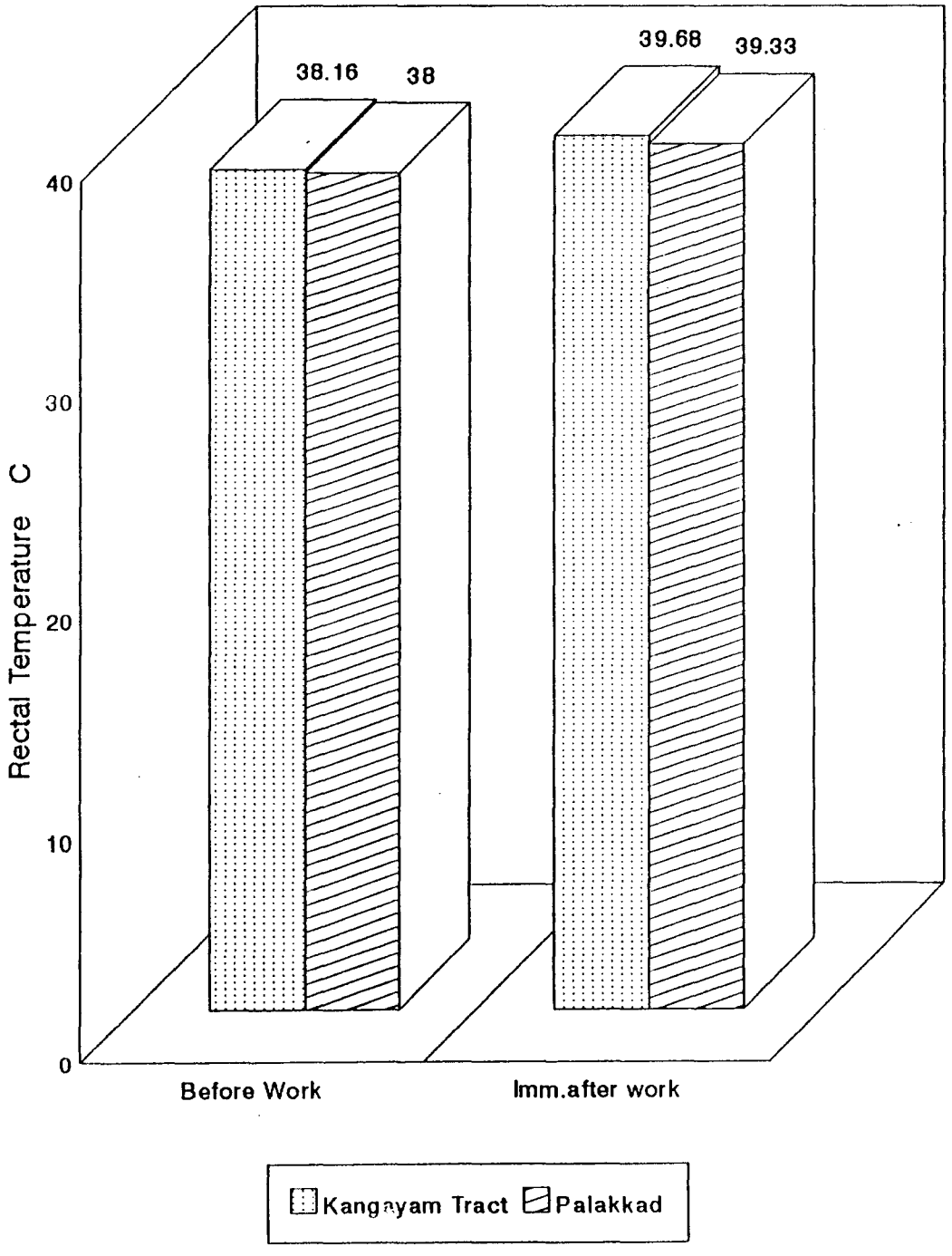


Fig.1,2 EFFECT OF DRY LAND PLOUGHING ON RECTAL TEMPERATURE IN KANGAYAM BULLOCKS



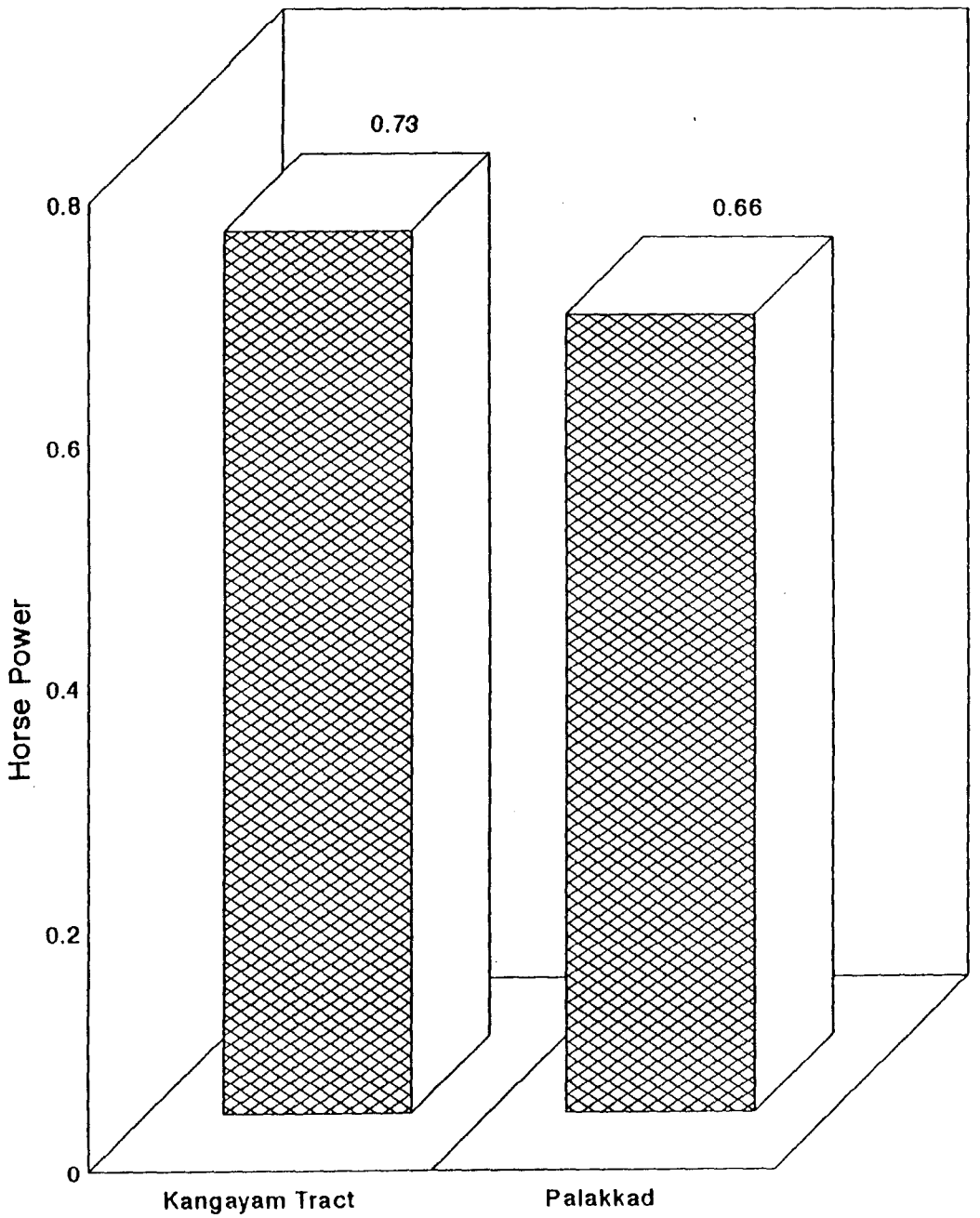
The mean pulse rate of bullocks was 64.40 ± 1.73 before work and 98.20 ± 1.89 immediately after work in the Kangayam tract. For the bullocks in Palakkad area, the mean pulse rate was 65.80 ± 2.64 before work and 96.90 ± 1.76 immediately after work. In both the regions, the pulse rate of bullocks immediately after work was significantly ($P \leq 0.05$) higher than that before start of work. The pulse rate before and after work did not differ significantly between the regions.

Average rectal temperatures of bullocks before and after work were 38.16 ± 0.18°C and 39.68 ± 0.17°C respectively in the Kangayam tract. In the adjoining Palakkad region the corresponding values were 38.00 ± 0.15°C and 39.33 ± 0.12°C respectively. There had been a significant ($P \leq 0.05$) increase in the rectal temperature of the bullocks in both the regions as a result of work. The rectal temperature before and after work were not significantly ($P \leq 0.05$) different between the regions.

4.2.3 Draughtability

In the home tract of Kangayam, the mean horse power generated by a pair of bullocks was 0.73 ± 0.06 and in the adjoining region of Palakkad it was 0.66 ± 0.03 (Fig.13). The horse power developed by the bullocks did not differ significantly at 5 per cent level between the two regions.

Fig.13 MEAN HORSE POWER OF KANGAYAM BULLOCKS WHILE DRY LAND PLOUGHING



4.3 Morphological characteristics and body measurements of Kangayam cattle

The Kangayam cattle is also called as 'Kongu' and Kanganad' in their home tract. The morphological characteristics of Kangayam bullocks in its home tract and in adjoining Palakkad region of Kerala documented by following the general procedure laid out by F.A.O. (1986) with suitable modifications, is presented in Table 23.

All the animals observed in the home tract of Kangayam and adjoining Palakkad region had short, straight and glossy hair coat. The coat colour in majority of the animals in the home tract (92.38%) and in adjoining Palakkad region (91.6%) was grey with a black patch on their knees and in front of fetlocks. Other shades like light fawn, dark fawn, full black and full white were very less in frequency.

The skin colour of all the animals in the two regions was black. The colour of the muzzle was black in both the regions except for one animal each in Kangayam tract and in adjoining Palakkad in which it was brown. The animal which had full white coat colour had brown coloured muzzle and brown coloured tail switch.

The colour of the eyelid was grey in majority of the animals in Kangayam tract (92.38%) and in adjoining Palakkad

Table 23. Description of morphological characteristics of Kangayam bullocks

Sl. No.	Characteristics/Type		Kangayam tract		Palakkad	
			n	%	n	%
1.	Hair					
	a. Length	Short	105	100	119	100
	b. Sheen	Glossy	105	100	119	100
	c. Curl	Straight	105	100	119	100
2.	Coat colour					
	a. Grey + a black patch on the knees and in front of the fetlocks		97	92.38	109	91.59
	b. Light Fawn		1	0.95	4	3.36
	c. Dark Fawn		5	4.76	4	3.36
	d. Black		1	0.95	1	0.84
	e. White		1	0.95	1	0.84
3.	Skin colour					
	a. Black		105	100	119	100
4.	Muzzle colour					
	a. Black		104	99.04	118	99.16
	b. Brown		1	0.95	1	0.84
5.	Eyelid colour					
	a. Grey		97	92.38	109	91.59
	b. Light Fawn		1	0.95	4	3.36

Contd.

Table 23 (Contd.)

c. Dark Fawn	5	4.76	4	3.36
d. Black	1	0.95	1	0.84
e. White	1	0.95	1	0.84
6. Colour of tail switch				
a. Black	104	99.04	118	99.16
b. Brown	1	0.95	1	0.84
7. Hoof colour				
a. Black	105	100	119	100
8. Horn colour				
a. Black	64	60.95	55	46.22
b. Woodish brown	41	39.04	64	53.78
9. Head profile				
a. Almost straight with slight depression on the forehead	105	100	119	100
10. Horn presence				
a. Present	105	100	119	100
11. Orientation of horns				
a. Lateral pointing tips	-	-	1	0.84
b. Inward pointing tips	52	49.52	82	68.90
c. Upward pointing tips	37	35.24	9	7.56
d. Backward pointing tips	10	9.52	18	15.13
e. Forward pointing tips	6	5.71	9	7.56

Contd.

Table 23 (Contd.)

12. Horn attachment				
a. Tight	105	100	119	100
13. Ears				
a. Horizontal	105	100	119	100
14. Hump				
a. Large	4	3.81	7	5.88
b. Medium	101	96.19	112	94.12
15. Croup				
a. Slightly sloping	105	100	119	100
16. Dewlap				
a. Large	4	3.81	2	1.68
b. Medium	101	96.19	117	98.32
17. Navel flap				
a. Small	105	100	119	100
18. Penis sheath				
a. Small	101	96.19	117	98.32
b. Medium	4	3.81	2	1.68

(91.6%). Other shades like light fawn, dark fawn, black and white were very limited as in the case of coat colour. The colour of the switch of the tail was black in majority of the animals in both the regions.

The colour of the hoof was black in all the animals observed in the region. All the animals in both the regions possessed horns. The colour of the horn was black in 60.95 per cent of the animals in the Kangayam tract and 46.22 per cent of the animals in the Palakkad region. Woodish coloured horns were observed in 39.04 per cent animals in Kangayam tract and 53.78 per cent of the animals in adjoining Palakkad region. Horns with inward pointing tips was seen in majority of the animals in Kangayam tract (49.52%) and in adjoining Palakkad region (68.9%). Upward pointing horn tips, backward pointing horn tips and forward pointing horn tips were also observed at various proportions in both the regions. The attachment of the horns was tight in all the animals observed.

The profile of the head was almost straight with a slight depression on the forehead in all the animals in both the regions. The orientation of ears were horizontal in all the animals observed in both the regions.

Majority of the animals in the home tract of Kangayam (96.19%) and in adjoining Palakkad region (94.12%) had a medium sized hump. Only 3.81 per cent of the animals in Kangayam

tract and 5.88 per cent in the adjoining Palakkad region had large humps.

The dewlap was of medium size in majority of the animals in the Kangayam tract (96.19%) and in adjoining Palakkad region (98.32%). All the animals observed in both the regions had a small navel flap. The penis sheath in majority of the animals in Kangayam tract (96.19%) and in adjoining Palakkad region (98.32%) was small in size. A small proportion of bullocks (3.81 per cent in Kangayam tract and 1.68 per cent in Palakkad region) had medium sized sheath.

The body measurements of different age groups of Kangayam bullocks in both the regions in terms of horn length, horn circumference, length of face, length of ear, height at withers, body length, chest girth, length of forelimb, length of hind limb, length of tail and length of switch are presented in Tables 24, 24a and 24b.

The morphological characteristics and body measurements of adult Kangayam cows in their home tract are given in Tables 25 and 26 respectively.

It is evident from Table 25 that all the Kangayam cows studied in their home tract had short, glossy and straight hair coat. The coat colour in majority of the cows (93.33%) was grey. The skin colour was black. All the cows had a black

coloured muzzle. All the cows studied had eye lids according to their coat colour. Colour of the tail switch and hoof were black in all the cows studied. Sixty per cent of the Kangayam cows had black coloured horns and the rest had woodish brown coloured horns. All the cows studied had the head profile almost straight with slight depression on the forehead. All the cows studied had tight horns with inward pointing tips.

All the cows studied also had horizontal ears, medium sized hump, slightly sloping croup, medium sized dewlap and small navel flap. All the Kangayam cows studied possessed a bowl shaped udder with cylindrical teats.

Young Kangayam bullocks of 1-2 years of age were having a mean horn length of 29.60 $\pm$ 1.21 cm in Kangayam tract and 31.80 $\pm$ 0.65 cm in Palakkad region, difference being non-significant. The mean circumference of the horn also did not vary significantly between the bullockss in the two regions; it being 24.20 $\pm$ 0.49 cm in Kangayam tract and 25.30 $\pm$ 0.50 cm in adjoining Palakkad region.

Face length was 41.20 $\pm$ 0.44 cm in Kangayam tract and 40.80 $\pm$ 1.10 cm in adjoining Palakkad region, the difference being non-significant. Ear length of young bullocks was 22.20 $\pm$ 0.17 cm in Kangayam tract and 20.50 $\pm$ 0.30 cm in Palakkad region, the difference being significant ($P \leq 0.05$).

Table 24. Body measurements of bullocks - Head region

Sl. No.	Age		Horn length (cm)		Horn circumference(cm)		Face length (cm)		Ear length (cm)	
			Kangayam	Palakkad	Kangayam	Palakkad	Kangayam	Palakkad	Kangayam	Palakkad
1.	>5 years	Mean	62.70± *	58.50± *	32.10±	32.10±	51.90± *	53.00± *	23.30±	23.00±
		S.E	1.50	0.58	0.50	0.26	0.32	0.28	0.13	0.14
		n	46	59	46	59	46	59	46	59
		Range	52-91	52-76	26-40	27-37	48-56	46-57	21-26	20-25
2.	4-5 years	Mean	53.20±	50.90±	28.80±	29.80±	47.30± *	49.30± *	22.80±	22.90±
		S.E	1.03	1.00	0.44	0.57	0.23	0.63	0.18	0.16
		n	18	24	18	24	18	24	18	24
		Range	49-60	41-59	26-33	23-32	46-49	44-54	21-24	21-24
3.	3-4 years	Mean	41.60± *	49.80± *	27.30±	28.70±	43.70± *	48.30± *	21.70± *	22.30± *
		S.E	1.48	0.55	0.37	0.63	0.51	0.24	0.18	0.16
		n	18	24	18	24	18	24	18	24
		Range	37-56	45-56	24-30	24-30	41-46	47-50	20-23	20-23
4.	2-3 years	Mean	31.30± *	37.50± *	24.60± *	28.00± *	42.20± *	45.80± *	20.20±	21.10±
		S.E	0.77	1.45	0.28	0.33	0.23	0.31	0.42	0.21
		n	18	8	18	8	18	8	18	8
		Range	27-37	33-41	24-26	26-30	41-44	44-46	16-23	20-22
5.	1-2 years	Mean	29.60±	31.80±	24.20±	25.30±	41.20±	40.80±	22.20± *	20.50± *
		S.E	1.21	0.65	0.49	0.50	0.44	1.10	0.17	0.30
		n	5	4	5	4	5	4	5	4
		Range	25-32	30-33	23-26	24-26	39-43	39-44	22-23	20-21

* Significant at 5 per cent level

Table 24a. Body measurements of bullocks - Trunk region

Sl. No.	Age		Height at withers (cm)		Body length (cm)		Chest girth (cm)	
			Kangayam	Palakkad	Kangayam	Palakkad	Kangayam	Palakkad
1.	>5 years	Mean	146.28±	146.20±	142.20±	139.80±	182.70±	182.10±
		S.E	0.86	0.83	0.88	1.35	2.07	1.33
		n	46	59	46	59	46	59
		Range	135-158	135-162	132-163	122-165	157-220	151-208
2.	4-5 years	Mean	136.94±	139.21±	134.50±*	138.80±*	174.70±	172.60±
		S.E	0.95	1.62	1.46	1.49	3.21	2.10
		n	18	24	18	24	18	24
		Range	124-143	124-149	127-143	127-142	148-198	156-198
3.	3-4 years	Mean	129.56±*	135.25±*	129.50±	131.30±	172.00±*	165.60±*
		S.E	0.83	1.21	1.18	0.94	1.41	0.71
		n	18	24	18	24	18	24
		Range	123-140	125-143	120-141	124-139	159-169	160-181
4.	2-3 years	Mean	126.89±*	129.13±*	125.20±	126.00±	159.30±	160.80±
		S.E	0.71	0.44	1.13	0.60	2.19	2.38
		n	18	8	18	8	18	8
		Range	120-132	127-131	118-136	123-129	150-168	152-168
5.	1-2 years	Mean	123.40±	128.25±	119.80±	123.50±	147.40±	147.00±
		S.E	1.51	1.65	1.16	1.85	2.02	1.90
		n	5	4	5	4	5	4
		Range	118-127	125-132	117-124	120-128	142-154	142-150

* Significant at 5 per cent level

Table 24b. Body measurements of bullocks - Limbs and tail

Sl. No.	Age		Fore limb (cm)		Hind limb (cm)		Tail length (cm)		Swith (cm)	
			Kangayam	Palakkad	Kangayam	Palakkad	Kangayam	Palakkad	Kangayam	Palakkad
1.	>5 years	Mean	108.20±	106.50±	120.60±*	116.30±*	82.50±*	77.50±*	45.30±*	42.30±*
		S.E	1.03	1.18	0.81	0.82	1.06	0.68	0.69	0.67
		n	46	59	46	59	46	59	46	59
		Range	95-127	93-124	106-130	104-127	71-98	71-90	37-56	36-57
2.	4-5 years	Mean	98.00±	101.00±	107.30±	107.00±	74.40±	73.40±	41.20±*	39.40±*
		S.E	0.89	1.10	0.97	2.29	0.42	1.16	0.35	0.78
		n	18	24	18	24	18	24	18	24
		Range	86-106	90-119	99-111	92-118	72-76	64-87	38-44	32-47
3.	3-4 years	Mean	91.40±*	89.80±*	104.90±	104.30±	73.60±	72.90±	38.10±	37.50±
		S.E	0.54	0.51	0.61	0.24	1.56	1.57	0.73	0.51
		n	18	24	18	24	18	24	18	24
		Range	83-92	85-94	102-110	102-107	66-86	58-80	33-40	30-41
4.	2-3 years	Mean	88.90±	87.30±	102.90±	101.10±	68.30±	66.10±	33.70±	34.80±
		S.E	1.13	1.31	1.58	1.91	1.08	1.45	1.06	1.45
		n	18	8	18	8	18	8	18	8
		Range	82-100	81-91	94-109	94-108	61-77	61-72	25-40	28-39
5.	1-2 years	Mean	86.40±	86.30±	99.20±	98.50±	64.00±	66.00±	31.80±	32.80±
		S.E	1.03	0.25	1.61	1.55	1.52	3.50	1.70	1.70
		n	5	4	5	4	5	4	5	4
		Range	83-89	86-87	94-104	94-101	59-68	60-76	28-36	28-36

* Significant at 5 per cent level

Height at withers was 123.40 ± 1.51 cm in Kangayam tract compared to 128.25 ± 1.65 cm in Palakkad region. The length of the body was 119.80 ± 1.16 cm in Kangayam tract and 123.50 ± 1.85 cm in adjoining Palakkad region. Chest girth was 147.40 ± 2.02 cm in Kangayam tract and 147.00 ± 1.90 cm in adjoining Palakkad region. They were not significantly ($P<0.05$) different.

Forelimb length was 86.40 ± 1.03 cm in Kangayam tract and 86.30 ± 0.25 cm in Palakkad region. Similarly hind limbs of young bullocks measured 99.20 ± 1.61 cm in length in Kangayam tract and 98.50 ± 1.55 cm in Palakkad region. Tail length was 64.00 ± 1.52 cm in Kangayam tract and 66.00 ± 3.50 cm in adjoining Palakkad region. Switch of tail was 31.80 ± 1.70 cm long in Kangayam tract and 32.80 ± 1.70 cm in adjoining Palakkad. All the body measurements of young bullocks with respect to fore limb, hind limb, tail and switch of the tail were not significantly ($P<0.05$) different between the two regions.

At 2-3 years of age, the horn length was 31.30 ± 0.77 cmin Kangayam tract compared to 37.50 ± 1.45 cm in Palakkad region. There was a significant difference ($P\leq0.05$) between the regions. Horn circumference was 24.60 ± 0.28 cm in Kangayam tract as against 28.00 ± 0.33 cm in Palakkad region. The differences were significant ($P\leq0.05$) between the regions.

Face length was 42.20 ± 0.23 cm in Kangayam tract and 45.80 ± 0.31 cm in Palakkad region. T-test revealed a significant difference ($P \leq 0.05$) between the regions. The ear length was 20.20 ± 0.42 cm and 21.10 ± 0.21 cm in Kangayam tract and Palakkad region respectively. There was no significant difference between the regions.

Height at withers was 126.89 ± 0.71 cm in Kangayam tract and 129.13 ± 0.44 cm in Palakkad region, the difference being significant ($P \leq 0.05$). Body length was 125.20 ± 1.13 cm in Kangayam tract and 126.00 ± 0.60 cm in Palakkad region, the difference being non significant. Chest girth was 159.30 ± 2.19 cm in Kangayam tract compared to 160.80 ± 2.38 cm in Palakkad region, the difference being significant ($P < 0.05$).

Forelimb length was 88.90 ± 1.13 cm in Kangayam tract and 87.30 ± 1.31 cm in Palakkad region, the difference being non significant. Hind limb length was 102.90 ± 1.58 cm in Kangayam tract and 101.10 ± 1.91 cm in Palakkad region. Here also the differences were non-significant.

Tail length was 68.30 ± 1.08 cm in Kangayam tract and 66.10 ± 1.45 cm in Palakkad region, the difference being non significant. The length of the switch was 33.70 ± 1.06 cm in Kangayam tract as against 37.50 ± 0.51 cm in Palakkad region, the differences being non significant.

At 3-4 years of age, the length of the horn was 41.60 ± 1.48 cm in Kangayam tract and 49.80 ± 0.55 cm in Palakkad region. A significant difference (≤ 0.05) between the regions was noticed. Horn circumference was 27.30 ± 0.37 cm in Kangayam tract and it was 28.70 ± 0.63 cm in Palakkad region, the differences being non significant.

Face length at this age was 43.70 ± 0.51 cm in Kangayam tract and 48.30 ± 0.24 cm in Palakkad region. There was a significant difference ($P \leq 0.05$) between the regions.

Ear length was 21.70 ± 0.18 cm in Kangayam tract and 22.3 ± 0.16 cm in Palakkad region. A significant difference ($P \leq 0.05$) between the regions was observed.

Height at withers for the age group was 129.56 ± 0.83 cm in Kangayam tract and 135.25 ± 1.21 cm in Palakkad region.The differences were found to be significant at 5 per cent level. Length of the body was 129.50 ± 1.18 cm in Kangayam tract and 131.30 ± 0.94 cm in Palakkad region the difference being non significant. On the other hand, chest-girth in bullocks of this age group in the Kangayam tract (172.00 ± 1.41 cm) was significantly ($P<0.05$) larger than their counterparts in the Palakkad region (165.60 ± 0.71 cm).

Length of forelimb was 91.40 ± 0.54 cm in Kangayam tract and 89.80 ± 0.51 cm in Palakkad region. A significant

difference ($P \leq 0.05$) between the regions was observed. Hind limb length was 104.90 ± 0.61 cm and 104.30 ± 0.24 cm in Kangayam tract and Palakkad region respectively. There was no significant difference between the regions.

The length of the tail was 73.60 ± 1.56 cm and 72.90 ± 1.57 cm in Kangayam tract and Palakkad region respectively, the difference being non significant. The length of the switch also did not vary significantly between the two regions, it being 38.10 ± 0.73 cm in Kangayam tract and 37.50 ± 0.51 cm in Palakkad region.

At 4-5 years of age, the length of the horn was 53.20 ± 1.03 cm in Kangayam tract and 50.90 ± 1.00 cm in Palakkad region, the difference being not significant at 5 per cent level. Horn circumference in this age group was 28.80 ± 0.44 cm in Kangayam tract and 29.80 ± 0.57 cm in Palakkad region, the difference being non significant.

Length of face was 47.30 ± 0.23 cm and 49.30 ± 0.63 cm in Kangayam tract and Palakkad region respectively; the difference being significant ($P \leq 0.05$). On the other hand, the length of the ear did not vary significantly between Kangayam (22.80 ± 0.18 cm) and Palakkad (22.90 ± 0.16 cm) region.

In this age group, the height at withers was 136.94 ± 0.95 cm and 139.21 ± 1.62 cm in Kangayam tract and Palakkad

region respectively, the difference being non significant. Length of body was 134.50 ± 1.46 cm and 138.80 ± 1.49 cm in Kangayam tract and Palakkad region. Analysis revealed a significant difference ($P \leq 0.05$) between the regions. Chest girth was 174.70 ± 3.21 cm and 172.60 ± 2.10 cm in Kangayam tract and Palakkad region respectively, the difference being non significant.

The length of the forelimb was 98.00 ± 0.89 cm in Kangayam tract and 101.00 ± 1.10 cm in Palakkad region. The length of the hind limb was 107.30 ± 0.97 cms in Kangayam tract and 107.00 ± 2.29 cms in Palakkad region. The length of the tail was 74.40 ± 0.42 cm in Kangayam tract and 73.40 ± 1.16 cm in Palakkad region. In all the three measurements no significant differences between bullocks of the two regions were seen. However, there was a significant difference ($P \leq 0.05$) between the regions with respect to length of tail-switch, the average switch length being 41.20 ± 0.35 cm in Kangayam tract and 39.40 ± 0.78 cm in Palakkad region.

Above 5 years of age, the horn length was 62.70 ± 1.50 cm and 58.50 ± 0.58 cm in Kangayam tract and Palakkad region. Analysis revealed a significant difference ($P \leq 0.05$) between the regions. The circumference of the horn, however, did not reveal any significant difference due to regions.

The face of Kangayam bullocks above 5 years in Palakkad region (53.0 ± 0.28 cm) was significantly (P<0.05) longer than those in the Kangayam region (51.90 ± 0.32 cm). At this [illegible] significant difference in ear length of animals of the two regions could be found.

Height at withers of bullocks above 5 years was 146.28 ± 0.86 cm and 146.20 ± 0.83 cm in Kangayam tract and Palakkad region respectively. The corresponding length of the body was 142.20 ± 0.88 cm and 139.80 ± 1.35 cm, chest girth 182.70 ± 2.07 cm and 182.10 ± 1.33 cm and the length of forelimb 108.20 ± 1.03 cm and 106.50 ± 1.18 cm. None of these four body dimensions revealed any significant differences between regions.

The length of the hind limb was 120.60 ± 0.81 cm in Kangayam tract and 116.30 ± 0.82 cm in Palakkad region.The difference ($P \leq 0.05$) between the regions was significant at 5 per cent level. Similarly the tails of above 5-year bullocks in Kangayam tract (82.50 ± 1.06 cm) were significantly ($P \leq 0.05$) longer than their counterparts in Palakkad region (77.50 ± 0.68 cm). The length of the switch was also significantly (P<0.05) more in the Kangayam tract (45.30 ± 0.69 cm) compared to Palakkad region (42.30 cm).

Table 26 presents the body measurements of adult Kangayam cows belonging to the Kangayam tract only. In the

present study, the length of the face was 45.06 ± 0.30 cm with a range of 43 cm to 47 cm and the ear length 23.06 ± 0.37 cm with a range of 21 cm to 25 cm.

Horn length ranged between 27 cm and 53 cm with a mean of 41.66 ± 2.09 cm. The circumference of the horn ranged between 16 cm and 26 cm with a mean of 22.06 ± 0.70 cm.

The height at withers of adult Kangayam cows was 128.46 ± 1.01 cm with a range of 122 cm to 135 cm; length 127.13 ± 1.78 cm with a range between 121 cm and 148 cm and chest girth 173.86 ± 3.37 cm ranging between 146 cm and 190 cm.

The length of the fore limb was 92.26 ± 1.85 cm with a range of 79 cm to 101 cm, the length of the hind limb 105.60 ± 1.68 cm ranging from 99 to 120 cm, the tail length 81.80 ± 1.86 cm and length of the switch 39.60 ± 1.29 cm in adult Kangayam cows.

Table 25. Description of morphological characteristics of Kangayam cows in their home tract

Sl. No.	Characteristics/Type		n	%
1.	Hair			
	a. Length	Short	15	100
	b. Sheen	Glossy	15	100
	c. Curl	Straight	15	100
2.	Coat colour			
	a. Grey + a black patch on the knees and in front of the fetlocks		14	93.33
	b. Black		1	6.66
3.	Skin colour			
	a. Black		15	100
4.	Muzzle colour			
	a. Black		15	100
5.	Eyelid colour			
	a. Grey		14	93.33
	b. Black		1	6.66
6.	Colour of tail switch			
	a. Black		15	100
7.	Hoof colour			
	a. Black		15	100
8.	Horn colour			
	a. Black		9	60.00
	b. Woodish brown		6	40.00

9. Head profile		
a. Almost straight with slight depression on the forehead	15	100
10. Horn presence		
a. Present	15	100
11. Orientation of horns		
a. Inward pointing tips	15	100
12. Horn attachment		
a. Tight	15	100
13. Ears		
a. Horizontal	15	100
14. Hump		
a. Medium	15	100
15. Croup		
a. Slightly sloping	15	100
16. Dewlap		
a. Medium	15	100
17. Navel flap		
a. Small	15	100
18. Udder shape		
a. Bowl	15	100
19. Teat shape		
a. Cylindrical	15	100

Table 26. Body measurements of adult Kangayam cow

Sl. No.	Item	Measurements (cm)			
		Mean	S.E	n	Range
1.	Face length	45.06	± 0.30	15	43-47
2.	Ear length	23.06	± 0.37	15	21-25
3.	Horn length	41.66	± 2.09	15	27-53
4.	Horn circumference	22.06	± 0.70	15	16-26
5.	Height at withers	128.46	± 1.01	15	122-135
6.	Body length	127.13	± 1.78	15	121-148
7.	Chest girth	173.86	± 3.37	15	146-190
8.	Fore limb	92.26	± 1.85	15	79-101
9.	Hind limb	105.60	± 1.68	15	99-120
10.	Tail length	81.80	± 1.86	15	68-90
11.	Switch length	39.60	± 1.29	15	33-51

Discussion

5. DISCUSSION

5.1 Management practices

5.1.1 Meteorological information

Meteorological data of Kangayam tract and adjoining Palakkad region during the study period has been presented in Table 2 and Fig.1, 2, 3 and 4. Work performance was carried out during relatively hot months of January to April when there was scanty rainfall and relatively low humidity. As the rainfall was nil or negligible during the months, the cloud cover was also less. Thus, the bullocks were under heat stress due to high ambient temperature and solar radiation from a relatively clear sky. Lower relative humidity during the period of work performance might have aided heat dissipation through the evaporative channel. Cattle, which have got greater capacity to mobilize endo-somatic water might have benefited from this under ploughing conditions.

5.1.2 Land and livestock holdings of farmers

It is evident from Table 3 and Fig.5 that the land holding size of farmers in the Kangayam tract was comparatively larger than the farmers of adjoining Palakkad region of Kerala.

Majority of the farmers in the Kangayam tract had a land holding size of above 4 ha. On the other hand, only 20 per cent of the farmers in Palakkad region had a similar holding size. It was seen that in the Palakkad region of Kerala small sized farms measuring less than 2 ha predominated. George and Nair (1990) observed that as human population pressure on land increased, the size of land holdings tended to decline in Kerala.

The types of livestock kept in 55 bullocks-keeping homesteads in the home tract of Kangayam and adjoining Palakkad have been depicted in Table 4. It is evident that in the bullock keeping homesteads, adult female cattle came next in number followed by adult female buffaloes, goats and sheep in that order. The variation in the type and proportion of different species and classes of livestock kept in the two regions varied mainly due to climate, holding size and economic reasons. George and Nair (1990) reported that average size of land holdings by and large influenced the types of livestock kept by the farmers.

5.1.3 Implements and accessories possessed by the bullock-keeping households

All the bullock owning farmers in the Kangayam tract and 94.5 per cent in the adjoining Palakkad region possessed indigenous ploughs (Table 5). One farmer in Palakkad possessed improved plough and two farmers did not possess any plough. As

Plate 3. A pair of Kangayam bullocks hitched to a typical country cart used by farmers for transportation of agricultural products, dung and fertilizers etc.

Plate 4. Kangayam bullocks drawing a typical local type cart in the Kerala region used for commercial transportation

far as cart is concerned, majority of the farmers in Kangayam tract (81.82%) and Palakkad region (96.36%) owned indigenous carts. Very few farmers in both regions possessed improved carts. However, the proportion of farmers owning improved carts was higher in Kangayam tract of Tamil Nadu (16.36%) compared to adjoining Palakkad region of Kerala (1.82%). The farmers possessing improved carts were the comparatively rich farmers with larger land holdings as they only could afford the more expensive improved carts. One of the reasons for lower proportion of farmers owning improved carts in Palakkad region might be the lower proportion of farmers with large holdings.

The farmer, his bullocks and agricultural implements (ploughs) and carts formed important components of the draught animal sub-system (Sreekumar, 1993). In a similar study on draught animal farming systems of Kerala it has been found that majority of the farmers in different parts of Kerala possessed indigenous ploughs. Also majority of the farmers in Kerala possessed indigenous carts. It has been stated that farmers preferred indigenous carts to improved ones because of the low cost. The same reason could be attributed to the farmer's preference towards indigenous ploughs to improved ploughs.

The result also indicate the lack of awareness on the part of farmers especially in the Palakkad region with regard to

the benefits of using improved implements and carts. More of technology transfer in this area through concerted extension activities is necessary.

5.1.4 Farmers preference with respect to duration of keeping bullocks

It is evident from Table 6 and Fig.6 that majority of the farmers in Kangayam tract (85.45%) and in adjoining Palakkad region (80%) preferred to keep the bullocks throughout the year. In a similar study on farming systems involving draught animals in the plain and high ranges of Kerala, Sreekumar (1993) observed that majority of the farmers in both the regions preferred to keep their bullocks round the year eventhough the bullocks were idle for a major part of the year.

The reasons stated included:

a. Requirement of manure to be recycled to the field,

b. Lack of availability of good quality of animals during peak ploughing season,

c. Sale/disposal immediately after the peak season did not fetch remunerative price,

d. High cost of animals at the onset of work season because of more demand and

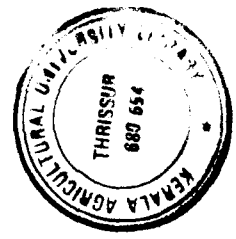
f. Limited scope of hiring during the peak season as bullocks are heavily utilized during the season.

The above said reasons for preferring to keep bullocks round the year in the homesteads of Kerala might equally apply to the regions of the present study also.

5.1.5 Source of obtaining bullocks

It is evident from Table 7 and Fig.7 that majority of the farmers studied (50.91%) purchased bullocks from markets (Shandies/cattle fairs) in both the regions. Very few farmers only raised their own replacements of bullocks in both the regions. Similar observations were made by Sreekumar and Reddy (1994) in Kerala.

The mean cost of a pair of Kangayam bullocks was Rs.10,927 $\pm$ 282.91 in their home tract and Rs.7,855 $\pm$ 238.78 in adjoining Palakkad region. Sreekumar and Reddy (1994) in a study reported that the average price of a pair of bullocks varied with the type of animal and region.



Maximum number of farmers in the Kangayam tract (18.18%) purchased their bullocks at 2.5 years of age and majority of the farmers in adjoining Palakkad region(29.09%) purchased their bullocks at 6 years of age. It was seen that the farmers of Palakkad region generally purchased older bullocks having some work experience. This might be because of the fact that the farmers of Palakkad purchased their bullocks from markets/shandies of bordering Tamil Nadu. Also the source of procurement might be the animals transported to Palakkad after putting 1-2 years of work in their native tract. Such animals were cheaper also.

5.1.6 Training

Majority of the farmers in both Kangayam tract (81.82%) and in adjoining Palakkad region (83.64%) purchased trained bullocks. The proportion of farmers who procured untrained young bulls or bullocks and later imparted training was 18.18 per cent in Kangayam tract and 16.36 per cent in adjoining Palakkad region. Training was imparted at around 2-3 years of age in both the regions. Similar observations were reported by Pattabhiraman (1958) in the home tract of Kangayam; Williamson and Payne (1978) in South and South East Asia and Sreekumar (1993) in Kerala. On the other hand, FAO (1972) reported that the suitable age for training bullocks was 3.5-4 years.

The age at which cattle are fit to commence work depends upon their weight which in turn depends upon the breed, climatic environment, management and feeding during growth and freedom from diseases and parasites. Cattle selected for work purposes are handled from an early age which makes control and training easier. In the beginning they are used for light work. The main reason for imparting training at an earlier age is that by the time the animal has attained mature size, it can be fully used for work, thus, in effect extending the period of utilization of the animal.

5.1.7 Selection criteria

It is evident from Table 8 that the qualities and attributes considered important in selection of bullocks did not differ between the two regions under study. The different attributes considered by farmers in selecting bullocks were physical appearance, physical appearance + whirling pattern of hair, physical appearance + temperament and physical appearance + whirling pattern of hair + temperament. Majority of the farmers in both the regions considered physical appearance + whirling pattern of hair as important attributes in selecting their bullocks. In an earlier study Sreekumar (1993) also reported similar trends among farmers in selecting their bullocks in Kerala.

Farmers considered various traits under the physical appearance and believed that they have a close association with their work performance. The important among these were well sprung strong ribs, a straight forehead and smooth curving even horns with hard horn base. Horn conformation is important for a good work-animal as the horns frequently comes in contact with yoke. A horn with light horn base may predispose to horn fracture. Farmers looked for bright and bulging eyes, broad nostrils and pinkish tongue while selecting their bullocks. Bright and bulging eyes are considered to be signs of active and alert disposition. Broad nostrils enable the animals at work to have more respiratory volume of oxygen. Pinkish tongue is an indication for the animal not being anaemic. Further, farmers while selecting the bullocks felt that if the tongue is very warm, animal may be suffering from febrile conditions and rejected such bullocks. They suspected such a condition as an early symptom of foot and mouth or similar diseases.

Other physical attributes that were looked by the farmers while selecting bullocks were thin and medium sized dewlap. Farmers felt that a large and thick dewlap will be heavier and its swinging when the animal is in action will be a discomfort for the animal, hence the animal will get fatigued soon. However, such a hypothesis has never been tested through experimentation.

Apart from this, farmers looked for straight and strong limbs with short dewclaws. Overgrown dewclaws and limbs brushing each other while walking cause discomfort for the bullocks when they are in action.

Farmers of both the regions studied did not consider temperament as a major criteria of selection. Similar observation was reported by Sreekumar (1993). On the other hand, Chantalakhana (1981) reported that majority of the farmers in Tailand considered temperament as an important attribute for selecting work buffaloes. The reason for not considering temperament as a main criteria for selection could be attributed to the fact that most of the bullocks purchased were already trained and in general docile/moderately tractable due to the regular contact with farmers.

5.1.8 Castration

Majority of the farmers (83.64%) in both the regions purchased bullocks that were already castrated. Only 16.36 per cent of the farmers in both the regions procured entire bulls and later on castrated them. Trimming of ears was also performed as the farmers believed that this would give an alert appearance to the bullocks. In this study the age at which farmers castrated their animals varied from 2-2.5 years in the Kangayam tract and 1.5-2.5 years in adjoining Palakkad region.

Littlewood (1936) reported that Kangayam bulls were castrated at 3 years of age, whereas Pattabhiraman (1958) reported that it was performed at 2 years of age. On the other hand FAO (1972) reported that work cattle could be castrated at an age of 18 to 24 months and that it should be performed shortly before the rainy season.

5.1.9 Feeding management

It is evident from Table 11 that the staple diet of majority of the Kangayam cattle in their home tract is sorghum straw and that of adjoining Palakkad region, paddy straw. Existence of similar paddy straw based feeding system was reported by Chantalakhana (1981) in South-east Asian countries, Gincy et al. (1988), George and Nair (1990) and Sreekumar (1993) in Kerala and Reddy et al. (1994) in Kerala and Karnataka.

In some localised areas in the home tract of Kangayam, they were grazed on pasture lands of 'Kolukattai grass' (Cenchrus ciliaris). This is a tropical/sub-tropical species of indigenous perennial rhizomatous grass found in the medium rainfall regions of semi arid-plains of North and South India.

Narayanan and Dabadghao (1972) reported that a system similar to the ley farming in England is prevalent in the Kangayam tract with Cenchrus ciliaris as the pasture grass.

Once in 3 or 4 years the land is given a light ploughing and sorghum is sown. After this is harvested the land is left fallow when the local grass makes luxuriant growth and serve as pasture for the Kangayam cattle of this tract. Similar pattern has been documented by Gunn (1909), Littlewood (1936) and Pattabhiraman (1958).

In Palakkad region of Kerala, bullocks were mostly grazed in fallow paddy fields, bunds etc. as extensive pasture lands as is present in the Kangayam tract are not available in this region.

It is evident from Table 12 that rice bran forms the major concentrate feed ingredient followed by cotton seed and groundnut cake. Similar system of feeding bullocks in which rice-bran formed a main concentrate ingredient has been reported in two different agro ecological regions of Kerala state by Sreekumar (1993). Rice-bran is the cheapest and easily available feed ingredient. Hence it forms a major concentrate feed ingredient.

From Table 14 it is evident that majority of the farmers in both the regions watered their bullocks three times a day during work season. On the other hand, majority of the farmer in

Plate 5. A thatched unpaved independent cattle shed used for housing Kangayam bullocks and other bovine livestock

Plate 6. A tiled independent cattle shed used for housing Kangayam bullocks and other livestock

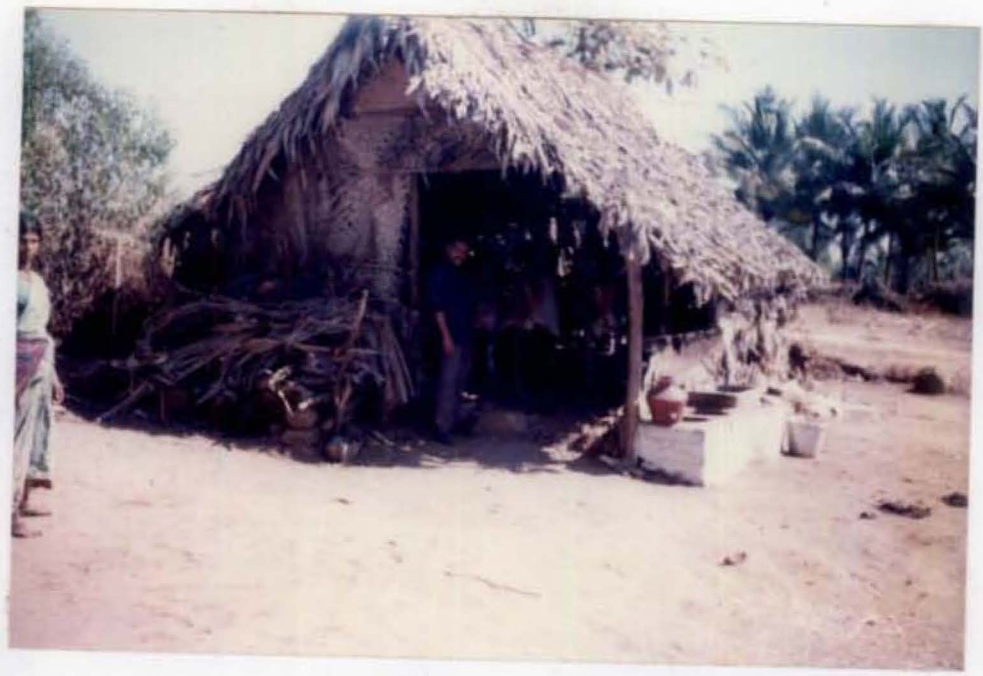


Plate 7. A typical scene from a cattle market selling Kangayam bullocks (Pollachi shandy)

Plate 8. A country method of castrating young bulls. The testicle are held between two sticks and then crushed with stone which is rather painful and cruel

Kangayam tract (60%) offered water 2 times a day and in adjoining Palakkad (47.27%) only once a day during rest period. This may be due to the farmers belief that water intake is increased as a result of work.

5.1.10 Housing

Majority of the farmers in the home tract of Kangayam and in adjoining Palakkad provided independent housing. Such houses were mostly "Kutcha" type made with locally available materials. Farmers who provided 'pucca' type of housing to their bullocks were less in both the regions. Similar system of providing simple houses to bullocks with locally available materials has been reported by FAO (1972) in Africa, Kumar and Sastry (1989) in Haryana and Sreekumar (1993) in Kerala. Also, it was observed that some farmers did not provide any housing to their bullocks in the home tract of Kangayam. Instead, during the months of April to August, when heavy wind is prevalent they put up some sort of wind screens and the animals were kept behind the screen. A similar pattern of housing has been described by Gunn (1909) and Littlewood (1936) in the home tract of Kangayam.

5.1.11 Washing

Majority of the farmers in the home tract of Kangayam washed their bullocks as per convenience whereas in adjoining Palakkad region they washed weekly once and also after every wet-land ploughing. This is in agreement with FAO (1972) regarding hygiene of draught cattle.

In Palakkad bullocks were used for wetland ploughing in contrast to that in Kangayam tract where dryland ploughing is more common. This pattern of utilization has necessitated frequent washing of bullocks in Palakkad region as compared to that of Kangayam tract. Further, the availability of water sources like ponds, lakes etc. in Palakkad region enabled the farmers to wash their bullocks more frequently than in the Kangayam tract where such water sources are lacking.

5.1.12 Shoeing

It is evident from Table 16 that majority of farmers in both the regions shoed their bullocks. Most of the farmers studied in the home tract of Kangayam (54.90%) and in adjoining Palakkad region (35.85%) shoed their bullocks at an interval of 31 to 60 days. Necessity of shoeing depends on working surface and terrain. Bullocks ploughing dry fields and those used for professional carting need more frequent replacement of shoes.

Frequency of shoeing also depends on the quality of shoeing material and skill of the craftsman applying it. Bullocks used only for ploughing are not generally shoed.

5.1.13 Health care

The common health problems of bullocks as reported by the farmers in both the regions studied were in agreement with the reports of common ailments of bullocks by Starkey (1985); Partoutoma et al. (1985); Gulati et al. (1988) and Sreekumar (1993). It is evident from Table 17 that 60 per cent of the farmers in the home tract of Kangayam and 63.64 per cent of farmers in adjoining Palakkad region got their bullocks vaccinated against various diseases like Foot and Mouth disease, Rinderpest, Black quarter and Haemorrhagic septicaemia. Gulati et al. (1988) reported that 64 per cent bullocks were vaccinated against H.S. and FMD in Haryana and Reddy et al. (1994) reported that only 30 per cent of the farmers studied got their bullocks vaccinated against FMD in Bangalore and Palakkad.

Majority of the farmers in both the regions were aware of the economic loss due to outbreaks of diseases like FMD in their bullocks probably due to previous experiences. Apart from this, State Animal Husbandry departments and milk co-operative unions of both the regions conduct mass vaccination programmes

against diseases like FMD, RP etc. All these have made majority of the farmers studied in both the regions to get their bullocks vaccinated against diseases like FMD and RP.

5.1.14 Disposal pattern of bullocks

The mean age upto which the bullocks were put to work was found to be 14.55 ± 52 years in the Kangayam tract and 15.78 ± 0.42 years in adjoining Palakkad region. This is slightly more than that reported for indigenous, crossbred and buffalo bullocks in plains and high ranges of Kerala (Sreekumar and Reddy, 1994). Similarly the reports by Joshi and Phillips (1953) and Pattabhiraman (1958) revealed that Kangayam bullocks were used for work for upto 10-12 years of age. On the other hand, Williamson and Payne (1978) reported that well managed and fed animals should work satisfactorily until they are about 17 years of age. Majority of the farmers in both the regions studied reported old age as the reason for the disposal of their bullocks. Similar observation was also made by Sreekumar and Reddy (1994) in Kerala.

From Table 18 it is evident that majority of the farmers in Kangayam tract (50.91%) reported the age upto which bullocks were put to work as 11-15 years. This may be due to the reason that they can purchase young bullocks from market and the

salvage value for adult bullocks was also remunerative. On the other hand, majority of the farmers in Palakkad region (52.73%) reported the age upto which bullocks were put to work as 16-20 years. This may be due to the reason that farmers of this region purchase mostly from shandies of bordering Tamil Nadu where bullocks which have put some work life in Tamil Nadu are only being sold. Farmers of this region procure slightly older animals which necessitates them to dispose of the bullocks at much later years of age (16-20 years).

5.1.15 Utilization pattern of bullocks

The utilization pattern of bullocks showed a trend in favour of Kangayam tract compared to Palakkad region eventhough the differences were not statistically significant. In the former, the bullocks were used for various types of work for a total of 1129.90 $\pm$ 59.45 hours in an year as against 988.56 $\pm$ 46.41 hours in the latter region. Similarly, while the bullocks were used for an average of 175.29 $\pm$ 9.18 days in the Kangayam tract, they were used only for 155.34 $\pm$ 8.53 days in the Palakkad region. A similar trend existed in the case of ploughing as well as carting. On the other hand more number of farmers in the Palakkad region (38) used their bullocks for threshing work than the Kangayam tract (9). While no farmer in

Kangayam tract used their bullocks for logging work, one farmer in the Palakkad region used bullocks for that purpose.

In a similar study on the utilization pattern of bullocks in plains and high ranges of Kerala, Sreekumar (1993) observed that the bullocks were used for 755.88 hours in a year in plains and 288.78 hours in a year in the high ranges. Observations on the total annual utilization of bullocks ranging from 51 to 828 hours have been reported from different parts of India (Srivastava and Ojha, 1987: Dubey, 1987; Varma and Verma, 1987; Kaushik et al., 1991; Tripathi, 1991; Singh, 1993 and Reddy et al., 1994).

The number of days of utilization of bullocks in both the regions studied indicated that the bullocks were used for only less than half of the days in a year. This observation is in agreement with the report of Ramaswamy (1985) which stated that bullocks were put to use in India for just less than half the days in an year. This also indicates the need for research and field trials to increase the utilization of bullocks, probably through employing them for unconventional uses.

5.2 Work performance

5.2.1 Speed of walking and stride length

It is evident from Table 21 and Fig.8 that the initial speed of walking of Kangayam bullocks while ploughing dry land in their home tract (1.249 ± 0.395 m/sec) was significantly ($P \leq 0.05$) higher than that of bullocks in adjoining Palakkad region (1.066 ± 0.349 m/sec). The speed gradually declined as time passed and at the end of 4 hours of work the speed was significantly ($P \leq 0.05$) less compared to the initial. The extent of decline was of the order of 20.53 per cent in home tract of Kangayam and 9.89 per cent in adjoining Palakkad region. Comparatively more decline in speed from the initial value in the Kangayam tract might be due to the significantly higher speed of walking in the initial phase of work. Similar decline in the speed of walking of bullocks was reported by many workers. A decline in the speed of walking to the extent of 10.92, 15.80 and 16.41 per cent was reported in crossbred, Malvi and local bullocks while ploughing for 5 hours in dry soil (Rautaray, 1986).

The mean stride length of Kangayam bullocks in their home tract and adjoining Palakkad was 0.88 ± 0.20 m and 0.80 ± 0.01 m respectively. Anil (1994) observed the stride length of

Kangayam bullocks while ploughing dry land to be 0.80 cm at Mannuthy, Kerala. Sreekumar (1988) on the other had reported that Kangayam bullocks walked while ploughing dry land at a speed of 1.24 m/second compared to 1.05 m/second by crossbred bullocks. Each work ox has a rate of movement best suited to its gait and an average of 0.88-1.2 m/second can be considered as the normal rate (Williamson and Payne, 1975).

5.2.2 Physiological responses

It is evident from Table 22 and Fig.10, 11 and 12 that the means of respiratory rate and pulse rate per minutes and rectal temperature of bullocks before work in Kangayam tract were 20.80 ± 0.99, 64.40 ± 1.73 and and 38.16 ± 1.18°C respectively, whereas that of bullocks in Palakkad region were 23.30 ± 1.09, 65.80 ± 2.64 and 38.00 ± 0.15°C respectively. The above parameters did not differ significantly between regions. After 4 hours of dryland ploughing, the respiratory rate, pulse rate and rectal temperature of bullocks in both the regions increased significantly ($P \leq 0.05$). The respective physiological variables immediately after work were 50.60 ± 2.76, 98.20 ± 1.89 and 39.68 ± 0.17°C in the home tract of Kangayam, whereas that of Palakkad region were 41.50 ± 1.82, 96.90 ± 1.76 and 39.33 ± 0.12°C. Significant increases in the physiological responses in

bullocks due to carting work were reported by Adkine et al. (1977) in Deoni, Red-Kandhari and Holstein x Deoni; Maurya and Devadattam (1982) in Jersey x Red Sindhi crossbreds and Upadhyay and Madan (1985) in Holstein x Hariana.

Work of ploughing also resulted in similar increases in the physiological reactions of respiration and pulse rates and rectal temperature in Jersey x Sahiwal crossbred bullocks (Rao and Upadhyay, 1984); Red-Dane x Sahiwal, Malvi and indigenous bullocks (Rautaray, 1986); Holstein-Friesian and Jersey crosses with local bullocks (Bhosrekar and Mangurkar, 1989), Jersey x Red-Sindhi cross-bred and Kangayam bullocks (Sreekumar and Thomas, 1990); Kangayam and Hallikar bullocks (Sreekumar, 1993) and Kangayam and graded Surti buffalo bullocks (Anil, 1994).

Increased respiratory rate may be the manifestation of increased oxygen demand and need for giving out end products of oxidation including heat. During exercise the tissues will need more oxygen and nutrients. To transport enough oxygen from lungs to the tissue, more oxygen should be dissolved in the blood. In order to effect this, the animal will resort to increased rate of respiration. Moreover, the increased carbondioxide produced by the working muscles have stimulating effect on the respiratory centre. Thus, it could be concluded that the increase in respiratory rate may be partly due to

increased demand of oxygen by tissues (working muscles), and partly due to heat stress.

In order to transport enough oxygen from lungs to the tissues, cardiac output has to be increased with enhanced oxygen carriage of blood. The important factor that increases the cardiac output is the need for increased ventilation in all exercising muscles as a result of increased muscle metabolism. When large number of muscles are exercising simultaneously, the peripheral vasodilation may be so great that the heart cannot pump extra amount of blood. Because of this the rate of heart beat will increase greatly from its normal to meet the requirement.

The increase in rectal temperature in working animals is due to increased heat production during exercise which cannot be fully dissipated immediately. The greater the work, the more will be the heat liberated. The heat gained from solar radiation coupled with metabolic heat and the heat produced by exercise add upto a very heavy heat load on the working animal. A considerable portion of the muscle energy liberated during muscle contraction is given out as heat.

5.2.3 Draughtability

During dry land ploughing Kangayam bullocks developed a horse power of 0.73 ± 0.06 in their home tract and 0.66 ± 0.03 in adjoining Palakkad region. The horse power developed by an animal depends upon the speed of operation and the draft required for the implement. The draft of any implement, on the other hand, depends upon the shape of the tool, orientation of the tool, depth of operation and soil conditions. The values of horse power developed ranging from 0.3 to 0.9 have been reported by various workers in indigenous and crossbred bullocks (Devadattam and Maurya, 1978; Upadhyay and Madan, 1985; Rautaray, 1986; Bhosrekar and Mangurkar, 1990 and Anil, 1994).

5.3 Morphological characteristics and body measurement of Kangayam cattle

The various morphological characteristics of Kangayam bullocks in the home tract of Kangayam and in adjoining Palakkad region has been presented in Table 23. As far as the hair characteristics are concerned all the bullocks observed in both the regions possessed short, glossy and straight hairs. Littlewood (1936) and Pattabhiraman (1958) have observed the hair of Kangayam cattle to be fine and short.

Plate 9. A typical Kangayam bull

Plate 10. A Kangayam cow and calf. The calves are reddish brown in colour when born

Plate 11. A pair of young bullocks of good merit

Plate 12. A pair of slightly older Kangayam bullocks being used for dry land ploughing

Majority of the animals in the Kangayam tract (92.38%) and in adjoining Palakkad region (91.59%) possessed a grey coat with a black patch on the knees and in front of the fetlocks on all the four legs. Very few proportion of animals in Kangayam tract were of dark fawn colour (4.76%), light fawn colour (0.95%), black colour (0.95) and white colour (0.95). Small proportion of animals with coat colour like dark fawn (3.36%), light fawn (3.36%), black (0.84%) and white (0.84%) were also observed in adjoining Palakkad region.

The colour of a typical Kangayam bull has been described as grey with dark grey to black markings on the head, neck, hump, shoulders and quarters, and the colour of the cow as white or grey with black markings just in front of the fetlocks on all four legs and sometimes on the knees (Gunn, 1909; Littlewood, 1936; ICAR, 1952; Joshi and Phillips, 1953; and Pattabhiraman, 1958).

Most of the animals under the present study were castrated bullocks and hence the dark shade over the head, neck, hump, shoulder and quarter were absent.

Gunn (1909) and Littlewood (1936) have also described other shades of coat colour like red, black and broken

colours in Kangayam cattle and these were considered as not desirable.

All the bullocks observed in both the regions possessed black coloured skin. This is in conformity with the observations of Gunn (1909) Littlewood (1936) and Pattabhiraman (1958).

Majority of the animals in both the regions had a black coloured muzzle except one animal in each region which had brown coloured muzzles. It is noteworthy that the animals with brown muzzles also had full white coat. Pattabhiraman (1958) has reported that colour of the muzzle in typical Kangayam cattle is black.

It was observed that the colour of the eyelids was in conformation with the coat colour with animals possessing grey, light fawn, dark fawn, black and white coloured eyelids in both the regions according to their coat colour.

Majority of the bullocks in Kangayam tract (99.04%) and in adjoining Palakkad region (99.16%) possessed a tail switch with black hairs. One animal in each region had a tail switch with brown coloured hairs. It was further noted that the animals which possessed brown tail switches also had full white hair-coats and brown muzzles. The typical colour of the tail switch is reported to be black in Kangayam cattle (Pattbhiraman,

1958). All the animals in both the regions possessed black coloured hooves which is in agreement with the observations of Pattabhiraman (1958).

All the animals possessed horns in both the regions. The colour of the horn was black (60.83%) in majority of the animals in Kangayam tract followed by woodish brown. On the other hand, majority of the animals in Palakkad region possessed woodish brown horns (53.78%) followed by black coloured horns (46.22%).

Regarding the orientation of horns, majority of the bullocks studied in both the regions had inward pointing tips. They curve outwards, backwards and then inwards almost completing a circle at the point where they approach the tips. Similar observations have been made by Littlewood (1936), Joshi and Phillips (1953) and Pattambhiraman (1958).

Among the bullocks in Kangayam tract. 35.24 per cent and 7.56 per cent of the bullocks in adjoining Palakkad region had horns with upward pointing tips. One reason for the difference in the distribution of horns with upward pointing tips might be the difference in the age of animals in the two regions. It was observed that young Kangayam cattle have horns with upward pointing tips. There were more younger bulls among those studied in the Kangayam region than the Palakkad area.

Plate 13. Some less frequent colours and horn shapes among Kangayam bullocks

Of the bullocks in Kangayam tract, 9.52 per cent and 15.13 per cent of the bullocks in adjoining Palakkad region had horns with backward pointing tips. Similar observation was also made by Littlewood (1936).

Head profile was almost straight with slight depression on the forehead in all the bullocks studied in both the regions, which is in conformation with the findings of Pattambhiraman (1958).

Ears were horizontal in all the animals studied in both the regions. Littlewood (1936), Joshi and Phillips (1953) and Pattabhiraman (1958) have described the ears of Kangayam cattle as erect and short. There seems to be some transformation in this morphological character over the years.

Majority of the animals studied in Kangayam tract (96.19%) and adjoining Palakkad region (94.12%) had medium sized humps. Joshi and Phillips (1953) and Pattabhiraman (1958) reported that hump is well developed in Kangayam bulls. The present study do not have any observations on bulls, but only includes bullocks and few cows, which possessed medium sized humps. It is common observation that in breeds where bulls have well developed humps, cows and bullocks have small to medium sized ones (Joshi and Phillips, 1953). Only 3.81 per cent of

bullocks in Kangayam tract and 5.88 per cent of bullocks in adjoining Palakkad region had large sized humps. This may be that these animals were castrated late.

All the animals studied in both the regions had slightly sloping croup. Patabhiraman (1958) has also reported the same while describing typical Kangayam cattle.

Majority of the animals in the Kangayam tract (96.19%) and in adjoining Palakkad (98.32%) possessed medium sized dewlap which was thin and extending only upto the sternum. Gunn (1909), Littlewood (1936), Joshi and Phillips (1953) and Pattabhiraman (1958) have observed that dewlap in Kangayam cattle is thin and short extending to the sternum only. Four animals (3.81%) in the Kangayam region and two (1.68%) in Palakkad region had large dewlaps. Generally large pendulous dewlaps are associated with better milk production and inferior draught capacities among zebu breeds. These variants might have been ignored in the earlier studies. On the other hand, this may also represent a gradual change in the breed towards better milk production potential and reduced draught capacity as very little selection pressure is being applied for better work ability these days. However, this can be confirmed only after further detailed investigation.

All the animals studied in both the regions had small navel flap. Majority of the animals in Kangayam tract (96.19%) and in adjoining Palakkad region (98.32%) had small penis sheaths. Gunn (1909), Littlewood (1936, Joshi and Phillips, 1953 and Pattabhiraman, 1958) reported that sheath is not pendulous and it is well tucked into the body in Kangayam breed of cattle.

Morphological characteristics of Kangayam cows are presented in Table 25. The coat colour in majority of the Kangayam cows observed (93.33%) was grey with black markings on the knees and just above the fetlocks on all four legs. This is in agreement with earlier reports (Gunn, 1909; Littlewood, 1936; Joshi and Phillips, 1953 and Pattabhiraman, 1958). Only one cow in the present study had a black coat colour. Littlewood (1936) reported fawn, red, black and broken colours in Kangayam cows.

All the cows in the present study had bowl shaped udders with cylindrical teats. No earlier reports with respect to udder shape of Kangayam cows are available. Pattabhiraman (1958) reported that in Kangayam cows udder is not very well developed, teats are fairly small and well set apart.

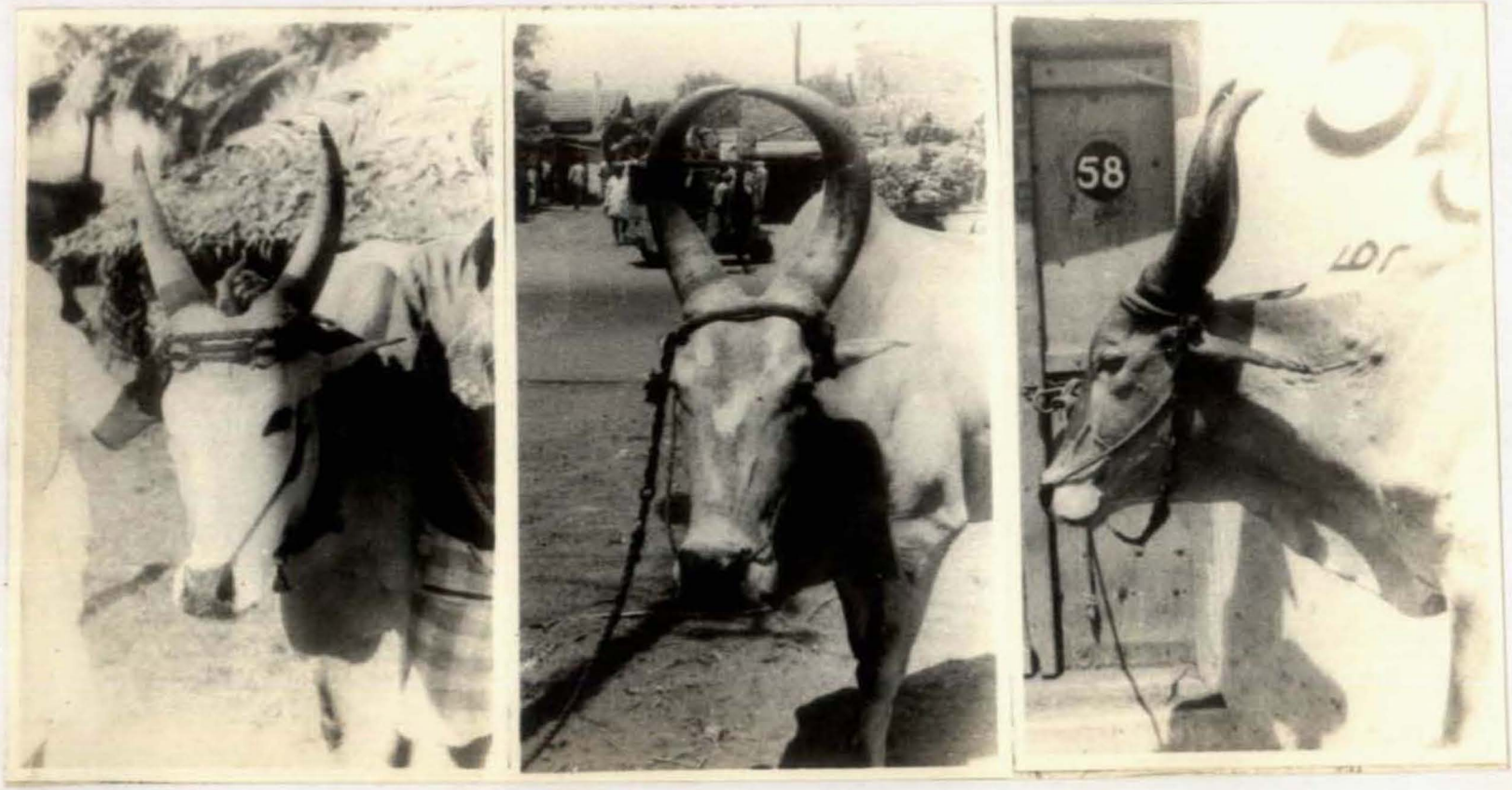
Other morphological characteristics observed in the present study were in line with earlier reports (Gunn, 1909; Littlewood, 1936; ICAR, 1952; Joshi and Phillips, 1953 and Pattabhiraman, 1958).

Plate 14. Typical horn types in Kangayam bullocks

1. Shows the typical appearance of horns in young bullocks

2. As the animal grows the horns grow outward and then curve inside almost meeting at the tips

3. The horn type in which the tips extends inward and backward almost giving it a lyre shape. The figure also shows typical horizontal ears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5.3.1 Body measurements

5.3.1.1 Horn length

The horn length of Kangayam bullocks in the Palakkad region was higher in the early stages. The differences were significant at 5 per cent level in the age groups of 2-3 years and 3-4 years. In 1-2 year group also there was a clear trend showing longer horns in the Palakkad region. However, as the bullocks matured, the trend was reversed with the bullocks in the Kangayam region possessing longer horns. The difference was significant ($P \leq 0.05$) in the group above 5 years. Their horn length was 62.7 $\pm$ 1.5 cm with a range of 52 to 91 cm compared to 58.50 $\pm$ 0.58 cm with a range of 52 to 76 cm in the Palakkad region. Littlewood (1936) reported a horn length of 37.5 cm at 6 years of age and 48 cm at 9 years of age in bulls. Pattabhiraman (1958) reported the horn length to be 30-45 cm in a typical Kangayam bull without mentioning the age. It appears that over the years the horn length in the Kangayam bulls has increased.

In the present study the length of horns in the Kangayam cows ranged between 27 cm and 53 cm with a mean of 41.66 $\pm$ 2.09 cm. Earlier reports stated it to be 38.75 cm to 57.5 cm (Table 1) (Littlewood, 1936; Joshi and Phillips, 1953; Pattabhiraman, 1958; Acharya and Bhat, 1984 and Sreekumar, 1993)

5.3.1.2 Horn circumference

The horn circumference of bullocks in the Palakkad region showed a trend of higher values than that of the bullocks in the Kangayam region eventhough differences were significant ($P \leq 0.05$) only in the 2-3 years group. As the age advanced the differences between the two groups became less and less and in the above 5 years group it became similar in both the groups. The horn circumference at the base of the horn was 32.10 $\pm$ 0.50 cm with a range of 26 to 40 cm in the bullocks above 5 years from the Kangayam tract. Compared to this the bullocks from the Palakkad region had a horn circumference of 32.10 $\pm$ 0.26 cms with a range of 27 to 37 cms.

From the foregoing discussion it can be seen that the horn growth in general was faster in the bullocks from the Palakkad region in the early stages. However, when the animals matured and advanced in age, the bullocks in the Kangayam tract equalled with respect to horn circumference and even surpassed the Palakkad bullocks with respect to horn length.

Pattabhiraman (1958) reported a horn circumference of 25 to 32.5 cms in a typical Kangayam bull. With respect to the circumference of the horn also there seems to be an increase in size during the course of time.

In the present study horn circumference was 22.06 ± 0.70 cm in Kangayam cows. Earlier reports stated it to be 17.5 cm to 26.25 cms (Table 1).

5.3.1.3 **Face length**

In the 1-2 year group there was no significant difference in face length between the two regions. However, as the animals grew a significant difference became apparent with the Palakkad strain having a longer face. The differences were significant at 5 per cent level in all the remaining age groups. The maximum difference was observed in the 3-4 year group where the average face length was 43.7 ± 0.51 cm for the animals in the Kangayam tract compared to 48.30 ± 0.24 cm for the Palakkad bullocks. The difference persisted even in the above 5 year group with the Kangayam tract animals averaging 51.90 ± 0.32 cm and Palakkad animals 53.00 ± 0.28 cm. Face length had a range of 44 to 54 cms when both the regions were put together. Compared to this Pattabhiraman (1958) reported a range of 45-50 cms in Kangayam bulls. There appears that there is a slight increase in the face length over the course of time. However the possibility of sampling error causing the difference cannot be ruled out.

In the present study the length of the face was 45.06 ± 0.30 cm in Kangayam cows. This is in agreement with the earlier reports (Table 1).

5.3.1.4 Ear length

In 1-2 year group the ear length was significantly ($P \leq 0.05$) more in the bullocks from the Kangayam tract. However, the trend was reversed in the 2-3 years group and in the 3-4 years group the ears of the bullocks from the Palakkad region were significantly ($P \leq 0.05$) longer. Thereafter the differences were narrower and in the two groups above 4 years the ear lengths were similar.

The differences in ear length may not be an anatomical feature in the two strains as ear trimming is practised in both the regions. In the Palakkad region ear trimming is done earlier, mostly in the 1 to 2 years age group. This has resulted in a significantly shorter ear in them at that period of age. The Kangayam tract bullocks are also subjected to ear trimming but slightly at an older age i.e., during the 2 to 3 years period. Because of this the ear length in the Kangayam tract bullocks in the 2-3 year age group and 3 to 4 year age group became less compared to 1 to 2 year group as well as the contemporary bullocks of the same age groups in the Palakkad

region, where some growth of the ear has taken place after an early trimming. Due to this the ear length was significantly more in the Palakkad region bullocks (22.3 ± 0.16 cm) compared to Kangayam tract bullocks (21.70 ± 0.18 cm).

In the above 5 years group in both the regions put together the ear length varied from 20 to 26 cm. This seems to be higher than the earlier reports of Littlewood (1936) and Pattabhiraman (1958).

In the present study the ear length was 23.06 ± 0.37 cm in Kangayam cows. This is higher than the earlier reports (Table 1).

5.3.1.5 Height at withers

The height at withers of the bullocks from the Palakkad region showed a trend of higher values compared to the bullocks from the Kangayam tract upto the age of 5 years with the differences being significant at 5 per cent level in the 2 to 3 years group and 3 to 4 years group. The maximum difference was observed in the 3 to 4 years group with the Palakkad bullocks measuring taller at 135.25 ± 1.21 cm in comparison to 129.56 ± 0.83 cm in Kangayam tract bullocks. However above 5 years of age the Kangayam tract bullocks caught up with the Palakkad region

bullocks in height at withers. The Kangayam tract bullocks above 5 years measured 146.28 ± 0.86 cm with a range of 135 to 158 cm. In comparison the Kangayam bullocks in the Palakkad region had an average height at withers of 146.20 ± 0.83 cm with a range of 135 to 162 cm. Earlier workers reported comparatively lower values with respect to height at withers (Table 1).

In the present study the height at withers was 128.46 ± 1.01 cm in Kangayam cows. This tallied with earlier reports (Table 1).

5.3.1.6 Body length

The body length measured from point of elbow to pin bone showed a trend of higher values in Palakkad region bullocks from young age upto 4 to 5 years period. The bullocks from Palakkad region measured significantly ($P \leq 0.05$) longer at 138.80 ± 1.49 cm in comparison to 134.50 ± 1.46 cm in Kangayam tract bullocks. However, as age advanced, the trend seems to be reversed with the Kangayam tract bullocks above 5 years measuring longer (142.20 ± 0.88 cm) than the Palakkad region bullocks (139.80 ± 1.35 cm).

The length of the bullocks above 5 years ranged from 122 to 166 cm. Earlier workers like Littlewood (1936), Joshi and Phillips (1953), Pattabhiraman (1958), Acharya and Bhat (1984)

and Sreekumar (1993) reported a lower range of values for bullocks varying in age (Table 1).

In the present study the length of the body was 127.13 ± 1.78 cm in Kangayam cows. Similar values were reported earlier (Table 1).

5.3.1.7 Chest girth

Chest girth was similar in both the groups upto the age of 3 years. In the 3 to 4 years group the girth was significantly ($P \leq 0.05$) larger in the Kangayam tract bullocks (172.00 ± 1.41 cm) than the Palakkad region bullocks (165.60 ± 0.71 cm). As age advanced the difference narrowed and above 5 years there was practically little difference between the two groups in the chest girth. The variable ranged between 151 and 220 cms in bullocks above 5 years. Earlier workers reported similar values but narrower in range (Table 1).

In the present study, the average chest girth of Kangayam cows was 173.86 ± 3.37 cm, which is higher than the earlier reports (Table 1).

5.3.1.8 Length of the fore limb

The length of the fore limbs in the two groups was similar in the 1 to 3 years category. However as age advanced the fore limbs measured longer in the Kangayam tract bullocks and in 3 to 4 years category the fore limb of Kangayam tract bullocks (91.40 $\pm$ 0.54 cm) was significantly ($P \leq 0.05$) longer than the Palakkad tract bullocks (89.80 $\pm$ 0.51 cm). However as age advanced the Palakkad bullocks caught up with the Kangayam tract bullocks and in the 4 to 5 years and above 5 years age groups the length of the fore limbs of bullocks in the two regions were similar. In the above 5 years category the variable ranged from 93 to 127 cm. No earlier reports with respect to length of forelimb could be found.

In the present study the length of forelimb of Kangayam cows was 92.26 $\pm$ 1.85 cm. There are no earlier reports with respect to limb length in Kangayam cows.

5.3.1.9 Length of hind limb

There was no significant difference in the length of the hind limb between the bullocks in the two regions upto the age of 5 years. There was a slight trend in favour of Kangayam tract bullocks throughout and in the age group above 5 years the hind limbs of Kangayam tract bullocks measured significantly ($P \leq 0.05$)

longer (120.60 ± 0.81 cm) than the Palakkad region bullocks (116.30 ± 0.82 cm). The length of the hind limb ranged between 104 cms and 130 cms in this age group. In the present study the length of hind limb of Kangayam cows was 105.60 ± 1.68 cm. No earlier reports in this respect could be traced.

5.3.1.10 Tail length

Tail length showed a trend of higher values in the Kangayam tract bullocks compared to Palakkad region bullocks except in the 1 to 2 years group in which the Palakkad region bullocks had higher average value with respect to tail length. The differences were significant only in the above 5 years category in which the Kangayam tract bullocks had significantly ($P \leq 0.05$) longer tail (82.50 ± 1.06 cm) than the Palakkad region bullocks (77.50 ± 0.68 cm).

Tail length in the present study was taken from the base of the tail to the start of the switch and the switch length was measured separately. This is the reason why the values of the tail length in the present study is comparatively much lower than the earlier reported values on this variable where the tail length was taken from the base of the tail to the tip of the switch. For example Pattabhiraman (1958) reported a range of 115 cm to 132.5 cm, when the tail length was measured in that

manner. In the present study the value received by adding tail length to switch length was similar to the values reported by Pattabhiraman (1958).

It was observed that the length of the tail of Kangayam cows was 81.80 ± 1.86 cm. Pattabhiraman (1958) reported a range of 92.5 cm to 121.25 cm when tail length was measured from the base of the tail to the tip of the switch. When the length of the switch was added to the tail length the values were similar to those reported by Pattabhiraman (1958).

5.3.1.11 Length of the switch

The length of the switch showed a trend of slightly higher values in the Palakkad region bullocks upto the age of 3 years. Thereafter there was a reversal in the trend with the Kangayam tract bullocks having longer switch than the Palakkad region bullocks. In the 4 to 5 years group and in the above 5 years group the switch of the bullocks in the Kangayam tract region were significantly ($P \leq 0.05$) longer than that of Palakkad region bullocks.

The tail switch in Kangayam cows measured 39.60 ± 1.29 cm. No earlier reports are available with respect to the switch length of Kangayam cattle.

Summary

6. SUMMARY

The study 'Analysis of farming systems involving Kangayam breed of cattle' was conducted at two different locations, in their home tract in Coimbatore/Periyar districts of Tamil Nadu and adjoining Palakkad region of Kerala state. Farmers rearing Kangayam bullocks were selected and information on different aspects of management and utilization pattern were collected by means of a pre-tested, structured schedule. Investigations into the work performance of the bullocks in the two regions were conducted by recording the speed, stride length and draughtability and the physiological responses to work with respect to respiration and pulse rates and rectal temperature. Body measurements and morphological characteristics of Kangayam bullocks and cows were also documented.

Majority of the bullock-rearing farmers studied in the Kangayam tract (56.36%) possessed more than 4 ha of land while in adjoining Palakkad region majority of such farmers (47.27%) possessed less than 2 ha of land. Larger proportion of the farmers in both the regions possessed adult female cattle.

All the farmers studied in the Kangayam tract and majority of the farmers (94.55%) studied in adjoining Palakkad region possessed indigenous ploughs. Most of the farmers in both the regions possessed indigenous carts. Only 10.91 per cent farmers in the Kangayam tract and 5.45 per cent in adjoining Palakkad possessed improved carts.

More number of the farmers in both the regions opted to keep the bullocks throughout the year rather than to dispose them after the peak season. Farmers procured their bullocks mostly from cattle fairs/markets, while other farmers and own farm also formed sources of procurement. The mean cost of a pair of Kangayam bullocks in their home tract was Rs.10,927 $\pm$ 282.9 and adjoining Palakkad Rs.7,855 $\pm$ 238.8. The mean age at purchase of bullocks in their home tract was 4.609 $\pm$ 0.337 years and in adjoining Palakkad region 5.173 $\pm$ 1.076 years. Majority of the farmers (18.18%) in Kangayam tract purchase their bullocks around 2.5 years of age, whereas in adjoining Palakkad region maximum number of farmers (29.07%) purchased their bullocks around 6 years of age.

Majority of the farmers in Kangayam tract (81.82%) and in adjoining Palakkad region (83.64%) purchased trained bullocks. The method of training did not vary much between the two regions.

Farmers considered different attributes while selecting bullocks. Majority of the farmers (61.82%) in Kangayam tract and in adjoining Palakkad region (76.36%) considered physical appearance and whirling pattern of hair on the bullocks' body as main attributes in selection. Majority of farmers (83.64%) in both the regions purchased castrated bullocks. Rest of the farmers purchased entire bulls/bull-calves and later on castrated them.

The bullocks in the Kangayam tract and in adjoining Palakkad region were fed locally available feed resources including crop residues, concentrates and agricultural by-products. In both the regions bullocks were mostly stall-fed with some amount of grazing. In some localised areas of the home-tract Kangayam bullocks were also grazed in fenced pasture-lands of 'Kolukattai grass' (Cenchrus ciliaris). Sorghum straw was the major roughage item fed to bullocks in Kangayam tract whereas and in adjoining Palakkad region, paddy straw formed the major roughage ingredient. In both the regions rice bran formed the major concentrate feed ingredient, followed by cotton seed and groundnut cake. In the Palakkad region a small percentage (19.61%) of farmers also fed boiled paddy as a concentrate.

During work days majority of the farmers in the Kangayam tract (65.45%) and in adjoining Palakkad region (58.18%) provided water three times a day. During rest days majority of the farmers in Kangayam tract (60%) provided water two times a day while in adjoining Palakkad region (47.27%) only once a day.

The type of housing provided to the bullocks varied among farmers. Majority of the farmers in both the region provided independent housing. Similarly 'Kutcha' type of houses with mud floor and thatched roof were more than the other types. In the home tract, some farmers did not provide any housing to their bullocks except a wind screen.

All the farmers studied invariably washed their animals after wet ploughing. When other types of work was being done or when there was no work, in Kangayam tract, majority of the farmers reported that they washed their bullocks as per convenience (27.27%) whereas in adjoining Palakkad region more number of farmers (36.36%) washed their bullocks weekly once.

Majority of the farmers in both the regions shoed their bullocks. In both regions, most of the farmers shoed their bullocks at an interval of 31 to 60 days.

The common health problems of bullocks in the two regions studied were bloat, indigestion, hoof injury, yoke gall, lameness, bursitis, neck sore, hump sore, sprain, string-hault, horn fracture, pyrexia, diarrhoea, ring worm infection insect bite allergy, Foot and Mouth disease (FMD), Ephemeral fever, Babesiosis, Actinomycosis and Actinobacillosis. Majority of the farmers in both the regions got their bullocks vaccinated against diseases like FMD, RP, HS and BQ.

Majority of the farmers in the Kangayam tract utilized their bullocks for work upto an age ranging from 11 to 15 years, whereas in Palakkad region, upto 16 to 20 years. The major reason for disposing of the bullocks by the farmers in both regions was old age.

In general, bullocks were used for tillage, threshing and carting operations and for sporting purposes like bullock cart racing. One farmer in Palakkad region utilized bullocks for logging timber. The total hours of utilization of bullocks in the home tract and in adjoining Palakkad region of Kerala were 1129.90 $\pm$ 59.45 hours spread over 175.29 $\pm$ 9.18 days in a year and 988.56 $\pm$ 46.41 hours spread over 155.34 $\pm$ 8.53 days respectively.

Investigation into the work performance of bullocks revealed that the mean initial speed of walking of bullocks was significantly ($P \leq 0.05$) higher in Kangayam tract when compared to Palakkad area. Mean overall speed of bullocks ploughing dryland in the Kangayam tract was 1.114 ± 0.028 m/sec compared to 1.052 ± 0.130 m/sec in adjoining Palakkad region. There was a significant ($P \leq 0.05$) reduction in the speed of walking from the initial value as a result of 4 hours of work in both the regions.

The mean stride length of bullocks in the Kangayam tract and adjoining Palakkad were 0.88 ± 0.02 m and 0.80 ± 0.01 m respectively. The stride length did not differ significantly between the regions.

The respiratory rate, pulse rate and rectal temperature increased significantly ($P \leq 0.05$) in both the regions as a result of 4 hours of dry land ploughing. There were no significant differences before work between the regions with respect to these physiological variables. There were significant differences ($P \leq 0.05$) in the respiratory rate towards the end of work between the regions. However there were no significant differences after work in the pulse rate and rectal temperature between the regions.

In the home tract of Kangayam, the mean horse power generated by a pair of bullocks was 0.73 ± 0.06 and in the adjoining Palakkad region it was 0.66 ± 0.03, the difference being non-significant.

All the animals in both the regions had short, straight and glossy hair coat. Majority of the animals in both the regions had a grey coat with a black patch on their knees and in front of the fetlocks. Other shades like light fawn, dark fawn, full black and full white were also found, but very less in frequency. The animal which had full white coat colour had brown coloured muzzle and brown coloured tail switch. All the animals observed possessed horns. The orientation of horns was inward pointing tips in majority of the animals in both the regions. Upward pointing tips, backward pointing tips and forward pointing tips were also observed in various proportions in both the regions. The profile of head was almost straight with a slight depression on the forehead and the orientation of the ears was horizontal in all the animals observed in both the regions. Hump and dewlap were medium in size in all the animals observed in both the regions All the Kangayam cows studied had a bowl shaped udder with cylindrical teats.

Some differences in the size and morphological characteristics of the Kangayam animals in the two regions under investigation were found. Differences were also noted in the relative speed of growth of certain appendages like horns. Horn length in the Palakkad region was higher in the early stages. However as the bullocks matured the trend was reversed with the bullocks in the Kangayam region possessing longer horns. The horn circumference at base was more in Palakkad region in the early life. But as the age advanced, the difference between the two groups became less and less with respect to this character and in the above 5 years group it became similar in both the groups. In the 1-2 year group there was no significant difference in face length between the two regions. However, as the animals grew, a significant difference became apparent with the Palakkad strain having a longer face.

The height at withers of the bullocks from the Palakkad region showed a trend of higher values compared to that of Kangayam tract. The body length showed a trend of higher values in Palakkad region from young age upto 4 to 5 years age. However, as the age advanced, Kangayam tract bullocks measured longer than that from Palakkad region. Above 5 years of age, chest girth had practically little difference between the two groups.

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Appendices

APPENDIX-I

List of villages included in the study

Kangayam Tract

1. Kattampatti
2. Kariampalayam
3. Kundadam
4. Kosumadai
5. Muthur
6. Nachipalayam
7. Najundapuram
8. Nallur
9. Nathakadayur
10. Palladam
11. Pongalur
12. Thipampatti
13. Thondamuthur
14. Suleswaranpatti
15. Uralpatti
16. Uthukuli

Palakkad Region

1. Ambatanpathy
2. Bunglow Kalam
3. Chandrapuram
4. Chittoor
5. Kozhinjampara
6. Kozhlipara
7. Menampara
8. Pambupara
9. Vannamada
10. Velanthavalam
11. Walayar

APPENDIX-II

Interview schedule for the FSR involving Kangayam breed of cattle

I 1. Name of the Farmer :

2. Name of the village :

3. District :

4. State :

II 1. Land holding :

2. Number of animals owned :

3. Number of bullocks owned :

4. Type of implements :

1. Ploughs

a. Indigenous :
b. Improved :
c Nil :

2. Carts

a. Indigenous :
b. Improved :
c Nil :

III 1. Source of Bullocks

a. Own farm :

b. Purchase from other farmers :

c. Shandies :

d. Own farm and shandy :

2. Selection attributes

   a. Physical appearance

   b. Physical appearance + whirling

   c. Physical appearance + temperature

   d. Physical appearance + whirling + temperature

3. Cost of bullocks

   a. Single - Rs.

   b. Pair - Rs.

4. Spurce of finance

   a. Own

   b. Bank loan

5. Age at purchase of bullocks :

6. Farmers preference in keeping bullocks

   a. Keep throughout the year :

   b. Dispose after peak season :

   c. Either keep or dispose :

IV 1. Type of feed resources

Sl.No.	Item	Quantity

2. Source of concentrates :

3. Quantity of concentrate feed ingredients fed during work :

4. Quantity of roughages fed during work :

5. Source of roughages :

6. Quantity of concentrate feed ingredients fed during rest :

7. Quantity of roughages fed during rest :

8. Details of grazing, if present

   a. During work period ..... Hours

   b. During rest period ..... Hours

9. Time and frequency of feeding during work period :

10. Time and frequency of watering during work period :

11. Time and frequency of feeding during rest :

12. Time and frequency of watering during rest :

V 1. Age of training :

2. Method of training :

VI 1. Age of castration :

2. Method of castration :

VII Housing management

I Lean to type II Independent

1. Type of house

   a. Pucca
   b. Kutcha

2. Type of roof

a. Tiled
b. Thatched
c. Others

3. Type of floor

a. Stone paved
b. Plank
c. Concrete
d. Mud

4. Housing provision

a. Only at night
b. Day and night
c. For part of day

IX Details of washing/grooming :

X Details of shoeing

a. Frequency :

b. Cost :

XI 1. Common health problems encountered:

2. Nature of treatment :

3. Vaccination schedule if any :

XII 1. Different operations performed and number of hours/day used for each operation in a year

	Activity	Hours/days
a.	.....	.....
b.	.....	.....
c.	.....	.....
d.	.....	.....

2. Peak season of use :

3. Details of hiring out :

4. Off-season activities if any :

XIII 1. Age upto which bullocks are used for work :

2. Reasons for disposal of bullocks

a. Old age

b. Disease

c. Want of money

d. Highly temperamental

c. Pair died

f. Season over

APPENDIX-III

Breed descriptor for Kangayam cattle

Breed description

a. Hair characters

Length - (Long/Short)

Sheen - (Glossy/Dull)

Curl - (Curly/Straight)

b. Colour

Colour 1

Colour 2

c. Skin

Colour 1

Colour 2

d. Muzzle

Colour 1

Colour 2

e. Eye lids

Colour 1

Colour 2

f. Hoof

Colour 1

Colour 2

g. Horns

(Black/White/Brown/Others)

h. Head

Profile

1. Ultra convex
2. Convex
3. Concave
4. Straight

i. Body measurement

Head

1. Length of horns
2. Circumference at base of the horn
3. Length of face
4. Length of ear

Trunk

1. Height at withers
2. Length of the body
3. Chest girth

Limbs

1. Fore - Length
2. Hind - Length

Tail

1. Length without switch
2. Length of switch

j. Horns

Present/Absent

k. Shape

Orientation

1. Lateral pointing tips
2. Inward pointing tips
3. Upward pointing tips
4. Downward pointing tips
5. Backward pointing tips
6. Forward pointing tips

l. Attachment

(Loose/Tight)

m. Ears

Orientation

(Horizontal/Drooping)

n. Body

Humb

(Large/Medium/Small/Absent)

o. Croup

(Horizontal/Sloping)

p. Dewlap

(Large/Medium/Small/Absent)

q. Naval flap

(Large/Medium/Small/Absent)

r. Penis sheath

(Large/Medium/Small/Absent)

s. Udder shape

1. Bowl
2. Round
3. Goat type
4. Pendulous

t. Teat shape

1. Cylindrical
2. Funnel
3. Pear
4. Bottle

ANALYSIS OF FARMING SYSTEMS INVOLVING KANGAYAM BREED OF CATTLE

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ABSTRACT OF A THESIS

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ABSTRACT

The study 'Analysis of farming systems involving Kangayam breed of cattle', was conducted at two different locations, in their home tract in Tamil Nadu and adjoining Palakkad region of Kerala. Information on different aspects of management and utilization pattern were collected by means of a schedule. Investigations into the work performance of the bullocks in the two regions were conducted. Body measurements and morphological characteristics of Kangayam bullocks and cows were also documented.

Majority of the bullock-rearing farmers (56.36%) in the Kangayam tract possessed more than 4 ha of land while in adjoining Palakkad region majority of such farmers (47.27%) possessed less than 2 ha of land. The average land holding in Kangayam tract was 4.24 $\pm$ 0.35 ha compared to 2.95 $\pm$ 0.54 ha in the Palakkad region. All the farmers in the Kangayam tract and most of the farmers (94.55%) in Palakkad region possessed indigenous ploughs. Majority of the farmers in both the regions possessed indigenous carts. More number of the farmers in both the regions opted to keep the bullocks throughout the year. Farmers procured their bullocks mostly from cattle fairs/markets. The mean age at purchase of bullocks in their home tract was 4.609 $\pm$ 0.337 years and in

adjoining Palakkad region 5.173 ± 1.076 years. Maximum number of the farmers in Kangayam tract procured their bullocks around 2.5 years of age, whereas in Palakkad region around 6 years of age.

Most of the farmers in both the regions purchased trained bullocks. Majority of the farmers in Kangayam tract (61.82%) and in Palakkad region (76.36%) considered physical appearance and whirling pattern of hair as main body attributes in selection. Larger proportion of the farmers in both the regions procured castrated bullocks.

The bullocks in both the regions received locally available feed materials While sorghum straw was the major roughage item fed to the bullocks in Kangayam tract, paddy straw formed the major roughage ingredient in the Palakkad region. In both the regions rice bran formed the major concentrate feed item followed by cotton seed and groundnut cake. During work days, majority of the farmers in both the regions provided water three times a day.

Majority of the farmers in both the region provided independent 'kutcha' type of houses. In the home tract some farmers did not provide any housing to their bullocks except a wind screen.

In Kangayam and Palakkad regions, majority of the farmers shoed their bullocks at an interval of 31 to 60 days. Most of them also got their bullocks vaccinated against diseases like Foot and Mouth, Rinderpest, Haemorrhagic Septicaemia and Black Quarter.

The total hours of utilization of bullocks in their home tract and in adjoining Palakkad region were 1129.90 ± 59.45 hours spread over 175.29 ± 9.18 days in a year and 988.56 ± 46.41 hours spread over 155.34 ± 8.53 days respectively.

Investigation into work performance of bullocks revealed that the mean initial speed of walking of bullocks was significantly ($P \leq 0.05$) higher in Kangayam tract when compared to Palakkad area. Mean overall speed of bullocks ploughing dry land was 1.114 ± 0.028 m/sec in Kangayam tract, while it was 1.052 ± 0.130 m/sec in Palakkad region. The mean stride length of bullocks in Kangayam tract and adjoining Palakkad was 0.88 ± 0.02 m and 0.80 ± 0.01 m respectively which did not differ significantly.

The respiratory rate, pulse rate and rectal temperature increased significantly ($P \leq 0.05$) in both the regions as a result of 4 hours of dry-land ploughing. In the home tract of Kangayam, the mean horse power generated by a

pair of bullocks was 0.73 ± 0.06 and in the adjoining Palakkad region 0.66 ± 0.03. However, these did not vary significantly at 5 per cent level.

All the animals in both the regions had short, straight and glossy hair coat. Majority of the animals had a grey coat with a black patch on their knees and in front of the fetlocks. Greater proportion of them had horns with inward pointing tips. All the Kangayam cows studied had a bowl shaped udder with cylindrical teats.

Some differences in the size and morphological characteristics of the Kangayam animals in the two regions under investigation were found. Horn size, in the Palakkad region was larger in early stages. However as the bullocks matured the trend was reversed with the bullocks in the Kangayam region having larger horns.

The face of mature bullocks in the Palakkad area was longer than that of bullocks in the Kangayam tract. The height at withers of the bullocks from the Palakkad region showed a trend of higher values compared to that of Kangayam tract. The Kangayam tract bullocks, eventhough shorter in early stages, overtook their counter-parts in the Palakkad region to measure longer beyond 5 years of age. Above 5 years of age, chest girth had practically little difference between the two groups.