

Buffalo Genetic Resources of India

MURRAH



Compiled & Edited by
DK Sadana, RS Kataria and BP Mishra



National Bureau of Animal Genetic Resources
(Indian Council of Agricultural Research)
P.O. Box No. 129, Karnal (Haryana)



Monograph 25, 2006

Buffalo Genetic Resources of India

MURRAH

Compiled and Edited by :

DK Sadana, RS Kataria and BP Mishra



NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES
P.B. NO. 129, KARNAL – 132 001 (HARYANA)



PREFACE

India is habitat of the best riverine breeds of buffaloes in the world. Majority of the buffalo breeds in the country are used for milk production; some defined and some lesser known breeds are also used for meat and draught purpose. The best dairy breeds of buffalo are: Murrah, Nili-Ravi, Mehsana, Surti and Jaffarabadi which have high potential for milk and fat production. The other five defined breeds also have fairly good potential for milk: Nagpuri, Pandharpuri, Bhadawari, Marathwadi and Toda. In addition to the above ten defined breeds, there are several defined populations that have regional importance. These are: Banni, Sambalpuri, Jerangi, Manda, Godavari, Assamese-Swamp, Kalahandi, Kuttanad, Tarai, Sikamese, Gojri, Parlakhemundi, Chilika, Kujang and South-Kanara.

Murrah is the world's best dairy type buffalo and capable of producing more than 35 kg milk in a day. Murrah has been used as improver breed in India and several other countries. Mehsana breed is known to have been developed by crossing the local Surti buffaloes with Murrah in Mehsana and Banaskantha districts of Gujarat. Mehsana is now a stabilized breed that is well accepted, and makes very significant contributions in terms of milk. Similarly Godavari breed has been developed by using Murrah on the non-descript buffaloes of the Krishna Deltaic region in Andhra Pradesh. Kujang has been developed by using Murrah on the non-descript buffaloes in Paradeep area of Orissa. Performance of crossbreds was close to Murrah. Many countries have imported Murrah buffaloes to establish purebred as well as crossbred herds.

Buffaloes are a third (35%) of the total milch bovines (Cattle and Buffalo) in the country but contribute more than half (53%) in milk production. Described as the "Asian tractor", buffalo is in fact a triple purpose animal - for milk, meat and work. Murrah buffalo being the finest buffalo-genetic-material in the world, it is opined that 'if India is to enter the world livestock trade, the best bet would be Murrah buffalo'. The country ought to capitalize this distinct status and explore the export potentials of Murrah buffalo.

This bulletin is a compilation of information on Murrah buffaloes available from various sources. The authors are thankful to all scientists, scholars, officials and workers who primarily generated information on different aspects of Murrah buffalo.

Authors

CONTENTS

Introduction	1
Origin and Breeding Tract	1
Management Practices	3
Physical Characteristics	4
Performance Traits of Murrah Buffaloes	4
Milk production	4
Age at first calving	5
Lactation milk yield	6
Lactation length	7
Service period	8
Dry period	9
Calving interval	10
Peak yield	10
Lifetime milk yield	11
Exodus of Murrah Buffalo Germplasm	12
Identification and Propagation of Murrah Germplasm	12
Central Herd Registration Scheme	15
ICAR Projects on Murrah	16
All India Coordinated Research Project on Buffalo	16
Network Project on Buffaloes	16
Murrah in Other Countries	17
Export Potential of Murrah Buffalo	19
Genetic Characterization of Murrah Buffaloes	21
Cytogenetic characterization of murrah buffalo	21
Characterization of murrah buffaloes	22
Study on genetic relatedness and diversity	23
Characterization of mammary gland genes	23
Breeding Farms	24
Contact Agencies	25
References	25



Pride Buffalo Breed of India - Murrah

Introduction

India holds primary global status in terms of (i) largest buffalo population in a country (ii) largest number of breeds (10 defined plus 15 distinct population groups) and (iii) world's best buffalo breed i.e. Murrah. Predominantly found in Haryana and adjoining states of Punjab, UP and Delhi, Murrah is a triple purpose animal – for milk, meat and work. Also known by several synonyms like Delhi, Kundi, Kali in India, Kerban-banleng in Sumatra, Kerban-shungei or Karban-sapi in Malaysia, Murrah is a truly global breed as it has been introduced in several countries and variously been used as an improver breed.

With increase in the popularity of Murrah buffaloes as dairy animals, farmers in different parts of the country started maintaining either Murrah buffaloes or got their local buffaloes mated to Murrah bulls for increased milk production. This has resulted in a great demand for genetically superior Murrah bulls throughout the country and abroad.

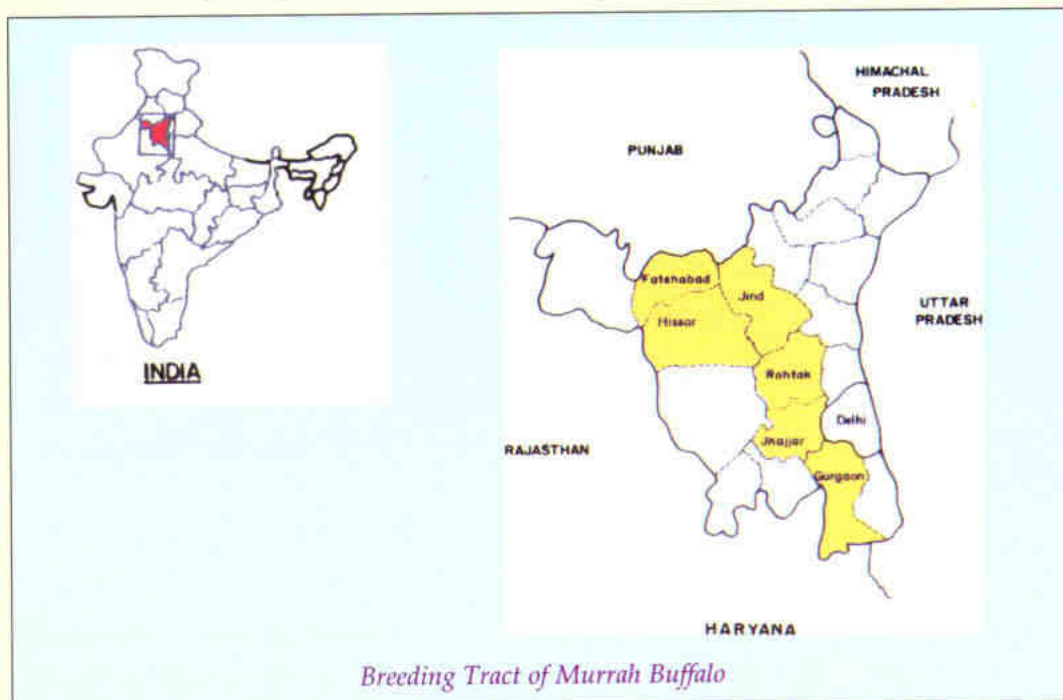
Buffalo milk is more suitable for the manufacture of fat and SNF rich products such as butter, ghee, milk powder and several other products such as Khoya, curd, yogurt, shrikhand, dried ice cream mix, dairy whiteners and above all the Mozzarella cheese – an essential ingredient of “Pizza” - the continental delicacy. Due to prohibition of cow-slaughter in India, buffalo remains an important meat animal as well. Known for its sturdiness and draught power, Murrah males are used extensively for draught and meat purposes. Further, the buffalo can better utilize poor quality roughages (by-products) and thrive well under poor managerial and adverse conditions. In view of its diverse contributions, Murrah is rightly known as “Black Gold”.

Origin and Breeding Tract

Buffaloes, in the northwest region of India have long been selected for high milk production and curled horns. These were named as ‘Murrah’ which means ‘curled’. These buffaloes were also named as ‘Delhi’ referring

to the centre of their origin. Its home tract stretches around the southern parts of Haryana comprising the districts of Rohtak, Jind, Hisar, Jhajhar, Fatehabad, Gurgaon and the Union Territory of Delhi. However, this breed has spread to almost all parts of the country and is being bred either in pure form or is being used as improver breed for grading up local buffaloes. In fact, this breed has even found an important place in the livestock industry of many developing countries like Bulgaria, Philippines, Malaysia, Thailand, China, Indonesia, Bangladesh, Nepal, former USSR, Myanmar, Vietnam, Brazil and Sri Lanka.

The native tract of the breed covering parts of Haryana lies between 28°15' and 30°0' North latitude, and 75°45' and 70°80' East longitude. Soils of the area are mostly light-textured, sandy and loamy. In some parts of the breeding tract surface soils are light in texture but heavier in lower horizons. These soils are deficient in organic carbon and available nitrogen, and medium to high in phosphorus and nitrogen.



The breeding tract has relatively hot and dry climate. Maximum temperature goes as high as 45°C during summer. Minimum temperature may reach near freezing point in winter with frost for a few days. Annual rainfall is around 300 mm in arid zone and 500 mm in semi-arid parts of the tract. These rains are caused mostly by southwest Monsoon during July to September, contributing around 80-85% of annual rainfall.

The major rain-fed crops are pearl millet, sorghum and cluster-bean during *Kharif*, and gram, mustard and barley during *Rabi*. Major crops grown under irrigated cropping system are paddy, wheat, barley and mustard.

Management Practices

In the breeding tract, these buffaloes are kept in a mixed type of housing system. The buffaloes are tied to a tree or a pole in the open, but shelter is provided during extreme weather conditions. Houses are well ventilated and mostly made up of *pucca* walls with *kutchha* floor. Animals are mostly stall fed. Berseem, oat and mustard are the green fodders fed in *Rabi*, and pearl millet, sorghum and cluster bean in *Kharif*. In lean season Murrah animals are maintained on wheat and pulse straws in conjunction with



oilcakes and other concentrates. Mostly, women are engaged in buffalo rearing (80%), and all the activities pertaining to feeding, milking, cleaning etc. are looked after by them. Calves are not weaned. Very few farmers rear bulls exclusively for breeding purposes, other-wise males are used both for breeding as well as draught purpose. Natural service is mostly practiced in the field.

Physical Characteristics

Murrah animals are jet black and massive with long and deep body. Head of female is short, fine and clear-cut. Bulls are heavy and broad with prominent cushion of short and dense hair. Horns are short and tightly curled in a spiral form. Eyes are bright, active and prominent in females but slightly shrunken in males. Ears are short, thin and alert. Neck is long and thin in females, and thick and massive in males. Hips are broad. Fore- and hind-quarters are drooping. Tail is long reaching below the hock up to fetlock and ending in a white switch. Udder is capacious extending from hind legs to just behind navel flap with prominent milk-veins. Teats are long and placed uniformly wide apart. Hind teats are generally longer than the fore teats.

Performance Traits of Murrah Buffaloes

Milk production

Performance traits of Murrah buffaloes are presented in table 1 to 8. Averages of length, height and heart girth of adult males are 150, 142 and 220 cm, and of females 148, 133 and 202 cm respectively. Average birth weight of male calves is 31.7 kg and that of female calves is 30 kg. Adult body weight ranges from 450 to 800 kg (average 567 kg) in males and from 350 to 700 kg (average 516 kg) in females. Average age at first service is around 943.4 days and average age at first calving is 1,319 days. Total lactation milk yield, 305-day milk yield, lactation length and dry period average are 1,678.4 kg, 1,675.1 kg, 307.0 days and 187.6 days respectively, in the first lactation; and 1,751.8

kg, 1,660.1 kg, 298.7 days and 154.8 days respectively for overall lactations. On an average, milk contains about 7.3% fat. Service period averages 177.1 days in first parity and 136.3 days in overall parities. First calving interval varies from 455 to 632 days (average 488.1 days), and overall calving interval varies from 430 to 604 days (average 452.9 days). Number of services per conception varies from 1.75 to 2.15 (average 1.93).

Age at first calving

Averages for age at first calving reported by various workers are presented in table 1. Even though the large variation in this trait indicates scope for improvement, the studies based on large population size indicate the average AFC for Murrah as 4 years.

Table 1. Age at First Calving in Murrah Buffaloes

No. of Observations	Mean± S.E. (Days)	References
478	1485.67±15.25	Sharma and Singh (1990)
412	1362.00±11.00	Gajbhiye and Tripathi (1991)
716	1335.17±08.01	Raheja (1992)
421	1319.48±09.11	Ravindra (1992)
701	1316.46±06.81	Dhara (1994)
716	1374.48±15.99	Gupta et al (1994)
320	1550.60±13.03	Narula et al (1994)
146	1581.00±69.00	Pundir (1994)
628	1381.26±09.26	Dass (1995)
917	1602.82±08.53	Sharma (1996)
685	1374.23±10.37	Jain and Sadana (1998)
832	1330.79±07.42	Nath (1998)
412	1362.30±10.90	Gajbhiye and Tripathi (1999)
289	1618.83±21.25	Kumar (2000)

Lactation milk yield

Milk yield varies from place to place depending upon the management practices and environmental conditions under which animals are reared. Large herds have shown average yield as 1800kg.

Table 2. First Lactation Milk Yield in Murrah Buffaloes

No. of Observations	Mean± S.E. (Kg.)	References
1352	2041.00±52.00	Singh et al (1990)
412	1647.00±44.00	Gajbhiye and Tripathi (1991)
716	1737.00±64.92	Raheja (1992)
424	1869.70±27.91	Sahaha (1993)
114	1832.16±79.28	Shabade et al (1993)
105	1067.32±60.12	Neog et al. (1993)
683	1694.36±27.71	Dhara (1994)
1647	1621.06±28.10	Dutt and Taneja (1994a)
320	1658.95±26.28	Narula et al (1994)
146	1466.00±89.00	Pundir (1994)
450	1482.06±39.98	Muralidhar and Deshpande (1995)
917	1631.52±21.18	Sharma (1996)
615	1693.00±29.70	Sethi and Khatkar (1997)
683	1748.70±26.20	Jain and Sadana (1998)
832	1894.94±21.31	Nath (1998)
396	1646.70±44.20	Gajbhiye and Tripathi (1999)
289	1618.70±38.58	Kumar (2000)



Lactation length

Buffaloes with longer lactation length are generally high milk producers provided they are given sufficient dry period for replenishment before subsequent calving.

Table : 3 First Lactation Length in Murrah Buffaloes

No. of Observations	Mean± S.E. (Days)	References
412	313.00±07.00	Gajbhiye and Tripathi (1991)
716	324.20±02.54	Raheja (1992)
421	302.25±03.10	Ravindra (1992)
114	357.90±12.99	Shabade et al. (1993)
105	274.60±12.60	Neog et al. (1993)
404	306.00±04.00	Dass and Sharma (1994)
683	289.55±03.68	Dhara (1994)
146	366.00±18.00	Pundir (1994)
917	331.30±03.24	Sharma (1996)
615	335.50±05.10	Sethi and Khatkar (1997)
832	333.39±04.89	Nath (1998)
396	313.70±06.70	Gajbhiye and Tripathi (1999)
289	319.50±04.97	Kumar (2000)

Service period

Even though a period of 60 days is allowed as post partum rest, Murrah in general has a long service period of 5-6 months.

Table 4. First Service Period in Murrah Buffaloes

No. of Observations	Mean± S.E. (Days)	References
716	232.09±10.37	Gupta et al (1994)
465	143.96±05.85	Dhara (1994)
917	291.85±07.14	Sharma (1996)
502	149.50±07.90	Jain and Sadana (1998)
832	143.41±03.97	Nath (1998)
243	154.70±05.00	Gujbhiye and Tripathi (1999)
289	177.83±4.70	Kumar (2000)





Dry period

Murrah has an average dry period of six months.

Table 5. First Dry Period in Murrah Buffaloes

No. of Observations	Mean± S.E. (Days)	References
1154	194.87±04.60	Singh et al (1990)
412	146.00±05.00	Gajbhiye and Tripathy (1991)
314	142.02±04.18	Sahana (1993)
469	145.13±04.21	Dhara (1994)
716	184.83±07.12	Gupta et al (1994)
103	212.10±45.00	Pundir (1994)
1647	187.10±05.66	Dutt and Taneja (1995)
917	265.12±05.96	Sharma (1996)
832	137.76±02.81	Nath (1998)
277	145.70±05.00	Gajbhiye and Tripathi (1999)
289	167.00±0.476	Kumar (2000)

Calving interval

Calving interval has direct bearing both on reproduction and production efficiencies.

Table 6. First Calving Interval in Murrah Buffaloes

No. of Observations	Mean± S.E. (Days)	References
412	455.00±08.00	Gajbhiye and Tripathi (1991)
716	505.66±05.51	Raheja (1992)
421	451.36±06.38	Ravindra (1992)
316	448.26±05.63	Sahana (1993)
471	456.22±05.24	Dhara (1994)
716	492.40±11.61	Gupta et al (1994)
337	508.91±07.04	Dass (1995)
917	581.14±07.15	Sharma (1996)
832	462.65±04.53	Nath (1998)
265	455.40±07.90	Gajbhiye and Tripathi (1999)
289	485.13±04.49	Kumar (2000)

Peak yield

Similar to other traits, there is variation in peak yield as well but minimum peak yield of herds is more than 7 kg.

Table : 7 First Lactation Peak Yield in Murrah Buffaloes

No. of Observations	Mean± S.E. (Kg.)	References
1352	9.61±0.18	Singh et al. (1990)
385	8.59±0.25	Gajbhiye and Tripathi (1991)
210	7.10±0.10	Sharma et al (1992)
399	9.64±0.14	Sahana (1993)
369	8.00±0.10	Rao and Rao (1994)
917	7.10±0.10	Sharma (1996)
615	7.90±0.10	Sethi and Khatkar (1997)
289	7.93±0.16	Kumar (2000)

Lifetime milk yield

Buffaloes are not kept in the herd until their natural death, so calculation of milk production for whole life is not feasible in practice. Different criteria had been used for estimating lifetime milk production by different authors. Murrah buffaloes are known for their longevity and persistent yield even in later lactations.

Table 8. Average lifetime milk yield in Murrah Buffaloes

No. of Animals	Mean±SE (Kg.)	Level of lifetime production	References
309	4335.39±103.37	Up to 4 lactations	Biradar et al. (1991)
1647	9993±338	Up to disposal	Dutt and Taneja (1994b)
210	9187.1±101.40	Up to 5 lactations	Sharma et al (1992)
145	4474.61	Up to 5 lacations	Mahdy (1996)
917	7834.4±188.6	Up to 4 lactations	Alli et al. (2000)
2107	5588±40.2	Up to 3 lactations	Kuralkar and Raheja (2000)



Exodus of Murrah Buffalo Germplasm from Breed Tract

Haryana has long been the prime source of Murrah buffaloes for trading all over the country. The state has about 25 lakh adult female buffaloes. Average daily milk yield from these buffaloes is 5.4 litres. In addition to trading in milk and milk products, movement of buffalo breeding stock is considered desirable and gainful for the state as the number of breeding stocks "leaving the state is within the populations abilities to spare". However, the exodus of large numbers of the most desirable genotypes of very high yielding Murrah buffaloes for commercial milk production in the metro cities is turning to be disastrous. Nearly one lakh young high yielding buffaloes (roughly 10% of the best available) leave the state annually for metro cities and almost all of them end up in the slaughter houses after their current lactation. With their untimely loss, the nation is deprived of the priceless progenies that would have otherwise been born to perpetuate the genome. Studies in the Mumbai stables indicated that over 70% of the Murrah buffaloes are of Haryana origin and are in their 1st to 3rd lactation.

Specific efforts have been initiated to tackle this problem. Haryana Govt. has recently established Haryana Livestock Development Board with the main aim of providing quality breeding services. The semen production has been initiated in three locations namely Hisar, Gurgaon and Jagadhari with the state of the art facilities required to produce high quality frozen semen. Identification of high producing buffaloes in the field conditions has been undertaken.

Identification and Propagation of superior Quality Murrah Germplasm

Haryana has initiated a cost incentive scheme to identify meritorious germplasm and to stop exodus and loss of these superior quality Murrah buffaloes. This scheme encourages the breeders to rear high producing buffaloes and retain them for breeding purpose. In addition to the cash incentive, the department purchases male progeny of these identified buffaloes on priority for wider use and improvement. The prize money ranges

from Rs. 1000 to 6000 depending upon the daily milk yield. In this respect around 10,000 buffaloes were identified during the year 2004. The male progeny of these high yielding buffaloes is purchased by the department. It is envisaged that the best of these buffaloes (with dam's peak yield of 18 kg and above) are to be retained for semen production, while the surplus young bulls are to be given to Panchayats at subsidized rates. During 2004, a total of 75 highly meritorious buffalo bulls were added to the semen bank and more than 4000 buffalo bulls were supplied to various Gram Panchayats. The scheme is very popular among the buffalo breeders and on their demand, has now been extended to entire state from the original seven districts.

Haryana is among the few states to provide insurance cover to valuable animals with 50% of the premium being paid by the Haryana Livestock Development Board. The Board whose main objective is to promote and strengthen breeding programme in the state is purchasing Murrah male calves of high pedigree from farmers at remunerative prices. The scheme encourages them not to neglect the male calf which otherwise starve to death. This will go a long way to ensure availability of quality germplasm in near future for production of high quality semen as well as for natural service.



Cash incentive is being given to encourage and promote breeders to keep good quality buffaloes throughout the state. This is helping in harnessing, conservation and propagation of superior Murrah germplasm. The collection, processing and freezing of semen has been upgraded. The National Project for Cattle and Buffalo Breeding (NPCBB) has been geared to promote and undertake progeny testing using ONBS and embryo transfer technology (ETT). An ETT Lab has been set-up at a cost of Rs. 45 lakh. Recognizing the importance of the valuable germplasm in the state and its demand in the rest of the country and abroad, a plan has been drafted to make the state disease free.

The Animal Husbandry Department is purchasing some of the high yielding Murrah buffaloes and keeping them at Govt. Livestock Farm, Hisar as future bull mothers. Performance evaluation is being undertaken through progeny testing programme. This elite herd would consist of 300 buffaloes. Establishment of an embryo bank on the lines of Semen Bank is envisaged to be established.



Central Herd Registration Scheme

CHRS for buffaloes is aimed at locating and registering superior buffaloes based on their production and breed characteristics. A herd book is maintained which enlists the buffaloes that qualify the criteria laid down under Herd Book rules. Minimum standard of lactation milk yield in 305 days is 2000 kg for an award of Rs. 50, 2700 kg. for Rs. 250 and 3200 kg for Rs. 500. So far a total of 2654 lactations were recorded and finally 696 lactations were registered. Average and highest yields are given in table below:

Table 9. Average and Highest Lactation Milk Yield in Buffaloes Under CHRS

CHRS Centre	No.	Average			
		Overall	Best 20 Buffaloes	Best 5 Buffaloes	Best Buffalo
Ajmer	23	3377±55.62	3403	3851	4131
Ongole	104	3197±29.09	3639	3999	4974
Rohtak	2031	3288±6.89	4268	4456	4560

CHRS is also engaged in nominated mating for improvement of breed and has been instrumental in the purchase of 85 Murrah bull calves (progeny of elite cows) for bull rearing farms under the Animal Husbandry Deptt. of Rajasthan. CHRS also maintains and provides information through internet on availability of quality Murrah stock for general use.

Andhra Pradesh Livestock Development Agency (APLDA) has also initiated work on use of Murrah semen for up-gradation of local buffalo population from the Murrah bulls maintained at four different collection centers of the state. Dam's milk yield of top five bulls maintained at these centers is given below:

Table 10. Dam's Milk Yield of Top Five Breeding Bulls at Various Frozen Semen Bull Stations in AP

Station	Dam's Milk Yield (Kg)				
	(1)	(2)	(3)	(4)	(5)
Karim Nagar	4325	4082	4075	4007	3951
Banavasi	3815	3807	3777	3707	3700
Vizag	4880	4880	4380	4283	4270
Nandyal	4325	4055	4050	3965	3762

Source: Andhra Pradesh Livestock Development Agency - Sire Directory (2004)

ICAR Projects on Murrah Buffalo

In addition to several minor projects on different aspects of buffalo productivity in its various Institutes, All India Coordinated and the Network Project have been taken up for genetic improvement of Murrah and other breeds of buffaloes.

All India Coordinated Research Project on Buffalo

This project was launched in 1970 at four centers, of which PAU, Ludhiana and NDRI, Karnal were earmarked for Murrah with the twin objectives of improving the production potential of buffaloes through assessment of genetic merit of sires and to increase the production by breeding, feeding and management. This programme remained in operation till 1980 wherein 12 sires were put to test mating and finally two bulls in each set were selected for elite/nominated mating. More than 2000 doses of semen from these bulls were frozen for subsequent use. Progeny tested bulls of Murrah have been extensively used at the AICRP centers maintaining Murrah breed and other institutional herds in the country.

Network Project on Buffaloes

Network Project on Buffaloes was initiated for sustainable improvement and conservation in the country. The project was initiated by

ICAR during 1993 with six institutional herds viz. CIRB Hisar, PAU Ludhiana, NDRI Karnal, CCSHAU Hisar, IVRI Izatnagar and CCBF Alamadi. Each of these centers has the activities viz. rearing of test bulls and their selection for test mating on institutional herd, evaluation of bulls on the basis of daughters' performance and establishing semen freezing laboratories. Average production characteristics at the centres of Network Project and breedable herd size are presented below:

Table 11. Production Characteristics at Centres of Network Project on Buffaloes (2000-01)

Characteristic	CIRB	PAU	NDRI	HAU
Approx. breedable herd size	320	250	200	150
Av. body wt (kg)	-	552	-	495
Age at first calving (months)	46.2±1.2	44.4	42.4	50.6±2.0
First lact. 305 day or less yield (kg)	1749±65	2000	1785	1894±44
All lact. 305 day or less yield (kg)	1914±36	2032	2019	2183±136
All lact. total yield (kg)	1997±41	2257	2075	2226±152
All lact. length (days)	306±9	347	292	305±16
Av. fat %	-	7.66	7.45	6.70
Av. dry period (days)	153±7	170	111	144±26
Service period (days)	146±9	197	107	146±27
Calving interval (days)	454±9	511	407	497±33
Wet average (kg)	6.68	6.70	6.65	6.70
Herd average (kg)	4.37	4.36	4.23	6.10

Murrah in Other Countries

There is continuing upsurge in the interest for Murrah breed in various parts of the world in order to upgrade the vast non-descript and local populations e. g. in Brazil, Italy, Philippines, Bulgaria and other countries.



In Brazil, Murrah buffaloes from India were imported for meat and milk production. Average milk production was about 6 kg with 7.2 % fat. Brazilian Association of Buffalo Breeders has been supervising the work of interbreeding of these buffaloes with the local buffaloes and registration for further breeding. Efforts have been made to establish purebred herd of Murrah as well as crossbred in Brazil and some adjoining countries (Venezuela, Trinidad, Peru and Guyana).

In Bulgaria, crossing of native Bulgarian buffaloes was done with Murrah imported from India; the performance of crossbred (Bulgarian X Murrah) was close to pure Murrah in body weight and milk yield (1649 kg) with fat content as high as 7.48%. After a few generations of selective breeding in the crossbred population popularly known as Bulgarian Murrah, milk production increased significantly.

Crossbreeding of native buffaloes with Murrah was undertaken in Thailand, China, Vietnam and other Asian countries. Crossbreeding between the riverine and swamp buffaloes doubled the increase in milk yield in one generation, from 438 to 1032 kg in the Philippines (Ranjhan,

1987), and 441 to 1154 kg in China (Youngzuo,1988). Triple crossbreds (Swamp+ Murrah+ Nili Ravi) produced as high as 1913.7 kg milk with 6.69% fat in China (Jianxin 1990).

In Philippines, 854 Murrah and Nili-Ravi buffaloes were imported from India between 1917 to 1956. These animals were distributed to a number of institutions. This stock was used for the production of Phil-Murrah and Phil-Ravi for combining draught, milk and meat production characteristics. In Vietnam, a Murrah herd of 650 buffaloes was established in 1978 at the Buffalo Research Center.

Export Potential of Murrah Buffalo

Murrah is the finest genetic material of buffalo in the world. This breed is comparable to the best dairy cows of the world in performance. This distinct status of Murrah Buffalos needs to be capitalized as there is huge scope for export of these animals. Besides acquiring hard foreign currency, the Murrah export is deemed necessary to sustain the tempo of the farm sector as a whole. Above all, the export of buffaloes or semen thereof will pick up at a much faster pace than that of traditional items. Under the present package of scientific breeding, the Murrah buffalo keeping is a commercially viable agro-based industry promising regular dividends to the individual breeder and multiple benefits to society at large.

Buffalo keeping and husbandry being a way of life in Haryana, the state has the privilege of being known as the 'livestock mint of India'. Haryana is now coming up as a market for producing export quality stock i.e. buffaloes capable of milk yields as high as 35 kg a day. Export of Murrah buffaloes (or semen thereof) assumes further significance as it will contribute towards employment generation, apart from diversification of overburdened agriculture. The export trade in high yielding buffaloes will prove as a prime mover for development of the breed. There is a need for developing strategic plans to increase the frequency of the best genotypes in the population, faster

than they are depleted. Globalization of Murrah would ensure not only better returns to the farmers but would also facilitate the much-needed capital formation in the rural sector.

In view of the fact that Murrah has adapted well in varied conditions and has widespread demand in other parts of India and abroad, renewed efforts have been initiated for its improvement and propagation. A five-year Murrah project under the Animal Husbandry Department envisages identifying top quality 1.5 lakh young buffaloes and giving incentives to the farmers to rear them. It would be concentrated in "Murrah-centric" villages of Hisar, Bhiwani, Jhajjar, Rohtak, Sonapat, Jind and Fatehabad where the Murrah is traditionally found. Under this project, the rearing of the animals would be undertaken under government supervision which would provide for its upkeep and maintenance. Once the animals "come of age", these would be ready for export to different parts of India and other countries.



Genetic Characterization of Murrah Buffaloes

Cytogenetic characterization of Murrah buffalo

It is established now that Asiatic river buffalo possesses 50 chromosomes. In Murrah, chromosomes of male buffalo from testicular tissue and from sperms revealed a haploid karyotype of 25 elements with 24 autosomes and one sex chromosome. Five autosomes were submetacentric, other 19 autosomes acrocentric, X and Y chromosomes also recorded to be acrocentric. X-chromosome is largest acrocentric pair in karyotype, easily distinguishable, whereas Y chromosome being smaller acrocentric, not distinguishable from other autosomes. An analysis of C-banded, G-banded metaphases revealed Y chromosome of Murrah occupying a position between chromosome 19 and 20, thus, can be used as a technique for identification of Y chromosome.

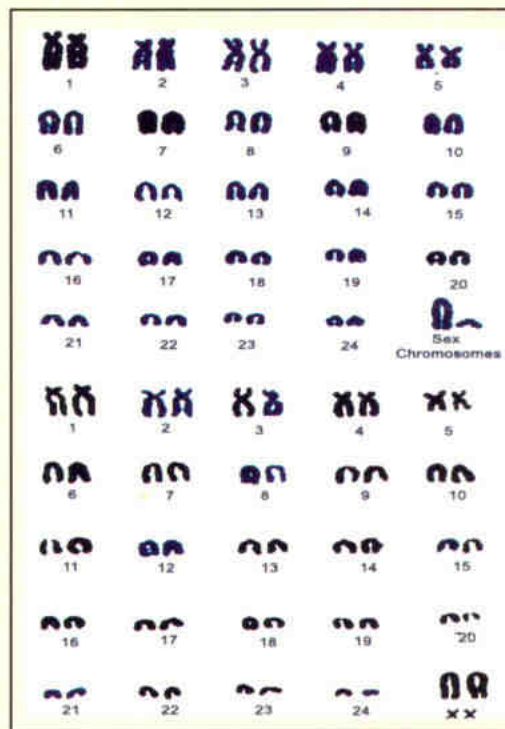


Fig. 1 Normal Karyotype of a Male (above) and a Female (below) Murrah Buffalo

Characterization of Murrah buffaloes using microsatellite DNA markers

Murrah buffalo is the breed of choice among the farmers through out the country due to its high milk yield. With the aim to study the genetic diversity in Indian buffalo population, microsatellite based genetic polymorphism study was initiated at DNA Fingerprinting Unit of NBAGR. Blood samples from 110 unrelated Murrah animals were collected from the villages of districts Rohtak and Jhajjar with the help of Central Herd Registration Scheme, Rohtak. As microsatellite markers isolated from buffalo genome were not available, microsatellite markers isolated from cattle genome were studied for their suitability in buffalo genome analysis. Using 25 selected microsatellite markers, the Murrah breed was genotyped.



Fig. 2 Microsatellite polymorphism at locus ILSTS 056 in Murrah Buffaloes

The number of alleles ranged from 3-10 for the 25-microsatellite loci studied in Murrah buffalo genome. The observed heterozygosity was maximum (0.88) at locus ILSTS 058 whereas it was minimum (0.31) for locus ILSTS 019. Out of 25 loci, 20 loci have heterozygosity more than 50%. It

indicated the suitability of these markers for polymorphism study in Murrah buffalo populations. Majority of these loci showed allelic ranges which were similar to that reported in the cattle genome.

Study on genetic relatedness and diversity

The RAPD-PCR technique has been applied as a means to achieve rapid screening of large number of primers for their capacity to detect genetic polymorphism in Murrah and Nili Ravi buffalo breeds. A total of 50 random primers were screened to detect relatedness and diversity between the two breeds. Out of 50 random primers screened, 26 (52%) revealed polymorphism between Murrah and Nili Ravi buffaloes and a total of 263 bands were generated using 26 primers with a range of 3 (OPG 06 and B4) to 26 (OPJ 04). Average band sharing within Murrah and Nili Ravi buffaloes was 0.783 and 0.730 respectively, whereas between breed band sharing value was 0.686. The Nei's (1972) standard genetic distance of 0.119 between Murrah and Nili Ravi clearly revealed a close genetic relatedness between these two North Indian buffalo breeds.

Characterization of mammary gland genes

Under a Department of Biotechnology Sponsored Project at NBAGR, Karnal, an expressed sequence tags (EST) library representing 2200

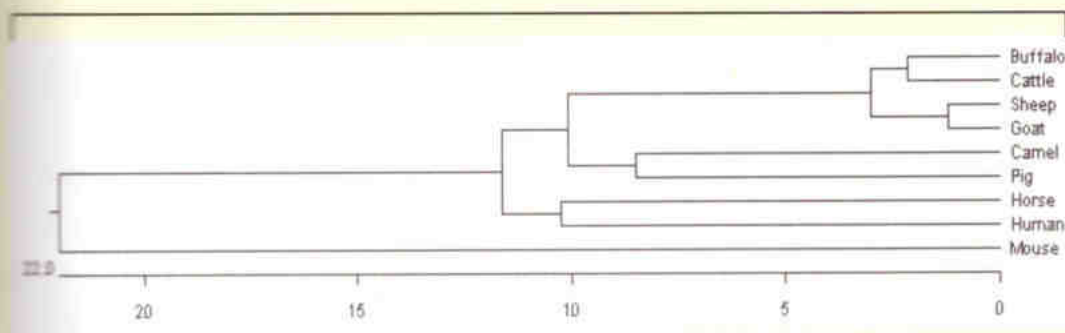


Fig. 3 Phylogenetic Analysis of Kappa Casein gene sequence

clones has been constructed from lactating Murrah buffalo mammary gland. The average insert size in the library was 600 bp with a range of 0.3 to 2.5 kb. Unbiased expression profile of non-normalized mammary gland cDNA library revealed majority (72.5%) of the transcripts expressed in lactating buffalo to be represented by the four milk protein genes (alpha S1, alpha S2, beta- and kappa-caseins). Complete sequence characterization of major milk protein genes has been accomplished and sequences submitted to GenBank. Phylogenetic analysis based on kappa casein gene sequence analysis grouped buffalo close to cattle.

Breeding Farms

1. Buffalo Breeding Centre, NDDDB, Nekarikallu, Andhra Pradesh
2. Government Livestock Farm: Banavasi; Horesikullu; Karimnagar; Kakinada; Mamnoon; Reddipalli; Visakhapatnam, Andhra Pradesh
3. Government of Assam: Barpeta; Berhampur; Guwahati; Jagdaur; Khanikar; Pachmile; Silchar, Assam
4. Government of Bihar: Sairakela; Sepaya, Bihar
5. Government of Goa, Dhat
6. Amul Research and Development Association, Gujarat
7. Sabarmati Ashram Gaushala, Bidaj, Gujarat
8. Government Livestock Farm, Hisar, Haryana
9. Central Institute for Research on Buffaloes, Hisar, Haryana
10. Choudhary Charan Singh Haryana Agricultural University, Hisar, Haryana
11. National Dairy Research Institute, Karnal, Haryana
12. Central Cattle Breeding and Research Farm, Beli-Charna, Jammu & Kashmir
13. National Dairy Research Institute, Southern Regional Station, Bangalore, Karnataka
14. Government of Karnataka: Bankapur; Hessarghatta; Koila; Kurikuppi; Torongal

15. Government of Kerala, Kodapanakunnu, Kerala
16. Kerala Livestock Development Board Ltd.: Dhoni; Kulathupuzha; Mattupetty; Peermade
17. Government of Madhya Pradesh: Anjora, Durg; Kiratpur; Ratona
18. BAIF Development Research Foundation, Uruli-Kanchan, Maharashtra
19. Government of Punjab, Mattewara, Punjab
20. Punjab State Coop. Milk Producers' Federation Ltd., Bhattian, Punjab
21. Central Cattle Breeding Farm, Alamadi, Chennai, Tamil Nadu
22. Agricultural College and Research Institute, Coimbatore, Tamil Nadu
23. Government of Tamil Nadu: Hosur; Ooty; Orathanadu; Pudukottai; Tirunelveli; Chettinad
24. Government of Uttar Pradesh: Hastinapur; Lakhimpur; Manjhara; Neelgaon
25. Pradeshik Co-operation Dairy Federation, Moradabad, Uttar Pradesh
26. Government of West Bengal, Haringhatta, West Bengal

Contact Agencies

1. Central Institute for Research on Buffaloes, Hisar, Haryana.
2. National Dairy Research Institute, Karnal, Haryana
3. Department of Animal Husbandry, Haryana
4. Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India, New Delhi

References

- Alli, A.; Ahmed, Z.; Mohiuddin, G. and Akhtar, P. 2000. Genetic and phenotypic parameter of some lifetime performance traits in Nili-Ravi buffaloes. *Buffalo Bulletin*. 17 (1):3-6 (Animal Breed. Abstr.), 68:485.
- Anonymous 2005. Central Herd Registration Scheme (CHRS), Dept. of AH & Dairying, Mini. of Agri. (GOI), New Delhi, Herd Registration Scheme Rohtak- 124 001 (Haryana) [<http://dahd.nic.in/chrs.htm>].

- Biradar, U.S.; Harapanahalli, M.D.; Bhat, A.R.S. and Mallikarjunappa, S. 1991. Lifetime production in Surti buffaloes. *Indian J. Dairy Sci.* 44: 352-353.
- Dass, G. 1995. Studies on prediction of lactation yield on test day values in buffaloes. Ph. D. Thesis, NDRI Deemed University, Karnal, India
- Dass, G. and Sharma, R.C. 1994. Factor affecting milk production in Murrah buffaloes. *Indian J. Anim. Res.* 28: 61-64.
- Dhara, S. K. 1994. Prediction of breeding of milk production by multiple regression and principal component analysis in Murrah buffaloes. M.Sc. Thesis, NDRI Deemed University, Karnal, India.
- Dutt, T. and Taneja, V. K. 1994b. Estimates of phenotypic and genetic parameters on lifetime performance traits in Murrah buffaloes. *Indian J. Anim. Sci.* 64: 384-387.
- Dutt, T. and Taneja, V. K. 1994a. Phenotypic and genetic parameters of age at first calving, first lactation milk yield and some measures of efficiency of production in Murrah buffaloes. *Indian J. Anim. Sci.* 64: 966-968.
- Dutt, T. and Taneja, V. K. 1995. Genetic studies on first lactation length, first dry period and first calving interval in Murrah buffaloes. *Indian J. Anim. Sci.* 65: 339-340.
- Gajbhiye, P.U. and Tripathi, V.N. 1991. Factors affecting peak yield and days to attain peak yield in Murrah buffaloes. *Asian J Dairy Sci.*, 10(3): 166-168.
- Gajbhiye, P.U. and Tripathi, V.N. 1999. Effect of season, period and age at first calving on first lactation traits in Murrah buffaloes. *Indian J Dairy Sci.*, 52: 199-203.
- Jain, A. and Sadana, D.K. 1998. Effect of genetic and non genetic factors on first lactation traits in Murrah buffaloes using alternate models. *Indian J. Anim. Sci.* 68:950-953.
- Kumar, A. 2000. Genetic studies on first lactation traits in Murrah buffaloes. M.V.Sc. Thesis, CCS HAU, Hisar, India.

- Kuralker, S.V. and Raheja, K.L. 2000. Factors affecting first lactation and lifetime traits in Murrah buffaloes. *Indian J. Dairy Sci.* 53 (4) : 273-277.
- Mahdy, A.E. 1996. Lifetime performance in Egyptian buffalo. *Alexandria J. Agric. Res.* 39 (3) : 69-87. (Animal Breed. Abstr.), 64: 395.
- Murlidhar, Y. and Deshpande, K.S. 1995. Factors affecting production efficiency traits in Murrah buffaloes. *Indian J. Dairy Sci.* 48 :40-42.
- Narula, H.K. ; Chhikara, B.S. ; Kanaujia, A.S. and Saini, A. 1994. Factors affecting some economic traits of production in Murrah buffaloes. *J. Dairying, Foods and Home Science* 13:98-102.
- Nath, M. 1998. Breeding value evaluation for milk production in Murrah buffaloes. M.Sc. Thesis, NDRI Deemed University, Karnal, India.
- Neog, P.K.; Das, D. And Goswami R.N. 1993. First lactation traits of Murrah buffaloes under the farm condition of Assam. *Indian Vet. J.* 70 : 232-235.
- Nivsarkar, A.E.; Vij, P.K. and Tantia, M.S. 2000. Animal Genetic Resources of India Cattle and Buffaloes, ICAR, New Delhi- 110 012.
- Pundir, R.K. 1994. Estimation of environmental effects on first lactation traits in Murrah buffaloes by maximum likelihood. *J. Dairying, Foods and Home Science* 13 : 77-82.
- Raheja, K.L. 1992. Comparison of progeny testing of Sahiwal sires by different methods of sire evaluation. *Indian J. Dairy Sci.* 45:64-69.
- Rao, N.A.V. and Rao, H.R.M. 1994. Peak yield as related to lactation traits in Murrah buffaloes. *Indian Vet. J.* 11: 1207-1209.
- Ravindra Kumar, 1992. Effectiveness of additive and multiplicative age correction factors for sire evaluation in Murrah buffaloes. M.Sc. Thesis, NDRI Deemed University, Karnal, India.
- Sahana, G. 1993. Association between productive and reproductive traits in Murrah buffaloes. M.Sc. Thesis, NDRI Deemed University, Karnal, India.
- Sethi, R.K. and Khatkar, M.S. 1997. Genetic parameters of production traits in Murrah buffaloes. *Indian J. Anim. Sci.* 67:141-142.

- Shabade, N.S.; Jagtap, D.Z. and Behla, N.D. 1993. Factors affecting production and production efficiency traits of first lactation in Murrah buffaloes. *Indian J. Anim. Sci.* 63: 1212-1213.
- Sharma, I.H.; Singh, Harpal and Prasad, R.B. 1992. Prediction of lifetime milk production from production traits in Murrah buffaloes. *Indian J Anim. Genetics and Breeding.* 14:27-28.
- Sharma, R.C. 1996. A study on selection indices based on different approaches for genetic improvement in buffaloes. Ph. D. Thesis, CCS HAU, Hisar, India.
- Sharma, R.C. and Singh B.P. 1990. Genetic studies on Murrah buffaloes in livestock farm in Uttar Pradesh. Proceedings II World Buffalo Congress held at New Delhi, India. 12-16 Dec. 1990.
- Singh, S.S., Rathi, S.S. and Sangwan, M.L. 1990. Environmental variances affecting production efficiency in Murrah buffaloes. *Buffalo J.* 6:105-112.
- Sire Directory, 2002. Network Project on Buffalo, C I R B, Hisar -125 001.
- Sire Directory, 2004. Andhra Pradesh Livestock Development Agency, Shantinagar, Hyderabad – 500 028.



Published by : Director, NBAGR

For enquiries, please contact :

DIRECTOR, NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES
(Indian Council of Agricultural Research)

P.O. Box. No. 129, G.T. Road By-Pass, Near Vasant Vihar, KARNAL - 132001 (Haryana)
Tel. : 0184-2267918 Fax : 0184-2267654 E-mail : director@nbagr.ernet.in