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Buffalo Breeding Research and Improvement Strategies in India

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Dairy buffalo production has been a tradition in parts of the world like the Caucasian countries. Asia and Egypt, where fresh buffalo milk, dahi (cultured sour milk), ghee (butter oil) and yoghurt are popular. In Italy the dairy buffalo industry is flourishing thanks to the popularity of buffalo mozzarella cheese. Because of the market for Mozzarella, buffalo farming is a profitable enterprise and is carried out in an organized manner with modern equipment. In South American countries like Brazil and Argentina, buffalo reared for both milk and meat. In recent years buffalo milk and milk products, especially Mozzarella cheese, have become immensely popular and dairy buffalo production has founds its way into non traditional areas with the number of buffalo farms mushrooming.

In India as well as Pakistan, in the vicinity of all the major cities like Mumbai, Calcutta and Karachi one can find a large number of buffalo farms of varying herd sizes. In Mumbai alone there are more than 200000 buffalo in down town districts and probably another 100000 in sub urban areas. Some of these herds have more than 1000 buffalo, an on average these herds have more than 100 buffaloes. Large scale dairy buffalo production is a greater reality in India and Pakistan than any where else in the world even though it represents less than two percent of the buffalo farms in these two countries.

Population:

There are 170 million buffalo in the world today, 97% in Asia, 2% in Africa mainly in Egypt, and 0.2% in Europe mainly in Italy (FAO, 2004). India has 56%, Pakistan 14% and China 13% of world buffalo population nearly 98% of water buffalo in Asia and the pacific region are raised by small farmers owning less than two hectares of land and fewer than five buffaloes. Buffalo contribute 72 million tones of milk and three million tones of meat annually to world food, much of it in areas that are prone to nutritional imbalances. In addition they are a major source of draught power, and that is why buffalo have been called the live tractor of the east.

India has over 97.9 million (census 2003) and they number to approximately 56.6% of total world buffalo population. Compared to the period 1981-82 buffalo number (69.8 millions) increased by a total of 28.10 million. The percent increase during 1997-03 is estimated 1.43% per annum as compared 2.39% during 1977-82, 1.71%/annum during 1982-87 and 2.08%/annum during 1987-92 respectively. (Table –1)

Today the average per capita availability of milk in India has reached 246 gm per day. When the world milk production in 2008 is around 700 million tones, India has produced 106 million tones. This was achieved due to the bovine population of 283 million (185 millions cattle and 98 millions buffaloes), and its strong wide spread milk procurement system. Today, the livestock sector contribution to agriculture GDP is around 25-28%. Dairy sector contribution is around 65-70% to livestock sector. The goals of the 11th five year plan for the livestock sector are expected to achieve an overall growth between 6% to 7% per annum for the sector as a whole and the milk production growth is estimated to 5% per annum form 100 million tones form 2008 to 126.42 million tones by 2011-12.

Breeds, their description and evaluation

Riverine (dairy type) buffaloes:

Around 65 percent of the river buffaloes are non-descript type and do not belong to descript breeds. The buffalo breeds may be grouped into following classes.
1. Horns are closed and set close to head & are down swept: e.g. Murrah, Nili-Ravi, Mehasana, Jaffarabadi, Sambalpur
2. Horns are sickle shaped and unswept: e.g. Bhadawari, Kalahandi, Kanara, Manda, Nagpuri, Pandharpuri, Tarai & Toda

Breeds of buffaloes of Indian origin and breeding tracts:

Group	Breed	Breeding tract
Murrah type	Murrah, Nili- Ravi	Rohtak, Jind, Hisar, Bhiwari, Sonepat (Hariyana) Ferozepur (Punjab)
Gujarat	Surti Jaffarabadi Mehasana	Kaira and Baroda, Kutch, Junagarh & Jamnagar distt. Mehsana, Sabarkantha, Banaskantha distt.
Uttar Pradesh	Bhadawari Tarai	Bhadawari estate, Beh Tehsil in Agra, Gwalior & Etawah distt. Tarai region of U.P.
Central India	Nagpuri Pandharpuri Kalahandi Sambalpur	Nagpur, Akola, Amarawati dist. South Maharashtra, West A.P., North Karanataka, Hilly region of Andra Pradesh and Orissa Bilaspur dist.
South India	Toda South Kanara	Nilgiri Hills West coast in Kerela

Buffalo found in the north-eastern states and the eastern costal region of India, China, South east Asian countries e.g. Philippines, Thailand, Malaysia, Vietnam, Srilanka, Burma, Laos, Kampuchea, Bangladesh etc., have been classified as swamp buffaloes on the basis of their genetic constitution (2n=48) & natural habitat.

Purpose of buffalo rearing:

In rural India, buffaloes are reared for milk production along with limited use of males for draught and meat production. The main purposes of rearing of riverine buffaloes are:

1. Milk Production
2. Meat Production
3. Draught Animals

Buffalo production system in rural areas:

Due to the better animal husbandry practices significant improvement has taken place in the buffalo production system in rural areas. The awareness in the farmers about the feeding, breeding and health management of live-stock considerably increased. The buffalo production system in rural areas may be classified as:

1. Extensive: Small farm, with a maximum of 2 buffaloes, kept on natural grasses, in communal paddocks during the rainy season. Agricultural by-products are used for feeding, marginal land, family labour and minimum investment, with simple, traditional technology.

2. Semi Intensive: Animals are kept in irrigated areas, with cultivated fodders, crop by-products and concentrates. Buffaloes are confined in adequate buildings.

3. Intensive: Herd strength ranges from 5 to 100 buffaloes, kept for milk production as in Haryana, Punjab, Uttar Pradesh, Rajasthan, Gujrat and close to the large populated areas in India. The herds are fed on cultivated fodders and concentrate.

Performance characteristic of different types of buffaloes

Body weight at different ages:

The birth weight in various buffalo breeds varies between 26-41 kg (Singh et al 1984, and Vijai et al 1993). As per the reports available in literature on body weights across the breeds revealed that Nili-Ravi had higher body weights at different ages followed by Murrah while, Surti had the lowest weight at all the ages (Singh, et al 1984, Tiwana, et al 1985 and Vijai et al 1993). The weight at first calving is found to range between 335-542 kg, it being highest in Nili Ravi (Singh and Yadav, 1986) and lowest in medium sized buffaloes (Tailor et al 1990 and Vijai et al 1993). Growth in general was linear from birth to 36 months. The average daily gain rages from 548 gm (3-6 months) to 404 gm (birth to 36 months).

Breeding behaviour:

Buffaloes continue to come in heat regularly in all months, highest being in October and lowest in April. However, Tiwana et al (1985), Singh 1985 and Tailor et al (1990) reported that around 75 percent of total calving took place during July to January (the most calving season) and 25 percent during February to June (the least calving season) suggesting that buffaloes are seasonal breeder. Buffaloes come in oestrus in cold month and are sub fertile during hot month. Sub fertility in the buffaloes and poor nutrition.

Age at first calving:

A large variation in age at first calving among different breeds of buffaloes was observed, it being highest (54.6 months) in village buffaloes chhikara et al (1978). The averages based on large numbers in Murrah and Nili Ravi were between 40 and 45 months (Singh and Yadav 1987, Singh et al 1987, Kanaujia et al 1990 and Singh et al 1992). In Surti and Bhadawari buffaloes, the age at first calving was slightly higher (46-54 months) reported by Punhir et al 1996 while Pandharpuri buffaloes had an average age at first calving between 38.4 and 39.8 months (Patil et al 1994).

Calving interval:

The first calving interval in Murrah and Nili Ravi buffaloes varies between 480-573 days (Singh et al 1987, Singh et al, 1992 and Dutt and Taneja, 1995). In Bhadawari buffaloes it was 525 days (Pundir et al 1996). Average calving interval in Surti buffaloes was 462 days.

First dry period:

The over all dry period ranged from 90-126 days in different buffalo breeds (Johari and Bhat 1979 and Singh et al 1992).

Service period:

A large variation in service period across the breeds has been observed. The over all service period in different buffalo breeds ranged from 115 days to 202 days (vij, 1984 and Singh et al 1992).

Lactation length:

Lactation length is an important trait influencing the lactation milk yield in buffaloes. The overall lactation length in Murrah buffaloes ranged from 245 days (Baru and Ghai, 1978) to 355.39 days (Singh et al 1987). However, in Nili Ravi and Surti buffaloes, average lactation length ranged from 300 days to 356 days (Singh et al 1987 and Kanaujia et al 1990). In Bhadawari, Marathwada and Nagpuri buffaloes, the over all lactation length was 376, 310 and 200 days respectively (Belorkar et al 1977).

Part and total lactation milk yield:

The use of part lactation records is made to reduce testing period to rank the bulls for their merit at an early age. Several workers (Gokhale, 1974, Kumar et al, 1977, Singh 1985, Singh and Yadav, 1986 and Singh and Yadav, 1987) reported that selection for milk yield could more effectively be done on part lactation because of its high heritability than the complete lactation yield. Around 10.75% of total milk yield was produced in first month of lactation while around 12.5%

and 11.25% of total milk were produced in second and third month of lactation respectively. Singh (1985) reported that 34.40% of total milk was produced in first three months of lactation.

The average first lactation milk yield in Murrah buffaloes varied between 1540 to 1867 kg (Singh et al 1984, Singh and Yadav 1987, KhatKav et al 1996), while in Nili Ravi, it was 1776 kg (Singh and Sigh 1989). The first lactation averages for Bhadawari, Nagpuri and Marathwada were between 693 and 926 kg (Belorkar et al 1977, Sharma and Singh 1978, and Pundir et al, 1996).Pandarpuri buffaloes gave a first lactation milk yield of 1375 and 1226 kg respectively in urban and rural areas (Patil et al, 1994). Compared performance details of Nili Ravi breed of Pakistan, Murrah of India and Egyptian buffaloes and found that 38% of all lactations in Nili Ravi had more than 2700 kg of milk as against 14% of all lactations in Murrah and 6 % in Egyptian buffaloes. Milk yield increased over the lactations with peak yield in fourth lactation (Patro and Bhat 1979 and Tailor et al 1992). More than 50% of the buffaloes left the herd by the end of fourth lactation and between 1 and 3% completed 10 lactations. Percentage of lactation terminated due to heath, reproductive problems and death were around 30% each in lactation 1 and 2 (Cady et al 1993).

Life time milk yield and productive life:

Nili Ravi and Murrah breeds on an average completed 3 lactations, some studied reported the average number of lactations completed in Murrah to vary from 4.4 to 5.8 with life time yield 8914-9994 kg (Sharma and Basu, 1986,Dutt and Taneja, 1994) and 4.5 to 5.6 lactations in Nili Ravi buffaloes (Cady et al. 1983). The average number of lactations completed and life time milk yield in Surti were 3.72 and 4960 kg respectively (Kulkarni, 1995). The average productive life in Murrah and Nili Ravi buffaloes ranged between 72.0 and 83.29 months (Johari and Bhat, 1979, Gokhale and Nagarcenkar, 1980 and Singh and Yadav, 1986).

Meat:

Buffalo has not been exploited fully as a meat animal in India though there is little religious taboo to their slaughter. About 86% of the world buffalo meat production is in Asia and mostly from old and culled animals. This meat is dark, is less tender, has a strong odour and thus is generally unacceptable. However, when young buffaloes are raised under intensive feeding their meat is lean, tender and highly palatable compares favourable with beef form cattle of similar age and weight. The dressing percentage in buffaloes is slightly lower than in cattle.

Draughtability:

In India 60% of the total farm power is derived form draught animals of which about 10% is from buffaloes. A buffalo can pull loads more than 6 times of its own body weight, but its usual load carrying capacity is 1-5 to 2.0 tones i.e. 3 to 4 times of its body weight. These loads it can pull for 2-3 hours continuously and for 6-8 hours in a day during winter and 5-6 hours in a day during summer with rest in between.

Constraints on buffalo improvement programmes in India:

India is located in the region bounded by latitudes 300S. Climatic stresses in the form of high ambient temperature, high humidity and erratic or inadequate rainfall all severely affect the productivity of dairy cattle. Low fodder yield potential, high prices of concentrates and susceptibility to a wide variety of animal diseases further to add to the problem. Generally, high intrinsic production is physiologically antagonistic to heat tolerance, survival and tolerance to parasites.

Poor education and management expertise of farmers, lack of knowledge at farm level about the genetics of milk production, poor understanding of production system, lack of feed-back to practical breeders, and shortage of qualified extension workers and week linkage between extension functionaries and farmers/ livestock keepers have been observed. Partial or complete lack of the infrastructure required for operating effective improvement programmes led to poor communications, in efficient recording system and poor data collection.

Breeding policy for buffaloes:

Target for genetic up-gradation:

a. Breeding Policy for buffalo should be in consonance with National Project for Cattle & Buffalo Breeding (NPCBB).

b. The aims of it should be to increased productivity of buffaloes by genetic improvement. However, its aim should be of conservation of native breeds.

c. In order to achieve self sufficiency in milk production its aim should be to achieve a level of 60% in respect of genetically improved buffaloes by end of year 2015 (instead of the year 2010 as envisaged under NPCBB due to delayed implementation of the said project in the states) and to further improve it to 80% by the end of year 2025.

d. This should be expected to be achieved through the consolidated and collective efforts of all the agencies engaged in buffalo breeding activity viz. State Animal Husbandry Department, Co-operative Milk Unions, NGOs, Private Sector Agencies and unorganized AI workers in the state.

Germplasm:

Semen of Surati, Murrah, Nili Ravi, Mehsana, Zafarabadi, Pandharpuri and Nagpuri buffaloes will be used for genetic up-gradation of non-descript buffaloes and also for performance- enhancement of descript buffalo-breeds.

Strategy:

a. Buffaloes of descript breeds (viz. Surati, Murrah, Nili Ravi, Mehsana, Zafarabadi, Pandharpuri & Nagpuri) should be bred only with semen of proven bulls of respective breed.

b. Non-descript buffaloes should be bred with germplasm of any one of the identified breeds except Mehsana & Jafarabadi. However, subsequent selective breeding will be aimed at increasing inheritance level of the first selected breed. For this, superior germplasm of respective breed of higher pedigreed bulls will be used.

c. Conservation of Pandharpuri, Tarai, Bhabawari and Nagpuri buffaloes will be practiced especially in their home tracts and in other areas having similar geo-climatic conditions. These breeds will be used for up-grading non-descript buffaloes if demanded by owners.

Conservation of indigenous breeds of buffaloes:

a. Pandharpuri, Tarai, Bhabawari and Nagpuri breeds of buffalo, need to be protected and propagated.

b. Suitable technology for breed identification shall be introduced and a team of properly trained man-power will be made available for this purpose with the help of National Bureau of Animal Genetic Resources (NBAGR), Karnal, Haryana.

c. The Breeder's Association will not only be encouraged to get involved in conservation of indigenous breeds but also will be allowed to function on in accordance with principles of management under its articles of association.

d.System of herd registration, suitably designed milk competition etc will be introduced to identify the high-yielder animals of indigenous breed and putting in place a suitable system of buy-back of pedigreed male-calves for developing them in to breeding bulls.

Table 1. State wise total number of buffaloes and annual growth rate 1992 to 2003

Sl. No.	States/ UTs	1992	2003	Annual growth rate (%) 1992-2003
1	Andhra Pradesh	9154	10630	1.46
2	Arunachal Pradesh	5	11	10.90
3	Assam	959	678	-2.66
4	Bihar	5353	5743	0.66
5	Chhatisgarh	-	1598	-
6	Goa	44	37	-1.45
7	Gujarat	5268	7140	3.23
8	Haryana	4373	6035	3.46
9	Himachal Pradesh	703	774	0.92
10	Jammu & Kashmir	732	1039	3.81
11	Jharkhand	-	1343	-
12	Karnataka	4251	3991	-0.56
13	Kerala	296	65	-7.09
14	Madhya Pradesh	7970	7575	-0.382
15	Maharastra	5448	6145	1.16
16	Manipur	115	77	-3.0
17	Meghalaya	34	18	-4.28
18	Meizoram	7	6	-1.30
19	Nagaland	34	34	-
20	Orissa	1539	1394	-0.86
21	Punjab	5238	5995	1.31
22	Rajasthan	7743	10414	3.14
23	Sikkim	2	2	-
24	Tamilnadu	2814	1658	-3.73
25	Tripura	20	14	-2.73
26	Uttar Pradesh	20066	22914	1.29
27	Uttaranchal	-	1228	-
28	West Bangal	1010	1086	0.68
29	Andaman & Nikobar	15	16	0.60
30	Chandigarh	23	23	-
31	Dadar and Nagar Haveli	3	4	3.0
32	Daman & Diu	1	1	-
33	Delhi	285	231	-1.72
34	Lakshadweep	-	-	-
35	Pandicherry	7	4	-3.90
Total		**83499**	**97922**	**1.57**

Source – Livestock census 2003, India

Table 2. State wise share of milk production by buffaloes during 2003-2004

Sl. No.	States/ vTS	Total milk production (000 to nnes)	Milk Production by buffaloes (000 to nnes)	No. of buffaloes (thousands)	% of buffalo milk over total	Avg. yield for animals
1	Andhra Pradesh	6959	5209	10630	74.85	490.00
2	Arunachal Pradesh	46	-	11	-	-
3	Assam	727	92	678	12.65	135.69
4	Bihar	3180	1824	5743	57.36	316.60
5	Goa	48	23	37	47.92	621.62
6	Gujarat	6421	4116	7140	64.10	576.47
7	Haryana	5221	4089	6035	78.32	677.55
8	Himachal Pradesh	786	379	774	48.22	489.66
9	Jammu & Kashmir	1414	-	1039	-	-
10	Karnataka	3857	1350	3991	35.00	338.26
11	Kerala	2111	40	65	1.89	615.38
12	Madhya Pradesh	5388	2887	7575	53.58	381.12
13	Maharastra	6379	2915	6145	45.70	474.36
14	Manipur	71	13	77	18.31	168.83
15	Meghalaya	69	2	18	2.90	111.11
16	Meizoram	15	1	6	6.67	166.67
17	Nagaland	63	1	34	1.58	29.41
18	Orissa	997	206	1394	20.66	147.78
19	Punjab	8391	6140	5995	73.17	1024.19
20	Rajasthan	8054	4899	10414	60.82	470.42
21	Sikkim	48	0	2	-	-
22	Tamilnadu	4752	1429	1658	30.07	861.88
23	Tripura	84	2	14	2.38	142.85
24	Uttar Pradesh	15943	10512	22914	65.93	458.75
25	West Bangal	3686	302	1086	8.19	278.08
26	Andaman & Nikobar	25	5	16	20.00	312.50
27	Chandigarh	44	30	23	68.18	13.4.34
28	Dadar and Nagar Haveli	8	-	4	-	-
29	Daman & Diu	1	-	1	-	-
30	Delhi	299	216	321	72.24	935.06
31	Lakshadweep	1	-	-	-	-
32	Pandicherry	40	2	4	5.00	500.00
33	Chattishgarh	812	272	1598	33.50	170.21
34	Uttaranchal	1188	742	1228	62.46	604.23
35	Jharkhand	954	281	1343	29.45	209.23
	Total	**88082**	**47979**	**97922**	**54.47**	**489.97**
	1993-94	60607	32527	83499	53.67	389.55

Source - Livestock census report 2003, Department of Animal Husbandry, Dairying and fisheries India.

Table 3. Productive and reproductive performance of different buffalo breeds

Breeds of buffaloes / Traits	Murrah at PAU, Ludhiyana	Jaffarabadi at GAV, Juna-garh	Nili-Ravi (CIRB, Nabha)	Bhadawari (IGFRI, Jhansi)	Pandharpuri (NARP, Kolhapur)	Surti (MPUAT, Ballabh Nagar, Rajasthan)	Godawari (ANGRAV, Venkata, Ramanna Gudem	Toda (Farmers field)	Mehsana	Nagpuri
1. Body wt. at Ist calving (kg)	552	529	546	385.5	420	462	450	-	-	-
2. Age at Ist calving (months)	44.4 (months)	1925 (days)	39.97	48.6	43	53.2	44.2	-	1265.9 (days)	55.0
3. Ist lactation milk yield (kg)	2000	1763	1932	711	1500	1618	2008	501	1988	1036
4. All lactations total yield (kg)	2032	2097	2153	781	-	1745	2047	-	-	-
5. All lactation length (days)	347	384	341	272	-	311	307	198	316.7	242.7
6. AV fat %	7.66	7.85	7.1	7.2 to 13	-	8.10	7.8	8.22	-	-
7. AV dry period (days)	170	189.7	150	297	-	234	84	-	-	-
8. Service period (days)	197	189	170	179	160	207	135	-	-	-
9. Calving interval (days)	511	533	481	478	465	510	570	15.74 (m)	427.5	429.6
10. Wet average (kg)	6.70	5.2	6.13	2.76	-	4.9	6.12	-	-	-
11. Herd Average (kg)	4.36	3.6	4.41	1.52	-	3.1	3.79	-	-	-
Source	Sethi 2003, 4th Asian buffalo congress souvenir									

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Buffalo Diversity in India: Breeds, Defined Populations, Production Systems and Avenues

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Abstract

Diversity of India's buffalo breeds and potential population groups has been described showing their capacities, present status and prospects for further development and wider usage.

Key words: India, Breeds, Strains, Diversity, Conservation, Global-warming

INTRODUCTION

Buffalo is one species being seen today as a saviour animal to meet man's increased requirements of food in the coming times. India and Pakistan are home to the best buffalo breeds in the world: Murrah and Nili-Ravi. And a host of potential breeds and several populations that are yet to be defined as breeds, but are there as latent resource for further development and utilization. Multipurpose and diverse buffalo types in India have the capacity to face the impacts of water shortages or global warming, yet continue to serve the humanity with milk, draft power and meat.

Diverse Buffalo Populations in India

India possesses both Riverine and Swamp buffaloes, Riverine (2N=50) are spread out in all parts of the country and the Swamp only in small areas in the North East part of the country. Utilization pattern of the two types is same as in other parts of the world: Swamp only for work and a very small amount of milk; whereas Riverine mainly for milk and secondarily, but very important for the entire country, for transport. Swamp buffaloes are not distinguished into breeds. In comparison, all descriptions of breed structure and diversity in the country is around Riverine buffaloes only. By virtue of their numbers and relevance the 'Buffalo' in India is synonym to 'Riverine Buffalo' - and this is in contrast to the buffalo types prevalent in Vietnam, Thailand, China and adjoining countries in the region where majority of buffaloes are swamp type that work in paddy fields.

India's diversity in buffaloes is multifarious. In terms of utility, buffalo is a triple purpose animal – milk, draft-power and meat. In terms of body-size, there are large buffaloes (Murrah, Jaffarabadi, Nili-Ravi) as well as medium sized (all other breeds). In addition, there are some small sized local buffalo populations that are not yet categorized into breeds – Kuttanad buffalo of Kerala is a good example of small sized buffalo. Even though most of the country's buffalo breeds are domesticated type, semi-domesticated (Toda) and wild type (in NE region) also exist. Amongst all the buffalo breeds, Murrah is a distinguished milch breed with Jaffarabadi and Nili-Ravi close-by. In contrast, Assamese buffaloes are largely a draft type, just as Jerangi of Orissa. There is diversity in buffalo production systems as well. Intensive stall-fed types

(Murrah, Mehsana, Nagpuri) distinguish well from the extensive free-range breed-groups (all other breeds and un-categorized populations). Former types are more amenable to industrial production that is suitable for city-town suburbs while the latter types function well under zero or low input support systems as these utilize the meager feed-fodder. Nevertheless, these minor groups also make major contribution to man in terms of employment and nutrition to the marginal populace. Diversity is also noted in the communities that rear buffaloes e.g. Gujars of Himachal and Toda of Tamil Nadu, as keepers of Gojri and Toda buffalo respectively.

The Buffalo breeds in their home tracts are stable, have a well defined place in the local natural cycles; consume the remnants of the crops, yet produce valuable milk and provide draft-power and dung/urine as organic manure. With excellent ability to convert poor quality feed fodder, buffaloes provide milk that is rich in nutrition and quality, meat that is known for flavour and marbling, and steady but sure-footed draft power in rural/remote areas and a host of other services, including Mozzarella cheese. It needs to be emphasized that not even a single of the 24 reported breeds/ populations is without its special importance in its home tract for meeting local requirements of food, energy and livelihoods in an environmentally suitable manner.

Global scenario

Although restricted in its spread to largely Indian Sub-continent where it originated around 5000 BC, buffaloes, by now, have spread to 41 countries [FAO, 2007], and the world is noticing increase in their numbers in the host countries mainly by virtue of its productivity and tolerance capabilities. Popularly termed as 'black gold', Murrah has widely spread to other parts of Asia and world and has widely been used as an improver breed. Brazil is the first country to purchase buffaloes from India a century ago (in 1895) after which imports were made by many other countries including Trinidad, Phillipines, China, Bulgaria, Thailand, Uganda, former USSR, and Vietnam. Murrah has been the preferred breed of choice for import by these countries, followed by Nili Ravi, Jaffarabadi and Surti. Buffalo has its origin in the less privileged areas of the world but has gained the attention of other countries and is now noticed by the world as an animal of hope for the future.

Buffalo Breeds and Defined Populations

India has a number of climatic zones with a multiplicity of prevailing socio-econo-biocultural systems. Several of such stable systems have resulted in unique local, vibrant and genetically stable breeds and populations groups that make significant contributions in the local milieu. India has 10 defined breeds spread out largely in Northern and Western India, and, in addition, 24 defined populations spread by and large in the Eastern parts. Of the 34 total reported hitherto, 10 breeds have been well defined owing to the comparatively large population size and contributions from each of those. Figure below shows the defined buffalo breeds.

Figure: Defined breeds of Buffalo – Murrah, Nil-Ravi, Bhadawari, Mehsana, Surti, Jaffarabadi, Nagpuri, Pandharpuri, Marathawadi and Toda

Historically, in Buffaloes, the defined population groups (other than defined breeds) have also received attention and some documentation. These population groups in buffaloes (and other species as well) have often been named based on location, colour, typicality etc. but not sufficiently documented for considerations as a distinct breed in comparison to other breeds in the region. The most imperative feature of such populations is their sustainable performance, assured reproduction and continued survival through innate strengths. More recently, there has been an increased interest in identifying and evaluating the strains.

Just as the defined breeds, the local defined populations are stable as well; these can survive the vagaries of shortages in terms of feed/fodder/water, extremes of temperatures and/or prevalence of diseases. Such capacities make these populations sustainable. Attempts at altering these populations by crossbreeding with Murrah for higher milk yield have not been successful. Surti buffalo, for example, has faced crossbreeding by Murrah and the resulting crossbreds show serious reproductive problems. Similar fate of Bhadawari has reduced its numbers while the crossbreds do not fit equally well in the rough ravine areas in the breed tract of Bhadawari. Chilika crossbreds with Murrah did not have the traditional strengths like feeding on weeds in knee deep Chilika waters. Failures in crossbreeding are partly ascribed to the inability to cull the surplus animals for meat. Nevertheless, the local breeds have expressed greater stability in their respective tracts.

Characterization of Indian Buffalo Breeds and Populations

Phenotypic and Molecular characterization of the ten defined Indian breeds has been completed and monographs have been prepared. Characterization of some Lesser Known Breeds viz. Terai, Banni, Chilika have also been completed. The monographs highlight detailed description of the breed in the form of Breed Descriptors covering its geographic distribution, population status, body biometry, performance traits and microsatellite analysis. Most of the breeds have been identified on the basis of morphological characters; information on genetic architecture is available for few breeds. The molecular characterization of AnGR for establishing genetic distances among various breeds has been undertaken using microsatellite based DNA markers.

Approach to Buffalo Improvement

Under the various schemes of ICAR [Indian Council of Agricultural Research] and SAUs [State Agricultural Universities], improvement of defined breeds and also some of the strains has been taken up in the recent past. Murrah, Mehsana and Nili Ravi breeds have received higher attention for improvement under various state schemes. An All India Coordinated Research Project on Buffaloes during the Ninteen Eighties initiated a networked approach by collaborating two main centres for Murrah improvement by Progeny Testing and exchange of semen. This scheme was upgrated to a Network Project under the Central Institute on Research in Buffaloes to cover more locations under the Associated Herd improvement scheme and now covers the breeds viz. Murrah, Jaffarabadi, Nili-Ravi, Surti, Bhadawari, Pandharpuri and also two strains viz. Godavari and Assamese Buffaloes. In addition, a Network Project on Animal Genetic Resources has completed survey work on Jaffarabadi and Nagpuri breeds; the in situ conservation of Toda and ex situ conservation of Pandharpuri and Jaffarabadi breeds have also been completed. Recently a state sponsored scheme 'National Project on Cattle and Buffalo Breeding' envisaged to raise AI facilities for buffalo breeding in the country. A field oriented approach 'Central Herd Registration Scheme' implemented at some of the locations undertook earmarking elite buffaloes at the farmers level with regular recording and genetic selection.

Approach to Conservation of Buffalo Breeds

From the point of view of conservation, the ten defined breeds can be classified into two groups. Group-1 comprises of stable breeds viz. Murrah, Mehsana, Jaffarabadi, Nagpuri and Pandharpuri. These do not face reduction in their numbers. Group-2 comprises of the breeds facing dilution and reduction in numbers; the breeds are Nili-Ravi, Bhadawari, Surti, Marathwada and Toda. Indirect conservation efforts have been made under different schemes at the institutional level. Breed societies have been established for Chilika buffalo and Banni buffalo.

Conservation models have been developed for all livestock species. A typical in situ conservation scheme identifies a set of 150 buffaloes on the basis of their peak yield and then recorded at monthly interval. The owners are provided an incentive for two years so that the animals are retained and kept in good health. The tagged females are inseminated with the semen/ bull of the same breed of higher genetic merit. The farmers rear the male progeny from these females up to six months; incentives are provided to retain the calf. As these calves grow, a total of 50 unrelated males are selected as future bulls. Under the ex situ conservation scheme, a total of 3000 doses of semen from a breed are collected for storage at two locations.

Avenues to Buffalo as an Animal of Hope for future

Buffaloes in India have a place of pride in all respects: production, productivity, population in the world, diversity/ breeds, service to the underprivileged, clean draft power, sure-footed transport, rich food/nutrition, support to a host of industries and livelihoods. For the purpose of a continued and sustained use of this important species, it is necessary to recognize and enhance its role and give higher attention to conserving and improving the diverse breeds as a global resource. Already, the world is looking at this Black Gold as a hope for food in the near future, especially in the face of imminent global warming.

Buffalo Production in America

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The different situations of countries in North, Central and, mainly, South America subcontinents are described. They all share a brilliant future for the buffalo. America has a buffalo population of approximately 4,12 million heads. It's number is growing at a rhythm of 12.7 % per year, well above all other continents. The production systems in the United States, Cuba and Trinidad are described, and also the first steps of buffaloes in Canada, Mexico, Panama, Costa Rica, Guatemala, Honduras and Belice. Among South American countries, first of all Brazil, a subcontinent itself rearing 3,5 million buffaloes, together with Venezuela and Colombia, during the last 30 years they had a great expansion in meat and milk production with buffaloes. Their production systems are also described. In Argentina the expansion of agriculture is displacing animal production toward the tropics in the last years, producing a significant increase of buffalo meat production, and more recently dairy production. The first steps of buffaloes in other south - american countries are described. In equatorial, tropical and subtropical areas of America the buffalo has proved to be very superior in productivity compared with cattle, thanks to its very good adaptation to these conditions. And in the temperate areas buffalo is increasing its milk industry, near important urban markets. The buffalo is a valious tool to increase food production: american continent has enormous areas available for this animal.

Key words: buffalo, America, production, brilliant future.

Buffalo Production Systems in China

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Abstract

Chinese buffalo is of swamp type, mainly distributed in countryside of 18 provinces in southern China?and China has the third population of buffalo in the world. There are 22.72 million buffalos in China in 2007, representing 17.37% of all cattle in the whole country. Chinese buffalo is mainly used for drought since their milk production is very low with an annual milk yield of 500-700 kg. Murrah and Nili-Ravi, the most famous river type dairy buffalo breeds in the world, were introduced from India and Pakistan in 1957 and 1974, respectively and used to crossbreed with Chinese buffalo for genetic improvement. The effect is very prominent that the performance of crossbred buffalos has been improved significantly after several decades and the milk yield reached 1200-2000 kg. Buffalo milk is of excellent quality and suitable for processing high quality added value products, such as cheese and whey, which are competitive in the international market. In recent years, Chinese government increased the input to dairy buffalo industry and the nation put forward that buffalo milk industry is a new growth point for the country economy, which has promoted the development of buffalo industry. This article briefly introduces Current situation, raising model and research development of buffalo in China.

Keywords: Production system, Raising model, Crossbred dairy buffalo.

China has been breeding buffaloes for more than 7000 years. Through long-term nature and artificial selections, buffalos possess many biological characters such as stocky build, powerful draught, resistance to high temperature and humidity, gaining well on the roughest of forage, friendly temperament, long years of service, high-quality of milk and so on. Therefore, buffalo has become a precious livestock resource in southern China. It has become a mainly farming tool for farmers, and has played an important and positive role in the development of agricultural production. However, with the process of urbanization and mechanization of agriculture, the draught value of buffalo gradually decreases. It is an inevitable trend for buffalo to be raised for milk and meat. Buffaloes have long been used for draught in our nation, their milk-yield is relatively low. Since end of 50s, China has performed buffalo crossbreeding and won initial success. But overall, the work moves slowly. In last twenty years, Chinese government has attached great ?importance to the development and utilization of buffalos, and the buffalo dairy has been faced with new opportunities for development. The objective of this article is to briefly introduce the status quo, raising s and scientific researches of buffalos in China.

1 Current situation of the development of buffalos in China

1.1 Quantity and distribution of buffalos

Chinese buffalo is of swamp type, has a total of 18 local varieties, mainly distributed in the countryside of 18 provinces in southern China. There are 23.27 million buffalos in China in 2008 (FAO), representing 28.17% of the total bovine population in our nation, which ranks the third in the world. It is reported by Zhang et al. that there are 9 provinces raising more than one million buffalos respectively, of which Guangxi ranks the first, with up to 4.378 millions, accounting for as much as 19.24 % of total buffalos in China.

1.2 Effects of buffalo crossbreeding

Chinese buffalo is small-sized and the milk and meat performance are poor. The adult local female buffalo weighs 250-400 kg, the average milk yield of local buffalos per lactation is 500-600kg, while that of the selected buffalos can reach to 800-1000kg. Therefore, the river buffalos must be imported to crossbreed with native buffalos, in order to improve them for dairy use.

China has respectively introduced famous water dairy buffalos breeds (Murrah and Nili-Ravi) from India and Pakistan to crossbreed with native buffalos in 1957 and 1974, after decades of research and practice, the producibility of hybrid offspring has been remarkably improved. It is reported that the average milk yields of Murrah crossbred F1 and F2 are 1240.5 kg, 1423.3 kg respectively, those of Nili-Ravi crossbred F1 and F2 are 2041.2 kg, 2267.6 kg respectively, and those of triple-crossbred and their inter se crossing offspring are 2294.6 kg, 1994.9 kg respectively. The contents of milk fat, protein and dry matter in crossbreds are 7.5%, 5% and 20%, respectively (Table 1). According to the fatten experiments for triple-crossbreds and Nili-Ravi crossbred F2 bulls in 18-24 months, they gained an average of 0.55-0.62 kg per day, the dressing percentage and net meat percentage of triple-crossbreds and Nili-Ravi crossbred F2 bulls were 52.4% and 42.4%, 57.1% and 48.1%, respectively (Table 2) . It is reported by Huang et al. that There are over one million crossbred buffalos born in the past 30 years in China, and there are over 0.4 million female buffalos for crossbreeding per year in recent years, Guangxi and Yunnan possess the biggest number of crossbred buffalos (Table 3).

Table 1. Comparison of milk performance in different buffalo breeds

Breed	Head	Lactation (d)	Lactation length X±S CV（%）	Milk yield X±S(kg) CV（%）	Average milk yield pre day (kg)	Corrected milk yield in 305 days X±S（kg） CV（%）	Highest daily milk yield (kg)
L	70	70	280.4±20.2 7.2	1092.8±207.44 19.0	3.79		6.6
MLF1	73	241	280.1±76.1 27.2	1233.3±529.7 42.9	4.40		16.50
MLF2	16	54	303.2±83.1 27.4	1585.5±620.6 39.1	5.22		13.00
NLF1	6	45	326.7±96.4 29.5	2041.2±540.9 32.4	6.25	2060.7±386.2 18.7	16.65
NLF2	9	20	325.8±93.2 28．6	2267.6±774.8 34.2	6.96	2298.4±6044.4 26.4	18.37
MNLF1	45	168	317.6±78.4 24.7	2294.6±772.1 33.7	7.22	2348.0±533.2 22.7	18.80
MNLF2	54	170	329.1±89.8 27.3	1994.9±635.0 31.8	6.06	2048.5±530.9 25.9	18.50
M	65	237	324.7±73.6 22.7	2132.9±578.3 27.1	6.57	2117.1±430.0 20.3	17.40
N	58	164	316.8±83.6 26．4	2262.1±663.0 29．3	7.14	2366.4±561.6 23．7	18.40

Note: L=Local, M=Murrah, N=Nili-Ravi.

Table 2. Comparison of meat production in different breeds of buffalo bulls

Breed	Age (mo)	Head	Gain in beef buffalos			Gain: feed	Beef production					
			Days	Total gain	Daily gain		Body weight	Carcass weight	Net meat weight	Dressing percentage,	Net beef percentage	Bone: meat
L	19~21	2	57.5 ±0.7	38.0 ±2.8	0.66 ±0.06	1:4.2 ±0.3	216.0 ±41.0	109.8 ±21.5	85.0 ±16.9	50.8 ±0.3	39.3 ±0.3	1:3.4
MLF1	24	2	100 ±0	74.3 ±8.2	0.74 ±0.08	1:3.7	447	251	190.4	56.2	42.6	1:4.8
NLF1	18	2	264.5 ±2.1	263.9 ±55.0	0.72 ±0.15	1:3.9 ±0	398.0 ±38.2	205.6 ±1.5	165.5 ±1.7	51.9 ±54	41.3 ±4.4	1:4.1 ±0.1
NLF2	26	1	188.0	103.0	0.55	1:3.9	361.0	206.1	173.5	57.1	48.1	1:4.9
MNLF1	18~24	6	275.2 ±61.9	163.8 ±93.2	0.62 ±0.08	1.4.7 ±0.8	440.7 ±57.6	230.6 ±28.4	187.0 ±26.1	52.4 ±1.8	42.4 ±1.5	1:4.5 ±0.5
MNLF2	19~27	3	159.0 ±50.2	57.7 ±4.6	0.39 ±0.13	1:1.6 ±1.1	313.3 ±27.5	170.3 ±17.2	132.8 ±19.6	54.4 ±2.6	42.3 ±3.9	1:3.8 ±0.6
M	19~24	3	65.3 ±17.9	28.0 ±15.8	0.14 ±0.20	1:9.9 ±8.2	292.0 ±13.8	210.9 ±15.4	164.5 ±18.4	53.7 ±3.6	41.9 ±3.1	1:3.6 ±0.1
N	19~24	3	67.7 ±23.7	31.0 ±22.7	0.43 ±0.16	1:8.4 ±4.5	436.7 ±26.0	219.1 ±23.4	171.9 ±22.7	50.1 ±2.3	39.3 ±2.8	1:3.6 ±0.5

Note: L=Local, M=Murrah, N=Nili-Ravi

Table 3. Crossbreeding Stat. from 1981-2007

Year	1981-2000	2001	2002	2003	2004	2005	2006	2007
No. of breeding (thousands)	201	46	116	256	327	359	406	414
No. of calves (thousands)	56	16	19	49	86	130	161	158.5

1.3 Milk production and processing

The crossbreeding of buffalos has been performed for many decades, while the number of crossbred buffalos for milking is not large. According to statistics of Cao et al., there were 30000 milking buffalos in China in 2006, 61.5% of them were crossbreds, while 38.5% of them were local buffalos, the milk-production mainly centralized in Guangxi, Guangdong, Fujian, Zhejiang and Sichuan. Although there are no detailed statistical data, it is estimated that the population of milking buffalos has been increased in recent years. The buffalo milk production was 0.29 million tons in China in 2008

Buffalo milk has been processed into dairy products for more than 100 years in China. As early as the end of 19th century, few farmers have done milking of local buffalos as a sideline, and processed milk into special products such as “milk cake”, “milk bean curd”, “creme” and “ginger juice milk”, which have become traditional refections and come down to now. In the early 20th century, some merchants have been involved in milk-processing in Guangdong and Zhejiang, they set up factories to produce condensed milk, which has been sold in southeastern Asia, the famous brands of condensed milk included “Feiyan” produced in Guangdong and “Qindiao” produced in Zhejiang. So far, there are few special buffalo milk processing factories distributed in Guangdong’s Nanhai, Guangxi Buffalo Research Institute, Guangxi’s Xuanwu and Lingshan. These factories are of small scale and poorly equipped, the products are of unitary variety and with no features. The main varieties of diary products include pasteurized milk, yoghourt, fancy milk drink and condensed milk. Guangxi Buffalo Research Institute has successfully developed buffalo milk cheeses in 2009, the cheeses have been shifted to intermediate productive test, and will be marketed soon.

1.4 Buffalo meat and hide

According to statistical data (FAO, 2008), the output of buffalo meat in China was 0.306 million tons. Most of the meats were directly sold to consumers, only few meats were processed to byproducts such as dried beef, sausages and hams. The output of buffalo hide in 2007 is 92 thousands tons (FAO, 2008), the hides were made into various products, which were sold well on the market.

2 Buffalo production in China

In recent years, as Chinese government paid great attention to the development of buffalos and increased the input, the dairy buffalo industry has been rapidly developed. As the enlargement of amount and scale of buffalo-raising, various raising models with different characteristics have been developed, the models contributed a lot to the development of buffalo industry and promoted the economy benefit of buffalo breeders.

2.1 Buffalo-raising models

2.1.1 Farmer-raising model

Tens of thousands of families traditionally raise buffalos in China, each farmer (family) generally raises 1-3 buffalos. The raising forms are behindhand, buffalos are grazed in field and fed on agriculture residual products without supplement of concentrate, and buffalos are mainly raised for draught. With the increasing of economy benefit of buffalo-raising, the number of buffalo raised by farmers also increased, many breeding-specialization families emerge, each breeding family raises 10-100 buffalos. However, the efficiency of this raising model with one household as a unit is low, because the raising conditions are poor, and the dispersion of the raising places bring trouble for milk-purchasing.

2.1.2 Subdistrict-raising model

Standardized raising subdistricts are encouraged by the government, the government-led subdistricts are of unified planning, management and building, only the qualified applicants are allowed to enter the subdistricts for buffalo-raising, the number of buffalos per subdistrict is 100-300. The subdistricts practice unified breeding, disease prevention and feeding, the products were purchased and sold exclusively by the districts. In this way, the yield and quality of milk are dramatically promoted. Furthermore, this model better organizes farmers in their access to the market and improves the overall efficiency of buffalo-raising, it is also a transition to large-scale raising. However, the other side of the subdistricts shows weaknesses in ragged management level, environmental pollution, irrational distribution and imperfect system.

2.1.3 Intensified-raising model

With the rapid development of buffalo dairy industry, small-scale raising can't ensure the supply of buffalo milk, so large-scale intensified buffalo farms with 1000-2000 buffalos on hand appear. The farms apply advanced raising managements, which can increase the yield and qulity of milk, lower investment cost, thus increase the benefits of buffalo-raising. However, the farms need more capital for investment, and entail high risk. At present, there are few intensified farms in China, but this model is still an inevitable trend for buffalo-raising.

2.1.4 National grade buffalo-breeding farm

The only buffalo-breeding farm is in Guangxi Buffalo Research Institute, the population of buffalos on hand is more than 1000. The buffalos, including Murrah, Nili-Ravi and local types are well managed and fed. On the one hand the farm provides breeding buffalos and well-bred semen for all parts of the country; on the other hand it is an important scientific research base for buffalo.

2.2 Buffalo crossbreeding popularization system

The local swamp buffalos are used as female parents, Murrah, Nili-Ravi and mediterranean buffalos which are famous for their high milk yield are used as male parents, the crossbreeding is performed. The breeding buffalos are provided by the national grade buffalo-breeding farm, frozen semen is provided by provincial crossbreeding stations and hierarchical management is implemented. The cities establish relay stations for frozen semen and liquid nitrogen, in order to facilitate the supply for AI of grass-roots. The provincial crossbreeding administration is shown in the following figure.

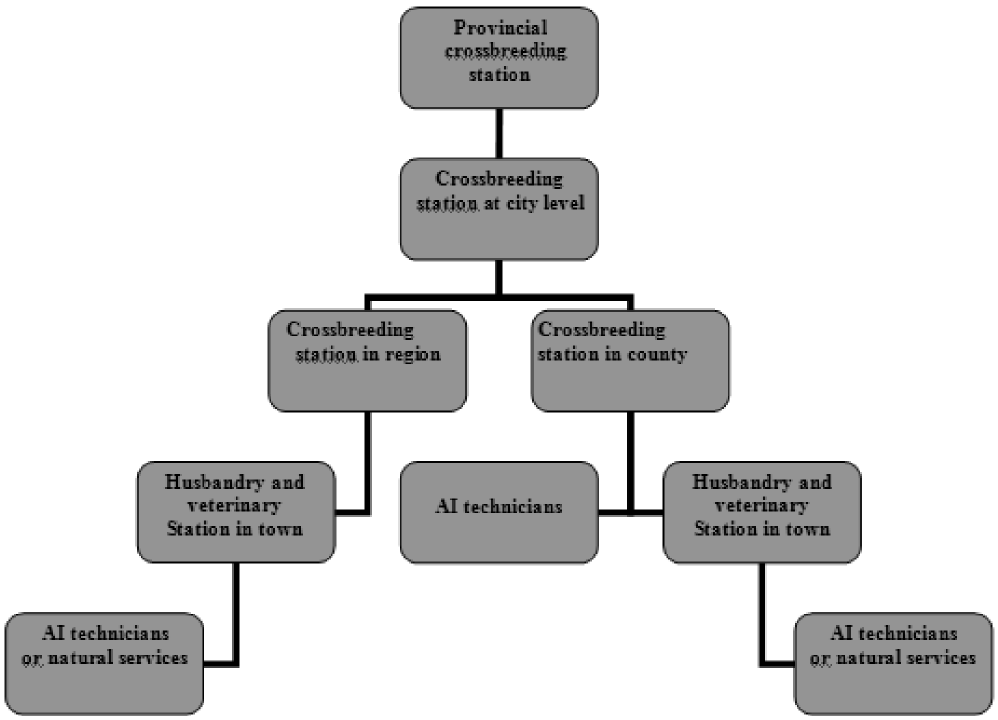

Figure 1. The construction of crossbreeding stations in China

2.3 Purchasing and marketing of buffalo milk

Milking can be achieved by machines and human, buffalo-raising subdistricts and intensified raising farms mainly rely on mechanical milking, and farmers mainly rely on manual milking. The milk from intensified farms is directly sold to processing enterprises, the quality is tested by enterprises and the price is fixed according to quality. While the milk from farmers and subdistricts is firstly purchased by milk stations and then sold to the processing enterprises.

3 Scientific researches in buffalo

Related to other livestock, the scientific researches in buffalo started rather late in China. China has introduced Murrah buffalos from India in 1957 and Nili-Ravi buffalos from Pakistan in 1974, respectively. As the two foreign buffalo breeds were introduced, the researches and experiments on feeding observation, semen freezing, AI and crossbreeding have been conducted, and have accumulated abundant scientific data. In recent twenty years, in order to satisfy the requirment of the development of buffalo dairy industry, researches have been carried out from many aspects such as crossbreeding, physiology, nutrition, reproductive techniques, embryo biology, dairy processing and disease prevention. Researchers have made great advances and breakthroughs especially in reproductive biotechnology, the studies on IVF, OPU, ET, embryo cryopreservation, sex control and SCNT have been done. A technology system for OPU- IVF- embryo cryopreservation- ET has been established, 200 IVF well-bred buffalos were obtained through this system, which formed the biggest IVF buffalo group in the world. China has obtained the first IVF buffalo calf by transfer of cryopreserved embryos, the first SCNT buffalo calf, the first inter-subspecies SCNT buffalo calf, the first inter-subspecies SCNT buffalo calf by transfer of cryopreserved cloned embryos and the first sex-controlled buffalo calves in the world. Some research results achieve or surpass the advanced level of similar international researches. The researches in buffalo propelled the development of buffalo industry.

4 Development prospect in buffalo

The buffalo dairy industry in China is a newly emerging industry, with great potential and promising prospect. Chinese government has attached great importance and increased input to the exploitation of buffalo industry during recent years, the government has also programmed the medium and long term development of buffalo industry. In the coming 10 years, the population of buffalo for milking will achieve 0.5 million, it brings opportunities to development of buffalo dairy industry. In the near future, we have reason to believe that buffalo dairy industry must come to be important for Chinese agriculture and rural economy, and become an important means to increase the income of farmers.

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Buffalo Versus Cattle? Let us Close this Controversy and Concentrate on Improving the Productivity of Buffalo

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The era between 1950-70 may be called as the “era of antagonism” against buffalo. During this period many professionals and politicians were harbouring hatred against buffalo. “Black Beauty” of Pakistan was being accused of being ugly, its big size required more feed and thus suitable for slaughter and many other such delegations were charges against it. It was intended to replace this species with temperate cattle breed from Europe and America. Inspite of all such efforts, buffalo population during the last an five decade increased tremendously from 6.7 million during 1956 to 20.3 million during 2001. Buffalo got her self recognized due to its better adoptability to poor feeding, harsh climate and infectious diseases. It survived being the “fittest”. However, recently some NGO’s in Pakistan have raised this issue again and in a recently held workshop at Lahore (Pakistan), it has been asserted again to eliminate the buffalo. One of the commercial buffalo farmer (having about 1000 buffalo) at Karachi discussed this matter with me. He was worried about a congregation of more than a million baffulo at Karachi as the sea was unable to accommodate buried such a large number of buffalos---- this has prompted us to discuss this subject of vital importance at this world forum. In this paper an effort has been made to review all such arguments and logic being put against buffaloes. In the light of research work conducted in Pakistan and elsewhere in the World. It further aimed to get the blessings of the participants of the World Buffalo Congress to recommend to such Governments and persons to close this debate once for all and concentrate on improving this valuable resource.

Buffalo is found in more than 50 countries of the World varying in ecology, climate, topography as well as socio-economic conditions. It thrives well in the tropical conditions of Indo-Pakistan as well as in the temperate climate of Italy. Pakistan is 2nd largest country of the World in having dairy type buffalo, which contributes 70% of the total mil produced in different countries of Asia, Buffalo has been the main stay of the rural economy of small farmers in many developing countries of the Middle East and South East Asia. In these countries, it is owned by the small farmers (2-3 buffalo) having no land and other resources. Women folk are deeply involved in the rearing of buffalo and they also control the income from them. In addition, there are values related to social and cultural aspects.

Myths about Buffalo

There has been a general failure to recognize and exploit the potential of this productive animal. It was for non technical reasons and due to pure lack of interest among planners, administrators and even professionals. Unfortunately buffalo has been improved very little over the past 50 years, because of all round apathy to this species. This animal has been the subject of controversy (Bugffalo versus Cow) for a long time. In Pakistan, people advocated relegating buffalo to much lower order in animal breeding programme. Some suggested a gradual elimination (Akhtar, 1987). There were many who believed that:

> “On comparative basis, the efficiency of Nili Ravi buffalo would be lowered than for Sahiwal Cattle in Pakistan”. (Ishaq and Shah, 1975).

> The buffalo would not be able to survive the challenges of emerging cross bred cattle population;

> "The large mature size of buffalo resulting in higher maintenance requirements in relation to milk yield suggests that emphasis on selection for meat production could yield high return". (Cady et al, 1983);

> Other pleaded that buffalo be developed as triple purpose i.e. milk, meat and draught animal (mono purpose versus multi-purpose animals);

> Some others also reasoned that tractors could substitute animal power and more particularly the buffalo. This was advocated to be true for south east Asian countries, where swamp buffalo dominated and was utilized for cultivation, transport, thrashing, water lifting and oil extraction etc.

These are some of the points agitating the minds of many in the past. However, a critical study reveals otherwise as discussed below:

1. Milk Production Potential

Buffalo had the potential to be the main dairy animal in Indo-Pakistan, sub-continent and some other countries of the world. Research at National Dairy Research Institute Karnal (India) has shown a significant al round improvement of buffalo as a dairy animal. Similar reports have also been available from Pakistan and Italy (Asghar et al, 1992; Aleandari, 1994; Veloceia et al, 1997; Roseti, 1997 ……..) both in India and Pakistan best herds are found at Military Farms and Milk Colonies like Aarey Milk Colony Bomby and Landy Buffalo Colony at Karachi). The milk yield in these countries ranged upto 4626 kg in a lactation peiod. McDowel et al, (1995) after making a computer search of the world literature from 1970-1993 found that in rank from high to low Nili Ravi tended to excel in lactation milk yield producing 2700 kg milk, the level of Peak Yield and daily milk. From many reports of Pakistan and India, it is revealed that about 3% of the yields exceed 3500kg. The wide gap in milk producing herds indicate large variability, an inherent potential in buffalo, which needs to be exploited.

2. Mechanization and Buffalo

It has been said that mechanization of Agriculture in the developing countries may make buffalo and cattle as surplus. A critical analysis reveals that mechanization should not be regarded as a simple replacement of animal draught power. Southern Europe is reasonably well mechanized yet. The current water buffalo population is more that million mature animals. In Balgharia and Yogosalavia, Bufffalo are still used frequently for road haulage (plate……). In almost all the eastern countries, swine buffalo are ridden by people (Plate …..). In Indonesia and Philiphine, they are also used for racing and fighting (Sunderasan, 1979 …..).

In view of the working capacity of buffalo, they have been referred as the "Living tractor of the east". In all the rice growing countries of South East Asia, buffalo is used for ploughing mud fields. The large hooves, flexible foot joints, slow and deliberate is the ideal animal to work in deep mud of rice fields.

3. Mono purpose versus multi-purpose animal

Development of buffalo as a triple purpose animal (dairy, meat and draught) has been advocated not withstanding the facts that such efforts in cattle in India have failed in the past (Pasu, 1985). Experimental evidence has suggested that draught capacity and meat characteristics have a negative correlation with dairy traits.

4. Feed utilization

In addition of the advantage to buffalo of having large size muzzle and high mobility of tongue enable her a high rate of intake of forage and crop residue (McDowell et al, 1995). Further, greater weight of rumen in buffalo is also harbours more microbial population to grow indicating better conversion of forage. Rumen asidosis is seldom observed in buffalo due to high rate of saliva secretion. Thus maintaining rumen pH.

Feeding habits of buffalo and cattle differ from each other, thus buffalo can consume poor quality pasture or feed (Plate …..). Buffalo can gain atleast maintain the body weight under the long period of under feeding which may often last over 5-7 months in many Asian countries.

The superiority of buffalo over cattle in digestibility and efficiency of utilization of feed nutrients is manifested only when then two species are fed only low plane of nutrition with course roughages as the main source of energy. (Cockrill, 1968b; Gilani, 1980; Zeoula et al, 1997a). El-shazley, (1960) reported that the digestibility of wheat straw cellulose was 24.3% for cattle and 30.7% for buffalo. The figures for Trifolium Alexandrium (Berseem) cellulose were 34.6 and 52.2% for cattle and buffalo respectively.

In order to study the comparative efficiency of buffalo and cows for their ability to utilize various nutrients of the ration along with their production performance, a series of feeding and digestion trials were conducted by Gilani, (1980). The data on average weight gain, feed efficiency and digestibility of various nutrients of the ration in growing calves and heifers of both species have been given in the following table.

It is evident that buffalo calves gained more, required less amount of feed per unit gain in weight and digested greater amounts of dry matter and nitrogen free extract (NFE) of the ration than cow calves under restricted feeding system. Almost similar was the condition of the heifers belonging to two species in ad-libitum feeding system, indicating thereby buffalo heifers, where on restricted feeding or ad-libitum feeding system proved better converted of their feed than cow heifers.

The data on the average digestibility coefficient of various nutrients, milk yield and milk composition in lactating buffalo and cow from the same experiment indicated superiority of buffalo over cows. Similar findings from Japan and Brazil have also been reported by many worker (Homa and Kurata, 1989; Zeoula et al, 1997a).

Estimation of genetic parameters and breeding values for some productive traits on Egyptian buffaloes

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Genetic parameters and predicting breeding values for some productive traits were estimated using data on 712 Egyptian buffaloes, from 121 sires born between 1990 and 2004, kept at Mehallet Mousa and El -Natafe farms, belonging to Animal Production Research Institute, Ministry of Agriculture, Egypt. Variance components for total milk yield (TMY), lactation period (LP) and body weight of cow at calving (BWC) were estimated by the restricted maximum likelihood method, using multi trait animal model, considering herd- year – season of calving and parity as a fixed effects and individual, permanent and errors as a random effects. Unadjusted means for TMY, LP and BWC were 1591 kg, 203 d, and 479 kg, respectively. Estimates of heritability were 0.115, 0.059 and 0.154 for TMY, LP and BWC, respectively. All genetic and permanent correlations among all traits studied were positive and highly significant ($P < 0.01$), except the permanent correlations between BWC and each of TMY and LP were negative. Predicted breeding values for TMY, LP and BWC estimated from cows, sire and dams are presented.

Key words: Genetic parameters, breeding values, Egyptian buffaloes.

INTRODUCTION

Evaluation of important traits other than milk yield should provide dairy producers with more useful information upon which to base their genetic decisions (8). Cow size is a trait that receives emphasis by dairy breeders (1, 8). Genetic correlation between body weight at calving and milk yield have been reported to be positive in many studies (1,2,8), however, no genetic correlation between body weight at calving and their milk yield has been published in Egypt.

The aims of the present study were to estimate the genetic parameters and breeding values using all available sources of pedigree, cows, sires and dams for total milk yield, lactation period and body weight of cows at calving by using Multi Trait Animal Model (MTAM) in a closed herd of Egyptian buffaloes.

MATERIAL AND METHODS

Data used in this study were collected from the history sheets of buffalo dairy herd raised at Mehallet Mousa and El-Natafe Experimental Stations of the Animal Production Research Institute, Ministry of Agriculture, Dokki, Cairo, Egypt. The data comprised 2676 normal lactation records spread over the period from 1990 to 2004. Abnormal record affected by diseases such as mastitis and udder troubles or disorders such as abortion were excluded. Cows were mated naturally until 2001 and after that artificial insemination were used. Heifers were served for the first time when they reached 24 mo., or 350 kg. Pregnancy was detected by rectal palpation 60 days after the last service. Traits studied are total milk yield (TMY) in kg, lactation period (LP) in days and body weight of cow at calving (BWC) in kg. Animals were grazed on Egyptian clover (Trifolium alexandrinum) during December to May. During the rest of the year the animals were fed on concentrate mixture along with rice straw and limited amount of clover hay when available. Cows producing more than 10 kg a day and those that were in the past two months of pregnancy were supplement with extra concentrate ration. Buffaloes were hand milked twice a day. Table1. Show data structure considered in the analysis, means, standard deviations, coefficients of variation, estimates of heritability, genetic correlations and permanent environmental correlations among different traits studied.

Table 1. Structure of data used in analysis, estimates of heritability(h2) , genetic correlations (rg) and permanent environmental correlations (rpe) among different traits studied.

	No.	Mean	SD	CV%	h^2
Traits					
Total milk yield, (TMY), kg	2676	1591	633	40	0.115± 0.036
Lactation period (LP), d	2676	203	63	31	0.059±0.028
Body weight at calving (BWC), kg	2676	479	92	19	0.154±0.023
Genetic correlations (r_g)					
TMY with LP					0.755±0.098
TMY with BWC					0.615± 0.161
LP with BWC					0.854±0.256
Permanent environmental correlations (r_{pe})					
TMY with LP					0.976± 0.022
TMY with BWC					- 0.340± 0.309
LP with BWC					- 0.538±0.268
Observations					
Cows	712				

Preliminarily analysis by using Statistical Analysis System (SAS) were used to study the fixed effects of herd – year – season (HYS, 118 classes) and parity (15 parities), all effects are significant effect ($P < 0.01$) on all traits studied (i.e., TMY, LP and BWC). Estimation of variance components, genetic parameters and breeding values were estimating by using multi trait animal model, by using the program of VCE 4 (version 4.25) and PEST program (5). The Model included individual, permanent environmental and errors as random effects, HYS and parity as fixed effects.

RESULTS AND DISCUSSION

Unadjusted means and standard deviations (SD) for TMY in kg, LP in d and BWC in kg were 1591 kg, 203 d and 479 kg, respectively (Table 1). The higher CV% value for TMY (40%) reflects a great variation between individuals in such an important productive trait.

Estimates of heritability for TMY and LP were 0.115 ± 0.036 and 0.059± 0.028, respectively (Table 1). The low h2 estimates for TMY and LP indicate that selection based on the phenotypic merit of the animal would not be effective. Information on the pedigree combined with the phenotypic of the individual may be used for selection of females in the initial stages, while progeny testing will be the right procedure for selection of bulls. The present estimates are lower than those reported by (3,6,7) using another sets of Egyptian buffaloes and ranged from 0.17 to 0.43 for TMY and from 0.13 to 0.16 for LP. In addition, Ghaffar et al. (2007) with Kundhi buffaloes in Pakistan , reported that h2 estimates for milk yield and LP were 0.209 and 0.009, respectively, while, higher estimate of h2 for milk yield was reported by Tonhati et al. (2000) (0.38) on Murrah buffaloes, they concluded that genetic change for this trait is possible by selecting the productive animals. Estimate of h2 for BWC was 0.154 ± 0.023 (Table 1).Similar results were reported by Abdallah and McDaniel (2000) (0.17) and Mantysaari et al. (2002) (0.16). According to moderate h2 estimates for BWC, suggested that efforts could be made to bring about improvement in that important economic trait through individual selection as well as better managerial practices.

Genetic correlations (rg) among all traits studied are positive and ranged from 0.612 to 0.854 (Table 1). These results indicated that selection for high milk yield bring correlated response for lactation period and also selection for heavy body weight of cows at calving will, gives higher milk yield and longer lactation period. Ahlborn and Dempfle (1992) with Holstein – Friesian and Jersey cows, found that genetic correlation between milk yield traits (milk, fat and protein) and body weight at calving ranged from 0.29 to 0.46. They concluded that body weight was moderately and positive genetically correlated with milk traits in both breeds, indicating that body size could be considered as selection criteria to restrict the correlated response in body size and to potentially increase overall economic merit, especially when selecting for milk. In addition, Mantysaari et al. (2002) found that rg between body weight at first calving and milk yield was positive (0.26) and concluded that heifers with higher genetic growth potential also have a higher milk production capacity. Regression coefficients derived from genetic covariances suggest that each 10 g increase in genetic growth capacity would increase the 305 day milk yield by 29.2 kg. While, Negative genetic correlation between body weight at calving and milk yield was reported by Abdallah and McDaniel (2000)(-0.15), indicating that genetically larger cows produced less than smaller cows of the same age but required less time from calving to conception.

Permanent environmental correlation between TMY and LP was positive and high (0.976±0.022) and indicated that the high productive cows were lactating for longer time, while, the rpe between BWC and each of TMY and LP were negative and unexpected.

The range of cow breeding values for TMY, LP and BWC were 819 kg, 65 d and 127 kg respectively and that of sire breeding values for the above mentioned traits were 1020 kg, 64 d and 116 kg, respectively. Where the range of dam breeding values were 493 kg for TMY, 44 d for LP and 93 kg for BWC. The present results show large differences among cows, sires and dams in productive traits studied. Similarly, Khattab and Mourad (1992) found that BLUP values as a deviation from the mean ranged from -147 to 154 kg for TMY and from -20 to 31 d for LP. Also, Abdallah and McDaniel (2000) concluded that the change in breeding values of body weigh of cows might have been a result of direct and indirect selection made by AI organizations. Present results shows that the important of cows, since it gave the higher range of breeding values for TMY, LP and BWC than dam breeding value. Thus, selection of cows for the next generation in the maternal line would place emphasis on good genetic maternal effects in addition to good estimates of breeding value. Higher range of sire breeding values for productive traits studied, shows that selection of TMY for top sire will increase LP and BWC in the next generation and this is a goal of dairymen. Our results shows that the accuracy of the estimates of sire breeding value was higher than the accuracy of cow breeding values, which may be due to the higher number of daughters per sire.

Finally, the present results indicate that, genetically, higher producing cows had higher breeding value for predicted body weight at calving than lower producing cows. Thus, it seems that genetic selection for high milk yield will lead to higher genetic growth potential.

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Murrah Buffalo in its Home Tract and across the Borders - an Analysis

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Keywords: Murrah, India, Crosses, Home-tract, Elite

Murrah is a world renowned buffalo breed of India known for high milk production with high fat percentage. The animals of this breed can efficiently utilize the roughages and crop by-products. Its milk is suitable for a wide range of quality products including butter, milk-powder, Mozzarella cheese, khoya, curd, yoghurt, shrikhand, dried ice cream mix, dairy whitener etc. The breed, on account of its aforementioned virtues, has attracted interest not only from other states of India, but also from many buffalo rearing countries of the world. There has been a consistent increase in the population of Murrah females in the state. Buffalo in Haryana increased from 3.37 million in 1982 to 6.03 million in 2003 - an increase of about 80% in a period of 20 years (Statistical Abstract of Haryana). A decline in the population of males has also been noticed. In its home tract a genetic drain in the reent years has been a cause of concern, as the elite young lactating buffaloes are sold to metros and do not return to their homestead after completion of lactation. Studies in the Mumbai stables (where buffaloes are kept for milk production for sale in the city) indicate that over 70% of the Murrah in the city stables are from Haryana state and are in their first to third lactation. The situation becomes worse in view of presence of only one and rarely two untested community bulls for the entire female buffalo population of the village, associated with low adoption rate of artificial insemination.

Performance of Murrah Buffalo in its Home Tract

Parts of Southern Haryana covering Rohtak and surrounding areas makes the Home Tract of the Breed. The area continues to generate good quality Murrah buffaloes which are being exported to other states and other countries. Under a state sponsored scheme CHRS (Central Herd Registration Scheme), pure Murrah buffaloes in the field areas were registered and their milk yield performance is recorded. Average yield from elite buffaloes under record has risen from 3184 Kg in 2004-05 to 3294 Kg during 2008-09. Unlike other breeds, Murrah breeding track maintains the potential to generate best of the breed animals; the traditional culture is yet maintained in the villages already prospered by export potentials of Murrah.

Performance of Murrah Buffalo crosses

The farmers in the state of Gujarat have been crossing Surti buffalo cows with Murrah bulls and Mehsana buffalo breed is said to have been developed from Murrah bulls x Surti buffalo cows crossbreeding. Performance of Murrah, Surti and their crosses was compared by undertaking a study at the National Dairy Research Institute, Karnal by raising Murrah and Surti buffaloes contemporarily. In crossbreds, a significant increase in milk yield and improvement in reproduction traits were observed (Basu and Sarma, 1982) in terms of efficiency of milk production (milk yield per day of calving interval).

Performance of Murrah buffalo crosses across borders

In Bulgaria, crossing of native Bulgarian cows with Murrah buffalo bulls imported from India was initiated in 1962. Murrah and Murrah x Bulgarian crosses were superior to Bulgarian buffaloes both for body weight and milk yield. The milk yield and total fat in the crossbreds were close to mid parent value (Nagarcenkar, 1978). Research on crossbreeding of the swamp buffaloes with the Murrah breeds has been conducted in different countries, e.g. China, Malaysia, Philippines, Thailand and Vietnam. The number of chromosomes in the swamp buffalo is 48 (2n= 24) while that in the Murrah breed is 50. Both males and females in F1 crossbred, in spite of 49 chromosome number, are fertile. It was also noticed based on a limited number of observations that the F2, F3 and F4 resulting from backcrosses to the Murrah also appeared to be fertile (Bhat, 1999)

Body weights

The data from 284 Carabaos and crossbreds (102 Philippine Carbaos, 182 Phil-Murrah crossbreds) were analysed. Both males and females in Murrah x Philippine Carabao crossbreds were heavier at birth and 12, 24 and 36 month of age than Philippine Carabaos. The variations in weights among the test animals were primarily due to breed of sire and locations. The least square mean weights of swamp X Murrah buffaloes were consistently heavier than those of swamp X swamp buffaloes at birth, and 6, 12, 18, 24, 36 and 48 months of age ($P < 0.05$).

Milk Production

Murrah has been reported to be well adapted to the local environmental conditions in Southeast Asian countries, levels of feeding and management, and produced about two to three times more milk than the swamp buffalo cows (Chantalakhana, 1978). The crossbred buffaloes were superior to swamp type in working ability and nearly equal in milking ability to the Murrah. Age at first calving varied between 4 and 4.5 years in the Murrah about 3.2 years in crossbred buffaloes in these countries. Murrah buffaloes produced 3.5-5 kg of milk per day during their 200-300 days of lactations.

An average lactation yield of 1382.9 kg in a lactation period of 213 days has been reported in the Murrah buffaloes born and reared in China; the base Murrah stock was imported from India. The Murrah grades were heavier and stronger than the local animals, especially in the hindquarters, good for working and produced more milk (Pei-Chien, 1978).

Liu et al (1985) reported that imported Murrah buffaloes and their crosses could thrive well on coarse feed and rough management conditions in China. Their performance in terms of body weight, production and reproduction compared well with those in their native tract and higher than the averages reported for Chinese buffaloes. The average lactation yield was 1976 kg (272 days) with fat percentage of 6.7 in Murrah, 118.2 kg (271 days) in Murrah x local F1 and 1540.3 kg (291 days) in F2 with a fat percentage of 7.5 as compared to 520 (210 days) to 751 kg (300 days) in Chinese buffaloes.

Shrestha and Parker (1992) studied the performance of purebred Murrah, Phil-Murrah and Philipine Carabao. The average lactation milk yield of 1804.4 kg, 705.6 kg in Murrah and Phil-Murrah F1 was higher than that of 259.4 kg in Philipine Carabao in averaged lactation period of 348.5, 259.5 and 200.8 days respectively. The average daily milk yield was reported to be 6.60, 3.73 and 1.94 kg based on 81, 12 and 10 lactation records in Murrah, Swamp x Murrah F1 and Swamp buffaloes in a lactation period of 237.1, 276.9 and 235.9 days respectively. The F1 crossbreds of swamp and riverine buffaloes, on an average, produced about twice the daily milk production of swamp buffaloes.

In Sri Lanka, upgrading of local buffalo cows with Murrah buffalo bulls imported from India resulted approximately 290% increase in milk yield over the local buffaloes, which yielded 355 kg per lactation. Murrah were superior to Murrah grade only by 241 kg (16%) in milk production with no apparent difference in lactation length. Assuming a generation interval of 6 years and a turnover of five generations, one could expect an improvement of approximately 34 kg milk per year through the upgrading programme. Liu (1978) reported average milk yield of 1518, 824, 1015 kg with 8.0, 4.6 and 6.0 kg peak milk yield in Murrah, Murrah x local F1 and G1 backcross to Murrah respectively in a location period of 240 days.

The above results indicate promising performance of crossbreeding of swamp buffaloes with riverine breeds.

Reproduction

Momongan et al. (1994) reported age at commencement of first behavioural oestrus as 881±171 and 1348 ±406 days in Phil-Murrah F1 crossbred Philippine Carabao heifers. The average weight at puberty was 362±48 kg and 282±32 kg respectively. This shows 80 kg weight advantage with 15 months earlier age at puberty in the crossbreds as compared with the Philippine Carabao local animals. Similarly, the Phil-Murrah F1 crossbreds were reported to conceive and give birth to calves one year earlier than the Philippine Carabaos. Liu (1978) reported the age at puberty as 431 days (range: 314-643) and 674 days (range: 384-1203) in Murrah and Murrah x Chinese swamp crossbreds and further reported that the Murrah and Murrah-swamp crossbreds reached puberty earlier than the local Chinese swamp buffaloes.

Draught animal power

The experiments undertaken revealed comparable work performance of crossbreds (Phil-Murrah F1) to Philippine Carabaos under similar conditions indicating the adaptability of these crossbreds to local agro-climatic and management conditions. However, information on their draughtability and acceptance by farmers in one region of the Philippines revealed that 39% of the farmers rated the crossbreds poorer than, 24% better than and 14 % equal to swamp buffaloes.

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Production Parameters from Different Breeds of Water Buffalo in Australia

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Abstract

Less than 100 Swamp Buffalo were introduced into Australia in the early part of the 19th century through the establishment and supply of British settlements on the north coast of the Northern Territory and were well suited to the tropical wet/dry tropical conditions. Some escaped or were abandoned and established large populations by the late 20th century (up to 360,000 head).

The national Tuberculosis and Brucellosis Eradication Campaign (BTEC) reduced the total population down to 15,000 farmed and 50,000-100,000 free-range animals by 1997 when freedom from these diseases was announced nationally.

Most of the research has occurred in the Northern Territory since domestication commenced in the mid 1960's. Since then Australia has exported live buffalo world wide and frozen meat to Europe and SE Asia.

In the mid 1990's, importations of Riverine Buffalo from Italy, Bulgaria and the USA occurred (76 head) and these have been the basis of a new dairy industry in Australia, which has also exported some dairy livestock to New Zealand, South Africa, Chile and Japan in the last 5 years. These live imports have been supplemented with dairy semen importations from Italy.

In 2007, an Australian buffalo database was set up at the Agricultural Business Research Institute of the University of New England to provide a Register for the industry, to analyse and provide genetic information and eventually provide Estimated Breeding Values (EBVs) to enable objective selection programs to proceed for the improvement of the water buffalo meat and dairy sectors in Australia.

This paper presents productivity measures that characterise the various herds, principally the Swamp buffalo research herd from 1983-1998 and the Crossbreeding and Riverine research herd from 1995 to the present day at the NT Govt Coastal Plains Research Station/Beatrice Hill Farm facility, and 2 of three commercial dairies from two other states of Australia

INTRODUCTION

Water Buffalo were introduced into Australia during the first settlements by the British into the Northern Territory from the Dutch East Indies (now Indonesia) between 1822 and 1849 with Swamp buffalo and a small number of Riverine buffalo from India into Darwin in 1882. The latter does not appear to have had much influence on the current NT population, possibly due to the lesser likelihood of escapes from captivity from Darwin into the surrounding feral herds.

More recent importations of Riverine buffalo from Italy, Bulgaria and the USA occurred in the mid 1990's totalling a further 76 head (11 Bulls and 65 heifers) and this has provided the basis for the fledgling buffalo dairy industry. Currently there are only 3 established dairies in Australia with some others in the planning stages and a shortage of suitable available breeders. The crossbreeding program at the NT research farm has produced many of the current milkers on 2 of the 3 commercial dairies in Australia and their progeny will provide most of the future breeders as the number of purebreds available steadily increases. The purebred herd at NT Govt. Beatrice Hill Farm (BHF) has grown from the 8 head originally imported (4 bulls and 4 heifers) between 1994-97 to produce 136 births (and 12 deaths, mainly calves from dingo predation soon after birth).

This includes 10 heifers sold to other producers during that period, so other purebreds have been produced outside the herd. There are also now (Jan '10) 11 calves that are the 5th backcross from Swamp breeder females mated to Riverine bulls (now regarded as purebred River) and these numbers will increase in rate over the short to medium term.

The total population currently in Australia is not exactly known but is estimated to be around 70,000 - 200,000 in Feb 2010, made up of the following,

Table 1.

STATE	Population Estimate (head)	Milking Dairy Buffalo
Queensland	150	265
New South Wales	100	10
Victoria	200	260
Tasmania	30	-
South Australia	320	-
Western Australia	100	8
Northern Territory Farmed	8-10,000	20
Northern Territory Feral	60,000-120,000 (swamp only)	-
TOTAL	68,900-200,000	563

In recent years despite the low numbers available, there have been small numbers of dairy buffalo exported (see Table 2)

Table 2.

Country		Dairy buffalo numbers exported
Chile		12
South Africa		24
New Zealand		100
Japan		10

Live Buffalo Exports:

The major outputs of the buffalo industry (majority are feral sourced swamp buffalo) are still exported overseas for slaughter into South East Asia. Over the last 5 years the numbers exported are shown in Table. 3 below.

Table 3.

Year	Country of Destination			Total Number Exported
	W Malaysia / Sabah*	**Indonesia**	**Brunei**	
2004	1,556 / 0	0	2,279	3,835
2005	672 / 314	100	816	1,902
2006	5,777 / 659	820	492	7,748
2007	582 / 152	2,865	306	3,905
2008	280 / 236	3,815	306	4,637
2009	0/176	3,274	327	3,777

MATERIALS AND METHODS

Most of the research data comes from the NT Government Farm at Beatrice Hill NT, (12°37'S131°18'E) located 70km ESE of Darwin. Buffalo farming research commenced in 1970 and continues today. The data relates to 2 project herds run on the farm since 1983 to 1998 (P1) and 1994 to 2008. (P2) Imported riverine buffalo from the USA were introduced in 1994 to 1997 and crossbreeding and backcrossing have been the focus of studies from then onwards. The focus on dairy stock commenced in 2002 when the first purchase of milking heifers was made by a dairy in Millaa Millaa Nth Qld. (ADBC). Their economic value as dairy stock exceeds that of meat animals quite considerably.

Pre-1998, (P1) the focus was on the selection of improved swamp buffalo for meat production (up to 300 breeders) and laid the foundations of the "TenderBuff" Quality Assurance package. This herd comprised up to 10 single-sire mating groups using Swamp bulls that were selected from within the herd on their pre-weaning and post-weaning growth rate performance.

The introduction of riverine buffalo genetics occurred in P2. Due to the small no. of imported riverine foundation stock (4 Bulls and 4 heifers), extensive use was made of backcrossing from existing swamp cows to help build numbers in the long term of purebred and crossbred dams, suitable for meat and dairy production. Italian semen was also used to reduce inbreeding potential. The US imported bulls and some of their progeny were maintained to produce the same cross for 10 years, until new Italian cross bull progeny came through the system. ie the same bull produced all the ¾ progeny in succeeding years until Italian crosses were readily available for joining. The 5th backcross is regarded as pure River. All except purebred River cows are seasonally mated for approximately up to 4 months coinciding with the wet season (Nov – May) for mating and calving. The pure River group is subjected to rolling AI programs which are not necessarily during the wet season.

The Growth (Birth, Weaning, Yearling, Final weights and Average Daily Gains) and Milk Traits (Total Fat, Total Protein, Total Lactose and Total Milk) were adjusted by the calving-year of the animal, the sex, the herd where they were born and the parity (milk traits) using PROC GLM in SAS software (SAS Institute Inc, 2000)

RESULTS

The introduction of riverine buffalo genetics provided instant success in the improvement of meat production with a +40% growth rate increase in the F1 animal over the purebred swamp progeny, reduced time to slaughter intervals and showed superior carcase characteristics.

Growth Traits:

Table 4. Breed Codes used:

Breed	**Breed Code**
Swamp	SP
River Buffalo (US origins)	RV
Riverine Buffalo Italian origins (Semen)	IB

Table 5.

Least Square Means

	SP	RV	RV-SP	RV-IB	75%RV-SP
Birth wt	37.4 ± 2.6	39.2 ± 2.7	44.1 ± 2.6	43.2 ± 2.6	39.4 ± 2.7
200Dwt	120 ± 14	162 ± 15	168 ± 15	190 ± 16	174 ± 15
400Dwt	201 ± 8	281 ± 11	286 ±11	326 ± 12	279 ±11
600Dwt	245 ± 5	314 ±8	313 ± 6	355 ± 11	293 ± 8

Average Daily Gain

Table 6.
Least Square Means:

	SP	RV	RV-SP	RV-IB	75%RV-SP
200Dwt	0.50 ± 0.08	0.71 ±0.08	0.73 ±0.09	0.93 ±0.09	0.77 ±0.09
400Dwt	0.50 ± 0.02	0.69 ±0.03	0.70 ±0.03	0.79 ±0.03	0.69 ±0.03
600Dwt	0.36 ±0.01	0.48 ±0.01	0.49 ±0.01	0.56 ±0.02	0.48 ±0.01

Milk Traits:
These results were obtained from the Queensland (Millaa Millaa) Herd (approx 350 records)

Table 7.
Least Square Means:

	SP	RV	RV-SP	RV-IB	75% RV-SP
N	1	21	70	8	92
Total Fat	-	110 ± 20	74 ± 19	127 ± 27	76 ± 17
Total Protein	-	68 ± 8	65 ± 6	82 ± 11	51 ±6
Total Lactose	-	71 ± 8	70 ± 7	100 ± 12	55 ± 6
Total Milk	-	1503 ± 153	1285 ± 121	1831 ± 215	1081 ± 112

Carcase Data from Beatrice Hill Farm:
A comparison of buffalo breed carcase data for 2004-05 financial year for various crosses of River X Swamp, slaughtered that year. Mean and ±95% CI are presented in Table 8.

Table 8.

Breed/ Trait Means	**Swamp** (S100%SP)	**3/8 Rx** (37% RV SP)	**½ Rx** (50% RVSP)	**¾ Rx** (75% RVSP)	**7/8 Rx** (87%RVSP)	**Total All**
No. of animals	33	37	8	17	3	98
HSCW (kg)	216.3±4.6	227.8±7.9	204.2±18.2	238.9±11.1	237.2±68.3	224.2±4.45
P8 Fat (mm)	6.4±0.98	8.2±1.02	5.1±1.97	13.0±2.32	11.3±2.87	8.3±0.80
Rib Fat (mm)	7.8±1.15	8.00±1.02	5.6±2.32	12.7±2.59	9.3±5.17	8.6±0.80
EMA (cm^2	55.1±1.8	62.2±1.9	60.5±7.7	63.0±4.4	67.3±25.0	59.9±1.48
Dressing %	50.4±0.50	51.7±0.86	48.9±1.27	52.9±1.05	49.9±4.78	51.1±0.46

Calving Patterns in a Southern Australian Dairy:
Figure 1.

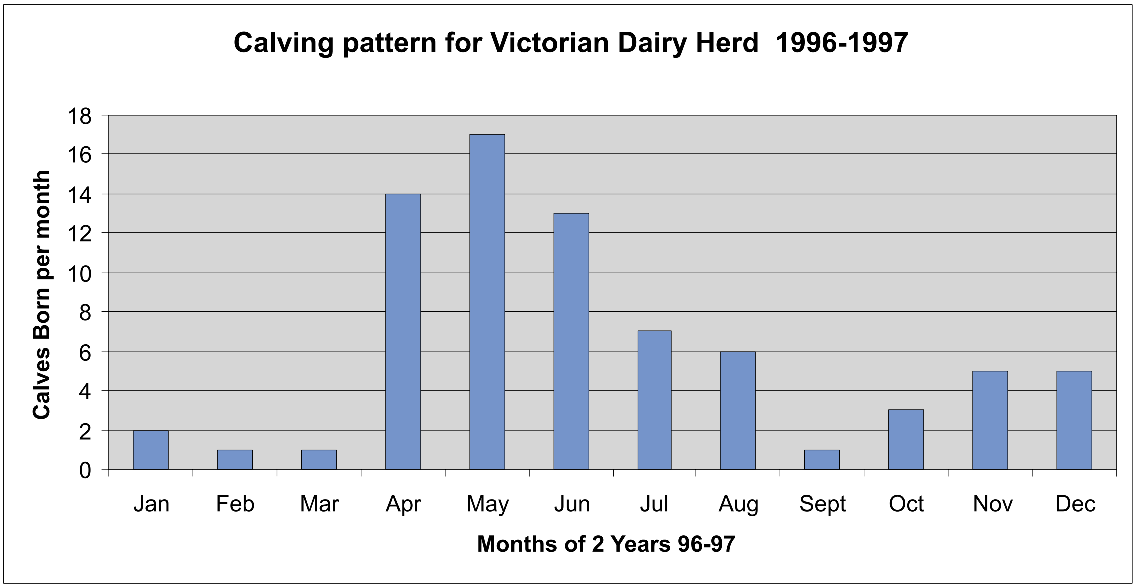
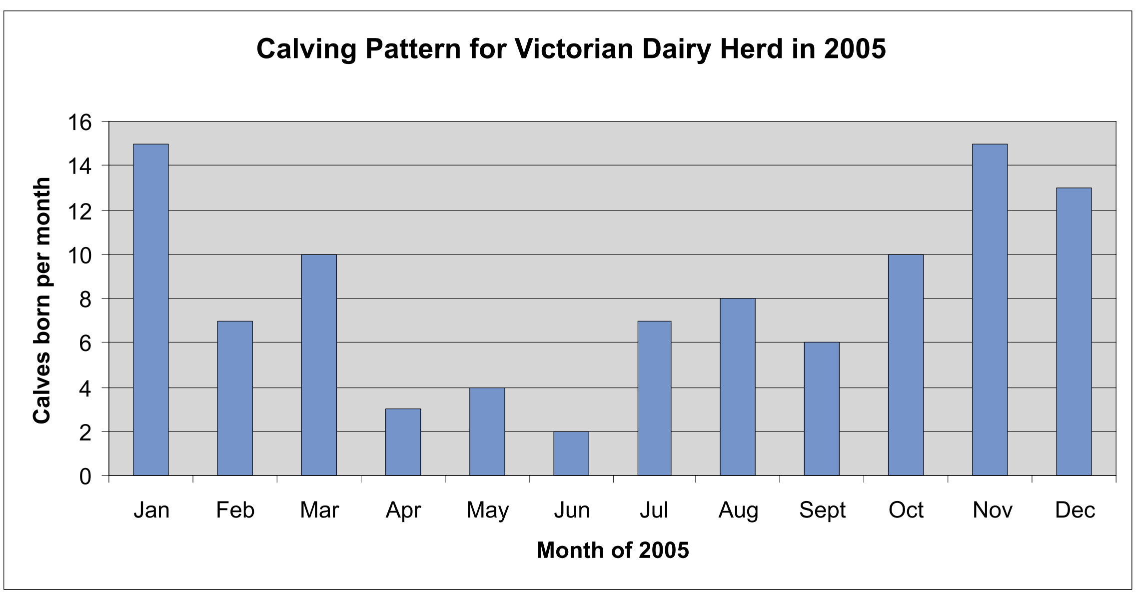


Figure 2.



The above Figures 1 & 2 show the calving distribution for a dairy herd that practises year round mating with bulls in cow mating groups in southern Victoria. The latitude of this herd is 38.3° south of the equator. Figure 1 shows the pattern of calving after arrival in Australia in 1995 and then the pattern after 10 years of residency in the state following importation from Italy and Bulgaria (figure 2.). A reversal of the pattern is evident however may still not yet be totally fixed.

Discussion:

The importation of riverine genetics has had a profound impact on production potential of the Australian buffalo industry. The dairy and meat potential of the River buffalo is demonstrated in the above data.

There is an increase in the birth weight particularly in the 1st cross calves and a large increase in the growth rates which exceeds 40% for 200 day and 400 day traits. There is a slight drop in that increase in the 600 day rate of gain, due to this period falling mainly in the dry season. It is recognised that the swamp cow has a better ability to hold its condition whilst lactating in the dry season, possibly due to its lower milk production. There also appears to be some further increase in growth rate and milk production due to the Italian genetics which is increasing in influence in the recent data.

Italian crosses are showing increases in milk components (15% in fat, 20% protein, 41% lactose and total milk yield (21%)

The Italian / River crosses are showing a greater impact again over the swamp growth rates by 86% for 200 day, 58% for 400 day and 56% for 600 day growth rates using least square means data. There is also a boost to production from the carcase area as demonstrated by the data, where increases in fat, eye muscle area, dressing percentage and yield have been recorded. The F1 progeny were a slight anomaly for that year as they were slaughtered at much lighter weights and much younger than the others in the comparison. Also of great significance are eating quality factors, particularly tenderness, which are the result of the faster growth rates of the crossbreds.

The calving patterns of the Victorian dairy herd are interesting in that the pattern has changed considerably over the 10 years to a summer calving pattern, despite year round mating with bulls and buffaloes preferred mating season being Feb to June with decreasing daylength. Influences such as feed supply and drought may be involved which over-ride mating season even at this latitude.

Conclusions:

The introduction of Italian and US riverine buffalo genetics into Australia in the mid nineties has proven to be of great productive advantage to add to the swamp base of the original introductions nearly 190 years ago. Whilst still a very small industry in terms of numbers in the Australian meat industry context, buffalo have spread only in the last 20 years to all Australian states despite some onerous restrictions and regulations. These new introductions have the potential to allow for a larger future expansion of the meat industry and a greater penetration of the cheese and yoghurt markets.

Acknowledgements:

DOR;The NT Government has shown considerable commitment to the establishment of a viable buffalo industry Australia wide over a long period.

RIRDC;The Rural Industry Research and Development Corporation has invested considerable funds in the last 10 years in developing the industry structures and research aimed at improving efficiency of production.

ABRI;he ABRI has provided the genetic expertise needed to provide Breedplan coverage for the industry based on the successful beef models that it has developed world wide.

BHF Staff;The industry would not be where it is today without the dedication of various Beatrice Hill Farm staff looking after the herds for more than 30 years.

ADBC; The Australia Buffalo Dairy Company has provided the insight and data to contribute dairy information to the database, not currently available in the Northern Territory.

Shaw River Buffalo Cheese;The support that they gave in setting up the Buffalo Register in Australia.

Dr David Ffoulkes;David has provided supervision, mentoring, undying support and high quality research input into the buffalo programme for over 20 years.

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Role of Buffalo in International Trade

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Abstract

While buffalo stock all over the world represents 12% of the world bovine stock, its share in buffalo exports of meat was around 27% of the world bovine exports measured in tons, in 2007. Such share of buffalo in world bovine exports shrinkages to 13.2% when measured in dollars. This shrinkage in buffalo export value of meat in comparison with its physical weight was due to less prices of buffalo products relative to cattle products.

The ratio of annual average "fob price" of buffalo exports to the same average of bovine price was estimated. A ton of buffalo meat was about one-half the cattle price. A ton of buffalo hides was about 40% of the cattle price. The live buffalo price was 14% of the cattle price.

Low export price of buffalo meat relative to cattle could be mainly due to low carcass weight of exported buffalo. Most of buffalo meat was exported for meat processing. Low export price of buffalo hides relative to cattle was due to less quality and less demand or probably, due to moving of the shoes industry to use synthetic leather for slippers manufacturing, rather than buffalo hide. The very low price of exported buffalo live animals could be mainly due to exporting live buffalo as weaned calves rather than fed bulls or steers as cattle ad/or less world demand for buffalo meat. However the high revealed comparative advantage coefficient of buffalo meat export from India (almost 100% of exports) relative to bovine exports confirmed the competitiveness of buffalo exports in the world market.

Meat is the bulk of buffalo exported products, followed by hides. Buffalo dairy products exports are rare due to lack of expanded dairy processing industries of buffalo milk in most of the countries raising buffalo. It is also due to lack of awareness towards the buffalo milk quality which limits the demand for buffalo dairy products and due to lack of enough surplus of supply beyond the domestic consumption for exportation.

Buffalo trade is centered in Asia. Thailand has the highest buffalo exports of live animals and hides. India exports the highest share of buffalo meat. Malaysia, Philippines and Thailand are the main importer of buffalo products.

Therefore, development of foreign trade of buffalo meat and milk production is vital for the development strategy in the world particularly in several Asian and African countries. Buffalo expands over 44 countries in four cotenants, Asia, Africa, Latin America and Europe. The total buffalo stock increased from about 135 million heads in 1991 to around 165 million heads in 2007, i.e., at annual growth rate of 3.3%, however, such stock was concentrated in four countries, India (61%), China (20%), Pakistan (13%) and Egypt (2.2%).1 Buffalo development has a significant role in alleviation of poverty in the developing countries where it is raised2 . Buffalo enterprise has also a main role in employment of rural communities' population3. Accordingly, this study made an economic appraisal of the buffalo products foreign trade performance using several indicators, particularly, the products and Geographic centralization, trade growth, instability of trade volume quantity and price, the F.O.B price ratio of buffalo to cattle of each tradable product, as well as the revealed comparative advantage coefficient of the buffalo tradable products. The study ended by a profile for developing the foreign trade development of buffalo products

INTRODUCTION

The economic principles provide apparent evidences that there are strong links between foreign trade and economic growth, either at country level or for the whole world market. A comparison between several econometric models of Western Europe, Central Europe, the United States, Canada and Mexico in order to analyze the impact of foreign trade and industry on development from demand and supply sides were conducted It was noticed that there are positive effects of foreign trade on economic growth either due to the role of imports from the supply side or to the effect of exports from the demand side. Many studies have shown the positive effects of exports but very few have focused on the positive role of imports. The main benefit from increasing exports is usually to increase the capacity to import intermediate inputs and other goods and services which are necessary to foster domestic production of goods and services.4.

International trade is a crucial precondition for growth5. It is thus an important element of peoples' desire to live in peace, prosperity and freedom. This applies to the developed as well as the world's poorest countries. The challenge is, however, that the poorest countries in the world have not sufficiently managed to take advantage of the trade liberalization that has taken place since the end of World War II.

Therefore, the strategy for trade and development should be "A way out of poverty". The world is constantly changing, and continuously we must learn to find new solutions to new challenges. The new strategy for trade since 2002, focusing on agriculture sustainability has been increased in order to help the developing countries to achieve poverty reduction and realize the millennium development goals (MDGs).

Transit Trade of Buffalo Products

It sees that there is a significant apparent transit trade in two of the three tradable buffalo products in the world market. These two commodities are the buffalo live animal and buffalo hide. Table 1, Shows that, always, the world imported physical quantities of both live animals and hides surpass the comparable world exports. The third tradable buffalo commodity in the world market is he buffalo meat which shows an almost a complete centralization of exports, as well be seen later in the following sections of this study. Therefore, the study presented and analyzed only the exports stream, rather than imports, of these three world commodities.

Structure of Buffalo Products Trade

It should be mentioned that, the available data have show no buffalo dairy products in the world foreign trade stream (either imports or exports). The three main buffalo outputs appeared in the world trade data are the meat, live animals and hide. Even though, hide trade has not shown an aggregate world values or quantities, these aggregate world data were calculated from the individual counties foreign trade data. The relative importance of each one of these three buffalo exportable products in total bovine exports (cattle +Buffalo produce) of the same product was estimated.

The main exportable buffalo product along the period (1980-2007) was red meat. The annual average exported value was around 181.7 million dollars, which represented less than 4% of the bovine meat exports during the same period. However, the relative importance of buffalo meat value in the total value of bovine meat has gradually increased from less 1% in 1980 to about 14% in 2007. Such increase was a result of doubling the export value of buffalo meat to reach around 884 million dollars in 2007. While the value of Buffalo meat exports has doubled between 1980 and 2007 the physical quantity has reached in 2007 en times its quantity in 1980, i.e. increased from about 40 thousand tons in 1980 to 491 thousand tons in 2007. Accordingly, the share of buffalo meat export in bovine meat exports has increased from 2% in 1980 to more than 26% in 2007, (Table 3). The less importance of buffalo meat export measured as value than its measurement as physical quantity is due to the less price of buffalo meat than cattle meat, a will be shown later in this study.

The other two exportable buffalo products, i.e. live animals and hide are not only of minor importance in buffalo export structure. But their export value has decreased over time. On the average the share of buffalo export value was about 0.10% and 0.22% of bovine live animal's exports and bovine hide exports over the period (1980-2007). The value of live animals export was about 8 million dollars, i.e. 0.3% of bovine live animal exports in 1980 and decreased to about 3.4

million dollars, i.e. 0.1% of bovine live animal exports in 2007, (Table 2). In addition, buffalo hide export has decreased from about 1.6 million dollars in 1980, i.e. 0.1% of bovine hide export value in the same year to 34 thousand dollars, i.e. 0.04% of the hide export value in 2007.

In general buffalo products exports (meat, live animals and hide) increased from about 51 million dollars representing 0.5% of bovine exports of same products in 1980 to 888 million dollars, i.e. 5.2% of bovine exports of same products in 2007. The annual average value of buffalo exports (meat, live animals and hide) was 194 million dollars, i.e. 1.6% of the average bovine exports of the same products over the period (1980-2007).

Geographic Centralization of Buffalo Exports

(Table 4) shows that up to the year 1999 all buffalo meat exports were from India. Since 200 little quantity of buffalo meat were delivered to the world market from other Asian countries that raise buffalo. However, such quantities from other countries rather than India had not reached more than 2% of all buffalo meat exports. Accordingly, there is a geographic centralization of buffalo meat exports from India.

With respect to live animals, the geographic centralization pattern of buffalo exports had changed over the period (1980-2007). It was centralized in Nepal market during (1980-1986), i.e. 79% of total exports then shifted to Loa Republic during (1986-1995), i.e. 82%, then to Thailand for two years (1996-1997), and returned to Loa Republic with Myanmar for the successive five years (Table 5). Recently Myanmar has exported the bulk of buffalo live animals over the period (2005-2007). It seems that such trade was a transit trade, as shown above in previous sections, and because that those countries are not of the major five countries raising buffaloes, which are India, Pakistan, China, and Egypt. The geographic centralization of buffalo hide exports had restricted within two countries (Table 6), Thailand and Viet Nam over the period (1980-2007). Even if such geographic centralization was true, i.e. from the same countries produce, it would be negligible as both commodities (live animals and hide) share in buffalo exports was very small.

Growth in Buffalo Products Exports

Estimates of the time trend of buffalo exports and associated FOB price are shown in (Table 7). The results indicated that there was a growth in buffalo meat exports market, as the quantity increased by 4.7% a year over the period (1980-2007). However, such development in buffalo meat exports was associated with a significant decrease in the price per ton by 5.3% a year, which made the share of the exported buffalo meat value in the value of the world bovine meat exports about one-half (Table 2, Table 3).

The exported market of Buffalo live numbers per year has grown lower than buffalo meat exports. The average annual growth rate in the exported numbers of buffalo meat was about two-fold that of live buffaloes, i.e. about 10.1%. In addition, the associated F.O.B. price per head of exported live buffalo was negative of about -5% of the average exported.

The exported market of Buffalo hide had passed two distinct time trends. The first was during the decade (1980-1991), where the tonnage of exported buffalo hides expanded by 28% a year. During the successive two decades (1991-2007), such tonnage decreased at an average annual rate of about 16%. It seems that the development in leather industry, particularly shoes manufacture, was behind such collapse in buffalo hide export market. The shoes industry has shifted to manufacturing the Slippers of the shoes from synthetic rubber rather than buffalo hide. The former is cheaper and more durable and elastic, which makes walking, is more comfortable. The export F.O.B. price of buffalo hide per ton has shown a significant negative trend over the considered two decades of about (-4.6%/year).

Instability in Buffalo Products Exports

It is not only necessarily, to perform a positive significant growth rate of exports but the market stability is also a sufficient condition for exports development. The stability of the exports market should be not only in physical volumes but also should expand to price movements over time. The stable growth in exports is required to assure also stable domestic demand for inputs requited for export industries, as the demand for inputs is derived demand from the primary demand, which composes of both domestic and foreign demand for the concerned outputs6. The demand for inputs includes not only raw materials but also labor employment. The generated income by exportable industries affects the GDP growth and then the economic growth. Accordingly, Stable growth of exports is effectively behind stable growth of domestic employment and economic growth and vise versa. Fluctuations in exports volume and/or prices affect negatively the domestic economic development of exporting countries.

Even though, the buffalo meat exports showed a relatively limited instability in the exported quantity of meat, i.e. around 21%, it was violated by very high instability in the F.O.B. price per ton, i.e. around 80% a year, (Table 7).

On the other hand, the buffalo live animal exports were increasing at high significant growth rate over the last two decades (Table 7), such growth was associated with significant instability in the exported number of animals, where the instability coefficient was very high (72%). Even though there was a high stability in F.O.B. price of exported buffalo live animals, it was associated with a significant decrease in the price level at an annul rate (-5%).

The exports of buffalo hide was not deteriorated in quantity sold during the last two decades with a negative annual change rate but was also associated with a high instability coefficient in the exported tonnage a year, i.e. around 62%. The F.O.B. price of buffalo hide has showed not only a significant change in its level, but also a Fluctuation as apparent instability of about 38% per year (Table 7).

Revealed Comparative Advantage of Buffalo Exports

Buffalo products compete with other livestock products in the international market. Competition is on the market revenue. As livestock edible products are of elastic demand, and then lower price means more batches of sale. Therefore the study estimated the F.O.B. price ratio of buffalo to cattle of each concerned product (meat, live animals and hide). The lower the ratio the higher is the competitiveness of buffalo product with cattle compatible product (Equation 1)7

(Equation 1): Buffalo is competitive with Cattle 1 > (Pbij)/ (Pcij) > 1 Buffalo is not competitive with cattle

Where:

.Pbij = Buffalo F.O.B. price of Product i in the year j

Pcij = Cattle F.O.B. price of Product i in the year j

Considering the output of ((Equation 1) as indicator for buffalo exports competitiveness with cattle, the estimated buffalo to cattle price ratio in (Table 8), (Table 9) and (Table 10), show that buffalo meat, buffalo live animals and buffalo hide are all, in general, of high competitiveness with cattle in the world market. The estimated price ratio is almost in all years are less than one. For buffalo meat such ratio ranged between (0.30 - 0.6). For live animals, the price ratio decreased gradually from 0.8 in 1980 to 0.14 in 2007. For Buffalo hide the ratio decreased from 1.97 in 1980 to 0.37 in the year 2007. Over the period (1980-1985) the price ratio of buffalo hide to cattle hide in the international market was greater than one. Accordingly, up to the year 1985 buffalo hide had no competitive advantage with respect to cattle hide. Over the successive years after 1985, this ratio had become less than one and decreased gradually up to 0.37 in the year 2007.

However, the simple price ratio in ((Equation 1) may hide the impact of less demand for buffalo products due to the consumer taste that my gives less preference to buffalo product than cattle product or due to the less quality of the buffalo output delivered to the international market . In addition, the less buffalo to cattle price ratio could be due to changes in the technology that has denied buffalo row material like buffalo hide for less cost more durable or better quality synthetic product.

Therefore, another indicator was applied to measure the Revealed Comparative Advantage of Buffalo Exports (RVC)8. if RVC > 0, then the country has revealed comparative advantage, and if the RVC< 0, then the country doesn't have revealed comparative advantage. Such indicator is estimated from (Equation 2)

Equation 2: RVCaim = (Xaim/Xnim) / (XarM/XnrM)

Where:

RVCaim = comparative Advantage in exports of commodity (a) from country (i) to selected market, m

Xaim = export value of commodity (a) from country (i) to selected market, m

Xnim = value of total agricultural exports of country (i) (except commodity, a) to selected market, m

XarM = export value of commodity (a) to the world market (M) (minus the export value of commodity (a) of country i to selected market, m)

XnrM = Value of total agricultural exports to the world market (M) (minus the export value of commodity, a, to the world market) minus agricultural exports of country (i), (except commodity, a), to the selected market, m

Such indicator was applied to the buffalo export of meat, as India is almost the only exporter of buffalo meat. (Table 11) shows the estimated Average value of RVC for India exports of buffalo meat to the world within each successive five years during the period (1980-2007). However it should be mentioned that the total agricultural exports in (Equation 2) was replaced by the total exports of bovine meat which is the sum of buffalo meat and cattle meat, The results showed that India has high revealed comparative advantage in buffalo meat exports. Therefore, It looks economically acceptable to have almost all buffalo meat exports are delivered the world market from Indian market.

Foreign Trade and Buffalo Development

Although buffalo products volume in international trade of bovine has shown a minor share, the total world stock of buffalo reached about 181 million heads in 2008 (Table 12). Such stock was about 12%9. The buffalo stock increase at annual growth rate of 8.8%, between 2007 and 2008, i.e. about two and half folds its annual growth rate over the period 1991-20078, not only that but buffalo stock holding in other countries rather than the four major ones has increase to be about 13% in 2008 (Table 12), while it was only 8% as estimated in a recent study 20078.

Expansion in buffalo products exports requires raising productivity rather than stock size to make production in balance with available feeds10. (Table 12) shows that there is a potentiality to raise milking buffalo share in buffalo population structure from a world average of 32% in 2008, to the proportion recognized in Italy, i.e. 63%. There is a potentiality to raise the average world milk yield from about 1529 kilograms per milking head to the average recognized in Pakistan, i.e. 1935 Kilograms per milking head in 2008. With respect to meat production (Table 13) shows that the off-take rate of slaughtered buffalo in the world is low. It was only 14% in 2008. There is a potentiality to approach at least the off-take rate of the buffalo population for slaughter in Egypt, i.e. 31%.

To provide the environment for production increase, via raising productivity, requires readjustment of current policies and development programs, which include: Reform the milk marketing system in villages by overcoming the obstacle facing all efforts towards raising the buffalo productivity, particularly the lack of an institutional framework in the rural area to expand the marketable rural supply of milk. The progressive farms in each region should be as a nucleus farm that provides the common farms with improved genetic makeup, either as buffalo heifers or as bull semen, The A. I. units should be located on those farms to serve the village (region) herds11

The gains of trade liberalization do not come about automatically. Development aid, trade related technical assistance, and market access must work closely together. The goal is to ensure that poor communities gain maximum benefits from free trade. The governments should place great emphasis on the close interplay between development and trade policies. This is the key priority of this strategy. It is through assistance at the country level to identify possibilities to exploit increased market access. Furthermore, environmental considerations must be recognized as a precondition for long-term growth. It is decisive that environmental sustainability becomes an integrated part of the priorities for trade and development.

Therefore, growth is not created by single efforts, but requires a long-term perspective as well as cohesive policies at both the local, regional, and international level. Although the cornerstone of growth is the development of the private sector, the business environment must be improved in order to create incentives for entrepreneurship in the world market– at least for small and medium sized enterprises. Consequently, this strategy is accompanied by an action plan to support business. Therefore such strategy shares the objective of alleviating poverty through economic growth, which in turn stems from trade and business development inter-dependent, as one will not be successful unless accompanied by the other.

Table 1. Excess in Buffalo Imports of live Animals and Hides above the Annual Exports

Year	Live animal (head)	Hide (ton)
1980	9782	3000
1981	18456	1837
1982	17534	3355
1983	12857	2732
1984	95695	1723
1985	38930	8281
1986	34159	17416
1987	14863	16591
1988	124	27994
1989	7412	29392
1990	2096	32688
1991	338	26899
1992	792	48567
1993	1122	61046
1994	632	64661
1995	91	40436
1996	158	40530
1997	293	54540
1998	509	40334
1999	110	29904
2000	66	20938
2001	149	10502
2002	762	49
2003	344	52
2004	12618	52
2005	15628	40
2006	13651	41
2007	13280	40

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 2. World Exports Structure of Buffalo Products (1980-2007)

Year	Meat (000 $)			Live Animals(000 $)			Hide (000$)			Total Exports (000 $)		
	Buffalo	Bovine	% of Buffalo	Buffalo	Bovine	% of Buffalo	Buffalo	Bovine	%	Buffalo	Bovine	%
1980	40588	5064748	0.8%	8698	3136461	0.28%	1689	1670158	0.10%	50975	9871367	0.5%
1981	43905	4767830	0.9%	4190	3127064	0.13%	1379	1438596	0.10%	49474	9333490	0.5%
1982	54177	4438874	1.2%	4219	3106450	0.14%	785	1661562	0.05%	59181	9206886	0.6%
1983	37180	4162913	0.9%	4637	2713065	0.17%	618	1765784	0.03%	42435	8641762	0.5%
1984	36244	3487496	1.0%	6586	2488752	0.26%	836	2422317	0.03%	43666	8398565	0.5%
1985	34199	3400246	1.0%	2402	2409971	0.10%	1121	2284553	0.05%	37722	8094770	0.5%
1986	35641	4507198	0.8%	1412	3047273	0.05%	951	2708521	0.04%	38004	10262992	0.4%
1987	37350	4996867	0.7%	8126	3401129	0.24%	25858	3062704	0.84%	71334	11460700	0.6%
1988	39310	5262469	0.7%	14754	3928516	0.38%	27687	3522370	0.79%	81751	12713355	0.6%
1989	40928	6104193	0.7%	14787	3872133	0.38%	22031	3265320	0.67%	77746	13241646	0.6%
1990	49171	6720885	0.7%	11150	4263282	0.26%	32038	3591843	0.89%	92359	14576010	0.6%
1991	66433	6635626	1.0%	3598	4368862	0.08%	31504	2863393	1.10%	101535	13867881	0.7%
1992	76643	6912258	1.1%	8535	4995263	0.17%	4463	2978693	0.15%	89641	14886214	0.6%
1993	73649	5724785	1.3%	8626	4770995	0.18%	4895	2849477	0.17%	87170	13345257	0.7%
1994	86828	5953004	1.5%	1530	5249481	0.03%	5712	3251978	0.18%	94070	14454463	0.7%
1995	143175	5985968	2.4%	2126	5596855	0.04%	5641	3562950	0.16%	150942	15145773	1.0%
1996	140399	4783021	2.9%	1127	4610900	0.02%	3498	3486717	0.10%	145024	12880638	1.1%
1997	171652	4693351	3.7%	1091	4453300	0.02%	2585	3687648	0.07%	175328	12834299	1.4%
1998	160949	4615523	3.5%	2468	4492128	0.05%	2239	2897036	0.08%	165656	12004687	1.4%
1999	152541	3948778	3.9%	9785	4273651	0.23%	2884	2635261	0.11%	165210	10857690	1.5%
2000	276773	3695822	7.5%	7482	4296465	0.17%	4031	3331252	0.12%	288286	11323539	2.5%
2001	244084	2753925	8.9%	8572	3781072	0.23%	4749	3630342	0.13%	257405	10165339	2.5%
2002	264222	3278565	8.1%	9114	4264594	0.21%	202	3571423	0.01%	273538	11114582	2.5%
2003	306116	3963559	7.7%	4551	4140831	0.11%	36	3592045	0.001%	310703	11696435	2.7%
2004	320886	3999009	8.0%	5500	4370054	0.13%	36	3694603	0.001%	326422	12063666	2.7%
2005	561539	4800759	11.7%	5063	5043934	0.10%	34	3590280	0.001%	566636	13434973	4.2%
2006	708268	5600187	12.6%	2515	6052640	0.04%	35	3808063	0.001%	710818	15460890	4.6%
2007	884200	6460368	13.7%	3386	6533746	0.05%	34	4201568	0.001%	887620	17195682	5.2%
Average	181680	4882794	3.7%	5930	4171031	0.14%	6699	3036659	0.22%	194309	12090484	1.6%

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009.

Table 3: Relative Importance of Buffalo Meat and Live Buffalo Exports in Comparable Bovine Exports

Year	Meat (tons)			Live Animals (tons)		
	Buffalo	Bovine	% of Buffalo	Buffalo	Bovine	%
1980	40067	2038217	2.00%	23737	7030910	0.30%
1981	38836	2028145	1.90%	11330	7267919	0.20%
1982	49779	1841502	2.70%	10688	7686528	0.10%
1983	33641	1894217	1.80%	11048	7094858	0.20%
1984	32610	1794627	1.80%	16665	6708834	0.20%
1985	37248	1841012	2.00%	6429	6401792	0.10%
1986	34810	2240686	1.60%	5062	7107714	0.10%
1987	37471	1871726	2.00%	25219	7377704	0.30%
1988	40123	1794862	2.20%	45956	7361299	0.60%
1989	48454	2213167	2.20%	45147	7306111	0.60%
1990	52211	2140518	2.40%	33381	8005187	0.40%
1991	69049	2374008	2.90%	12335	8349227	0.10%
1992	76365	2463857	3.10%	29662	9182124	0.30%
1993	82170	2120658	3.90%	32565	8919633	0.40%
1994	93590	2118368	4.40%	7658	9718557	0.10%
1995	131839	2011561	6.60%	9418	10346269	0.10%
1996	124575	1858844	6.70%	4931	8853528	0.10%
1997	150857	1911836	7.90%	5046	9358047	0.10%
1998	148411	1733383	8.60%	21905	9028360	0.20%
1999	155443	1582086	9.80%	61307	9361011	0.70%
2000	262567	1643006	16.00%	55615	9438863	0.60%
2001	233282	1362486	17.10%	78498	8793362	0.90%
2002	292765	1549903	18.90%	76368	9124314	0.80%
2003	319210	1563230	20.40%	40825	7951543	0.50%
2004	275861	1415733	19.50%	49500	8087046	0.60%
2005	428686	1639571	26.10%	51548	8291599	0.60%
2006	483100	1754588	27.50%	25069	9490044	0.30%
2007	490802	1856458	26.40%	33061	9084923	0.40%

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 4 Geographic centralization of Buffalo meat Exports

Year	Buffalo Meat Exports (Ton)		
	World	India	% in World Exports
1980	40067	40067	100
1981	38836	38836	100
1982	49779	49779	100
1983	33641	33641	100
1984	32610	32610	100
1985	37248	37248	100
1986	34810	34810	100
1987	37471	37471	100
1988	40123	40123	100
1989	48454	48454	100
1990	52211	52211	100
1991	69049	69049	100
1992	76365	76365	100
1993	82170	82170	100
1994	93590	93590	100
1995	131839	131839	100
1996	124575	124575	100
1997	150857	150857	100
1998	148411	148411	100
1999	155443	155443	100
2000	262567	262491	99.97
2001	233282	233052	99.9
2002	292765	292163	99.79
2003	319210	319087	99.96
2004	275861	275861	100
2005	428686	428686	100
2006	483100	473198	97.95
2007	490802	480429	97.89

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 5. Geographic centralization of exported buffalo live animals over the period (1980-2007)

year	country	Geographic centralization (% of total Buffalo Exports)
1980-1986	Nepal	78.87
1987-1995	Loa People's Democratic Republic	82.33
1996-1997	Thailand	83.81
1998-2004	Lao people's Democratic Republic	41.02
	Myanmar	50.96
2005-2007	Myanmar	86.07

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 6. Geographic centralization of exported buffalo hides in (1980-2007)

year	country	Geographic centralization
1980-1986	Thailand	76.01
1986-1991	Viet Nam	22.27
1992-2007	Viet Nam	84.72

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 7. Estimated Growth and Instability of World exported buffalo products and their FOB prices (1980-2007)

Commodity	Element	Estimated Time Trend ($\hat{Y}$ = a +bT)	Annual growth rate %	Instability coefficient %
Buffalo meat	export quantity (tones)	$\hat{Y}_{ij}$ = - 70278 + 15349 T_j (-2.78)** (10.00)**	10.08	20.62
	FOB price ($/kg)	$\hat{Y}_{ij}$ =0.921 + 0.011 T_j (13.56)** (2.58)**	1.02	79.61
Buffalo live animal	export quantity (head)	$\hat{Y}_{ij}$ = 9301.2 + 1402.81 T_j (1.28) (3.21)**	4.73	71.65
	FOB price ($/head)	$\hat{Y}_{ij}$ = 428.4 - 12.85 T_j (35.14)** (-17.50)**	-5.31	8.13
Buffalo hide	export quantity (ton): (1980-1991)	$\hat{Y}_{ij}$ = -9420.62 + 3223.14 T_j (-2.04)** (5.13)**	27.95	27.57
	export quantity (ton): (1990-2007)	$\hat{Y}_{ij}$ = 21413 - 813.32 T_j (3.85)** (-3.01)**	-15.80	62.38
	FOB price ($/ton)	$\hat{Y}_{ij}$ = 1.816 - 0.05 T_j (14.32)** (-6.55)**	-4.58	37.74

(**) indicate to the significance at level < 0.01

Where ?ij = the estimated quantity of the FOB price of the exported commodity (i) in the year (j)

Tj = The explanatory variable of time trend, applied as the time series of successive years (1980-2007) used as serial numbers, 0, 1,2, …., 28.

Values between parentheses is the calculated (t) value for the statistical inference of the estimated equation's parameters

Average Annual Growth Rate = b/?× 100

Instabilité Coefficient = ??Y- ?)2/?? (Y-Ûy)2 = [1-R2]

Source: Estimated from the raw data of (Table 2, Table 3)

Table 8. World F.O.B. Price ratio of Meat (Buffalo to. Cattle) during (1980- 2007)

Year	Buffalo Meat ($/kg)	Cattle Meat ($/kg)	F.O.B. Price (Buffalo/ Cattle)
1980	1.01	2.51	0.40
1981	1.13	2.37	0.48
1982	1.09	2.45	0.44
1983	1.11	2.22	0.50
1984	1.11	1.96	0.57
1985	0.92	1.87	0.49
1986	1.02	2.03	0.51
1987	1.00	2.70	0.37
1988	0.98	2.98	0.33
1989	0.84	2.80	0.30
1990	0.94	3.19	0.29
1991	0.96	2.85	0.34
1992	1.00	2.86	0.35
1993	0.90	2.77	0.32
1994	0.93	2.90	0.32
1995	1.09	3.11	0.35
1996	1.13	2.68	0.42
1997	1.14	2.57	0.44
1998	1.08	2.81	0.39
1999	0.98	2.66	0.37
2000	1.05	2.48	0.43
2001	1.05	2.22	0.47
2002	0.90	2.40	0.38
2003	0.96	2.94	0.33
2004	1.16	3.23	0.36
2005	1.31	3.50	0.37
2006	1.47	3.85	0.38
2007	1.80	4.08	0.44

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009.

Table 9. World F.O.B. Price ratio of Live Animal (Buffalo to Cattle) during (1980- 2007)

Year	Buffalo ($/head)	Cattle ($/head)	FOB price Ratio (Buffalo/ Cattle)
1980	366.43	446.37	0.82
1981	369.81	430.35	0.86
1982	394.74	404.16	0.98
1983	419.71	382.34	1.10
1984	395.20	370.91	1.07
1985	373.62	376.46	0.99
1986	278.94	428.83	0.65
1987	322.22	461.48	0.70
1988	321.05	535.01	0.60
1989	327.53	531.24	0.62
1990	334.02	533.40	0.63
1991	291.69	523.61	0.56
1992	287.74	544.85	0.53
1993	264.89	535.88	0.49
1994	199.79	540.42	0.37
1995	225.74	541.24	0.42
1996	228.55	520.96	0.44
1997	216.21	476.02	0.45
1998	112.67	498.49	0.23
1999	159.61	458.49	0.35
2000	134.53	457.09	0.29
2001	109.20	432.88	0.25
2002	119.34	470.33	0.25
2003	111.48	522.87	0.21
2004	111.11	543.02	0.20
2005	98.22	611.51	0.16
2006	100.32	639.21	0.16
2007	102.42	721.44	0.14

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 10. World F.O.B. Price ratio of Hide (Buffalo to Cattle) during (1980- 2007)

year	Buffalo ($/ton)	Cattle ($/ton)	FOB price Ratio (Buffalo/ Cattle)
1980	2.49	1.27	1.97
1981	1.61	1.14	1.42
1982	1.82	1.18	1.53
1983	1.78	1.25	1.43
1984	1.97	1.57	1.25
1985	1.95	1.48	1.31
1986	1.38	1.63	0.85
1987	0.89	1.84	0.49
1988	1.07	2.13	0.50
1989	0.99	1.98	0.50
1990	1.09	2.09	0.52
1991	1.13	1.76	0.64
1992	0.99	1.75	0.56
1993	0.93	1.66	0.56
1994	0.87	1.80	0.49
1995	1.32	1.96	0.67
1996	0.73	1.80	0.40
1997	0.68	1.78	0.38
1998	0.57	1.55	0.37
1999	0.38	1.44	0.26
2000	0.45	1.66	0.27
2001	0.49	1.87	0.26
2002	1.01	1.91	0.53
2003	0.69	2.01	0.34
2004	0.69	1.98	0.35
2005	0.85	1.96	0.43
2006	0.85	2.03	0.42
2007	0.85	2.28	0.37

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation: Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 11. Revealed Comparative Advantage (RVC) of buffalo meat export from India

Period	Average (RVC)
1980 -1985	9.29
1985 - 1989	9.40
1989 - 1993	9.10
1993 - 1997	8.63
1997 - 2001	9.07
2001 - 2007	9.56

Source: Estimated from collected data from Food and Agricultural Organization (FAO), Internet Site (www.fao.org), 15 November 2009

Table 12. Buffalo Milk productivity Performance in 2008

	Stock (Head)	% of total stock	Milk Buffalo	% of Milk Buffalo	Yield (Kg/Milk Buffalo)
China	23271909	12.88%	5452000	23%	532
Egypt	5023162	2.78%	1650000	33%	1600
India	98595000	54.56%	38100000	39%	1598
Italy	294000	0.16%	186000	63%	1183
Pakistan	29883000	16.54%	10845000	36%	1935
Total % Averages	180702923	100.00%	58399702	32%	1529

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

Table 13. Buffalo Meat Productivity Performance in 2008

Country	2008				
	Stock (Head)	% of total stock	Slaughtered Animals	% of Slaughtered	Carcass Weight
China	23271909	12.88%	3061750	13%	100
Egypt	5023162	2.78%	1550000	31%	174
India	98595000	54.56%	10846000	11%	138
Italy	294000	0.16%	10516	4%	228
Pakistan	29883000	16.54%	5940000	20%	119
Total, % and Averages	180702923	100.00%	24468941	14%	137

Source: Collected and Calculated from: Food and Agricultural Organization of the United Nation Statistical Data Base (FAOSTAT), Internet Site (www.fao.org), 15th of November 2009

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What Modern Skills and Technologies the Buffalo Farmers in Different Countries Could Learn from Each Other's Experience to Increase the Productivity of Buffalo?

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The author presented a paper entitled "Improving Services for Increasing Productivity of Buffalo" at the 6th Asian Buffalo Association Congress last year at Lahore. It was suggested to set up Buffalo Information Centers (BIC's) in China, India, Pakistan, Thailand and some country of Latin America (preferably Argentina) to improve awareness of the farmers by disseminating knowledge of modern skills and technologies available in the vast literature at global level. However, since this literature is in English language, it is neither understandable to the farmers (mostly being illiterate), nor available even in the libraries of the universities/colleges of veterinary and animal production sciences in different countries. It was envisaged that these BIC's using print and electronic media, should produce literature (leaflets, booklets, films and documentaries etc) in the national languages of the countries. They should also launch vigorous awareness campaigns through extension teams to demonstrate various modern skills to the farmers at their door step. It is envisaged that as a result of such extension activities, the farmers would be able to adopt them thus replacing the centuries old practices of buffalo production------. This followed a heated debate in the question answer session. One of the participants asked a pertinent question as to what are those skills which are to be imparted to the farmers to increase productivity of buffalo?--------- This paper aims at answering such questions. In order to increase the productivity of buffalo, following technologies/skills are worth mention.

Nutrition: Improving the feeding of roughages (dry & green fodder)

1. Green & dry fodders are the main feeding stuffs to fill the belly of ruminants for providing energy. In Pakistan (and may be elsewhere) there are two scarcity seasons when green fodder is in acute shortage. These periods are from May to July (Summer) when Berseen (Trifolium alexndrium) is exhausted in the fields and the second period is from November to January (Winter). Slide # 1 shows the cultivation of Mott grass which provide lush green fodder during May to July. Slide # 2 shows cattle grazing in the field of this fodder. Slide # 3 and 4 show the cutting of green fodder for feeding to animals.

Slide # 1 Cutting of Barseen

Slide # 2 Chaff Cutting

Slide # 3 Mott grass during summer

Slide # 4 Cattle grazing mott grass

2. Increasing the dietary protein and energy contents: In all the rice growing countries, rice straw provides a bulk of ration and particularly during winter nights. Similarly, wheat being the staple food of Pakistani people, its straw is obtained as a by product to be used as dry fodder. Slide # 5 shows increasing the digestibility of wheat and rice straw by treating it with 4% urea and keeping it for about a month or so before feeding. This not only degenerates the lignin contents for easy utilization by rumen bacteria but also makes it rich in protein (NH3). Experiment in many countries have shown good effects of feeding to buffalo.

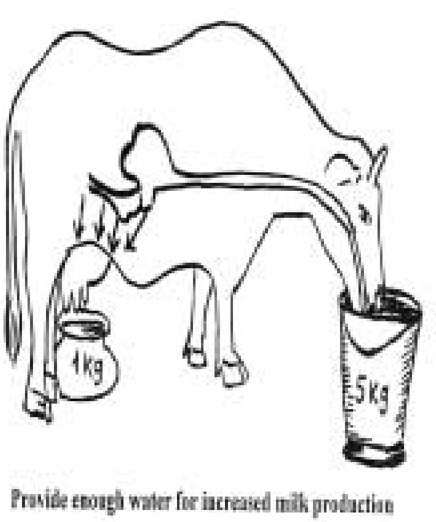
Slide # 5 Demonstration of urea spray

Slide # 6 Wheat straw packed after urea treatment

Slide # 7 Straw after treatment in Italy

Slide # 8

Sl

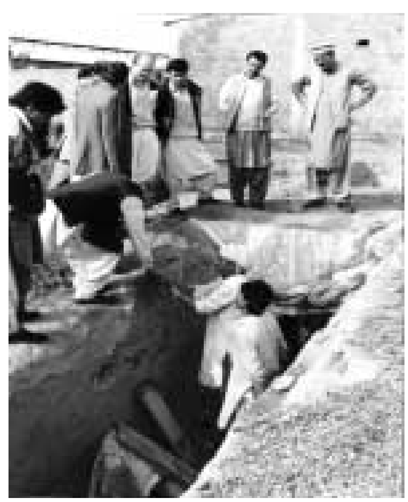


Sl

Slide # 11

Slide # 12 Balance Nutrition

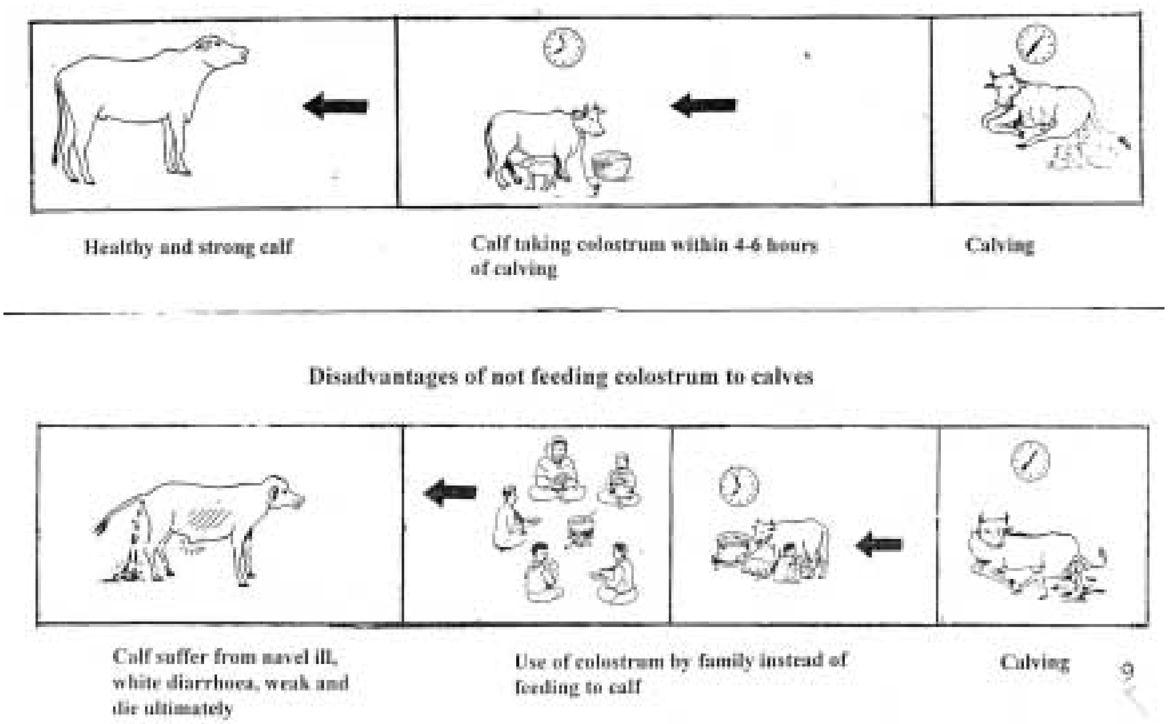
Slide # 13 Straw treatment at farmer's level

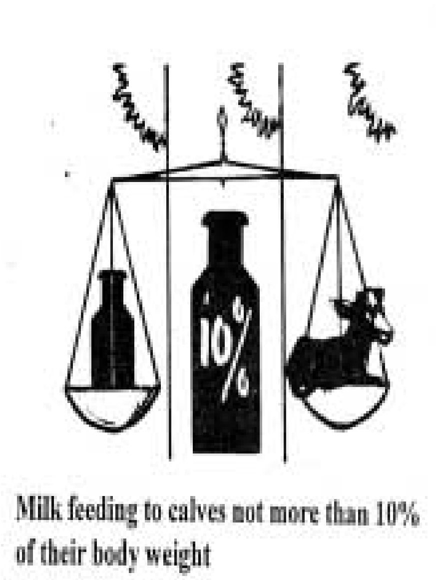


Slide # 14 Pit for silage making

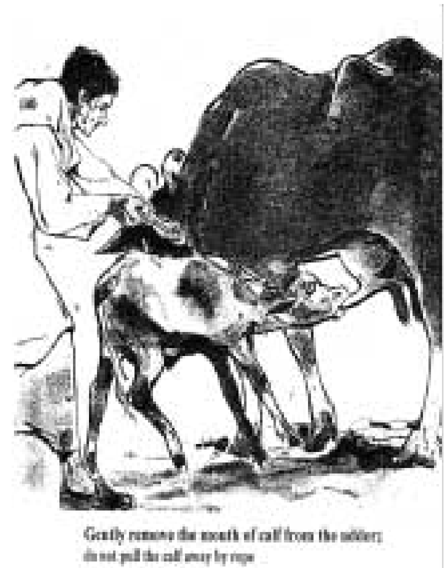
3. Rearing of Calves: Another very important aspect of buffalo keeping is the rearing of male calves which are generally not kept by Pakistani farmers. ----- Million of male calves are slaughtered/die annually in their early age for want of proper feeding and care. These may be saved by providing them colostrums (first milk) from the dams for 2-3 days slide # 15 & 16 show the feeding of colostrums.

Slide # 15 Advantages of colostrums feeding





Slide # 17



Slide # 18

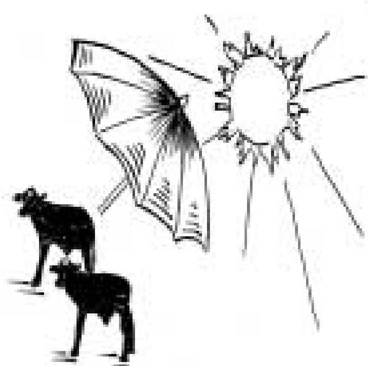
Slide # 19 Claves require balanced feeding for proper growth

Slide # 20 Claves trying to get milk just after calving.

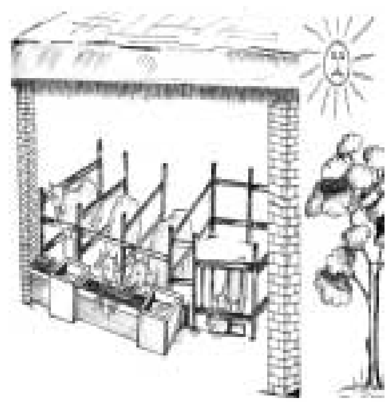
Slide # 21 Calf suckling dam

Slide # 22 Bottle feeding of calf.

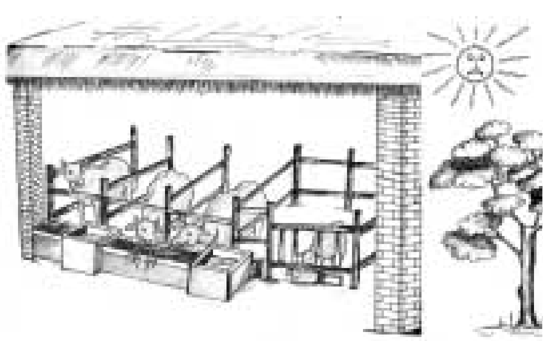
4. Housing and hygienic measures: Proper housing and hygienic measure are essential for getting maximum benefits from buffalo rearing slide # 23-25 show an open paddock providing shelter during the day time.



Slide # 23 Protect claves from sun

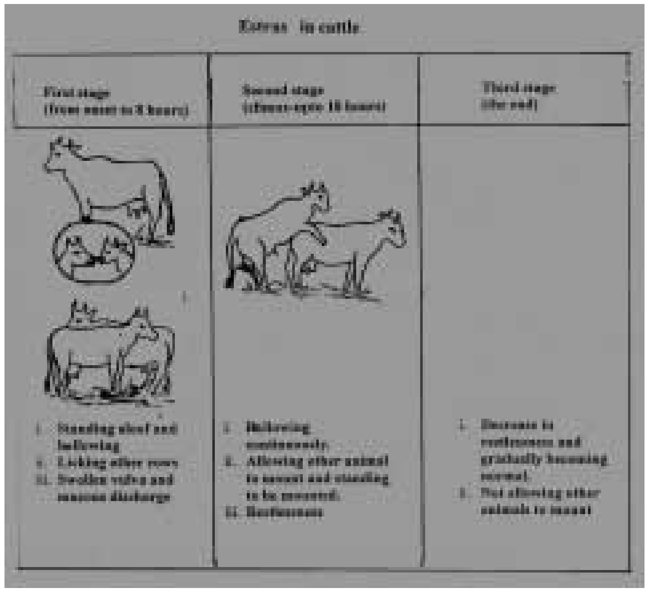


Slide # 24



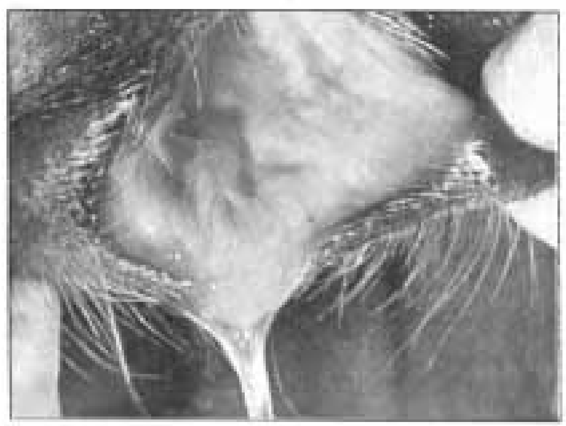
Slide # 25 Proper housing increases productivity

Reproductive Management



Slide # 26 Heat detection

Slide # 27: Secretion from vagina



Slide # 28 Cow in heat stands when pressed on the back.

Normal parturition

Fore-legs come out first and then head appears. Farmer should allow animal to calve normally but ready to provide any help if needed. Keep luke warm water in ample quantity available.

Slide # 29

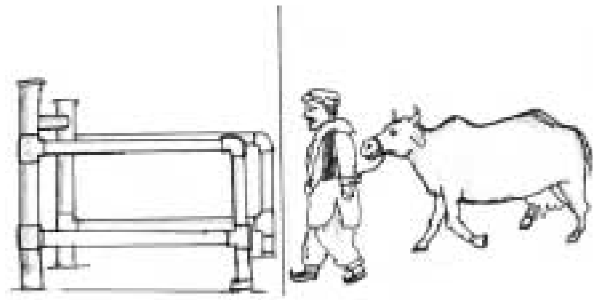
Abnormal births (Dystokia)

In case of difficult or abnormal birth:

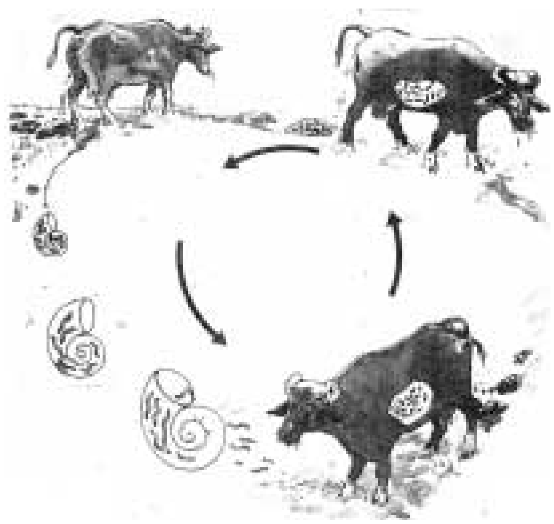
1) **Never pull the legs**
2) **Pull only when the dam is straining**
3) **Pull always towards the direction of the udder**

Slide # 30

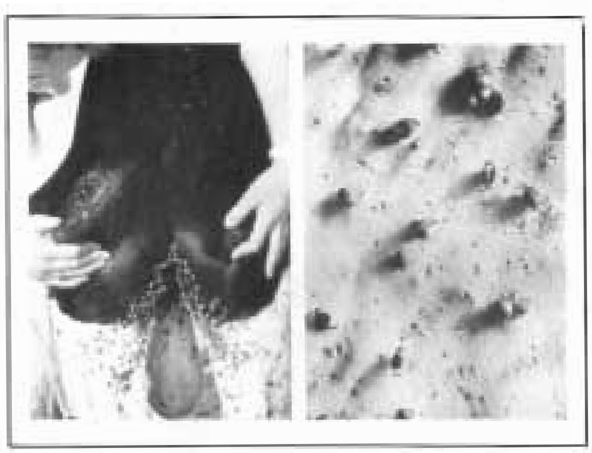
Management of Diseases

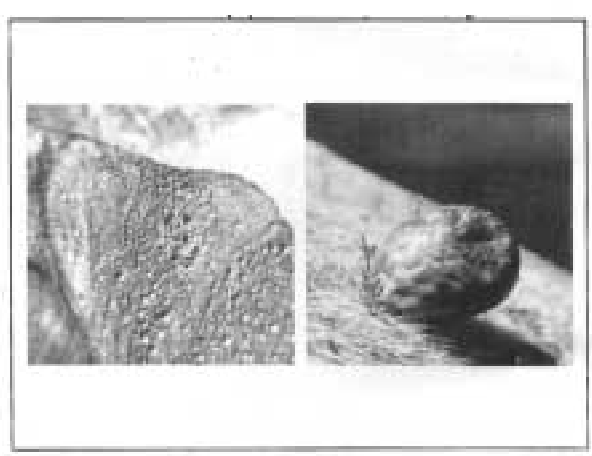


Slide # 31 Slick animal to hospital for treatment



Slide # 32 Internal parasites cause decreased productivity





Slide # 33 & 34 Tick infestation

Slide # 35 & 36 Tick sucking blood and affected skin