Comparison of Growth, Milk Yield and Draughtability of Murrah-Philippine Crossbred and Philippine Native Buffaloes[a]

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ABSTRACT : Data collected between 1981 and 1991 at the Philippine Carabao Center at Central Luzon State University (PCC-CLSU) were used for the comparison of growth, milk yield and draughtability of Murrah-Philippine crossbred and Philippine native buffaloes. Body weights and body measurements were available at 3-month intervals from birth to 36 months of age for a total of 34 Murrah×Philippine native buffalo F1 crossbreds (CBB; 21 cows, 13 bulls) and 32 Philippine native buffaloes (PNB; 16 cows, 16 bulls). Lactation records were available for 14 CBB and 19 PNB cows. Data for draughtability under wet and dry ploughing conditions were available for 4 CBB and 4 PNB steers. The results indicate that crossbreds grow faster (0-9 months of age: cows 442±19 vs. 301±21 g/day, bulls 305±23 vs. 296±21 g/day; 9-36 months of age: cows 227±10 vs. 147±12 g/day, bulls 282±13 vs. 138±12 g/day), mature earlier and produce more milk (1st lactation: 1139±153 vs. 450±112 kg; 2nd lactation: 1115±132 vs. 488±136 kg) than native buffaloes, but have a poorer draughtability (wet ploughing: force as % of body weight 8.8±0.2 vs. 12.2±0.6; dry ploughing: cut depth 10.98±0.25 vs. 11.92±0.13 cm, velocity 0.50±0.03 vs. 0.60±0.02 m/sec, force as % of body weight 9.0±0.6 vs. 11.3±0.7). The correlation coefficients between body weight and body measurements at birth and at 3-month intervals indicate that heart girth has a relatively high correlation with body weight, especially in crossbreds. It is concluded that in Philippine smallholder farming systems in which meat and milk production are secondary to draught power, the native buffalo is preferable from the point of view of input needed to maintain the number of animals kept for a required draught force. *(Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 5 : 580-586)*

Key Words : Philippine Native Buffalo, Buffalo, Crossbreeding, Growth, Milk Yield, Draughtability

INTRODUCTION

The Philippine native buffalo, classified as a swamp buffalo (*Bubalus carabanensis*), is essentially a draught animal utilised in agriculture. In the Philippines, the advent of mechanisation reduced the role of this native buffalo in local farming activities, although buffalo remain a practical source of draught power in smallholder production systems. Indiscriminate slaughtering has contributed to its rapid population decline. Furthermore, due to the custom to castrate large bulls for ease of handling as draught animals, smaller bulls were used for breeding. This resulted in native buffalo becoming smaller and less productive in terms of meat and milk yield. Selection favouring smaller size as a result of castration of large bulls for draught purposes may prove to be a compromise or even an advantage in countries (like the Philippines) where farm sizes are declining, accompanied by increasing scarcity of feed resources (Mahadevan (1985), cited by Sivarajasingam (1987)).

In the early eighties the Philippine government, with the aid of FAO, initiated research to improve the growth, milk production and draughtability of buffaloes by crossbreeding Philippine native buffaloes with breeds of river type buffaloes (*Bubalus bubalis*) such as Murrah and Nili-Ravi and the Thai swamp buffalo. The Murrah is the main breed used for crossbreeding, as this breed is the most readily available. The objective of this paper is to evaluate the growth, milk yield and draughtability of Murrah x Philippine native buffalo F1 crossbreds in comparison to that of contemporary Philippine native buffaloes.

MATERIAL AND METHODS

Data collection

The data used were collected between 1981 and 1991 at the Philippine Carabao Centre at the Central Luzon State University (PCC-CLSU). The project site

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[a] The Netherlands Fellowships Programme (NFP) is acknowledged for granting R. C. D. Salas the opportunity to pursue MSc education at the Wageningen Agricultural University (WAU), The Netherlands. The support of the Central Luzon State University (CLSU-Phil), the National Economic Development Authority (NEDA-Phil) and the Philippine Carabao Centre (PCC) is also acknowledged.

Received April 1, 1999; Accepted July 26, 1999

is about 300 m above sea level. The climate in the area has two pronounced seasons, the rainy season and the dry season. The rainy season is from May to early November. The mean annual rainfall is 1955 mm with maximum rains registered in July and August. The mean annual temperature is 28℃ (PCARR, 1981).

Growth data: A total of 34 Murrah x Philippine native buffalo F1 crossbreds (CBB; 21 cows, 13 bulls) and 32 Philippine native buffaloes (PNB; 16 cows, 16 bulls) were weighed and had body measurements taken at 3-month intervals from birth to 36 months of age. The body measurements included wither height, heart girth, body length from tail implant to shoulder and body length from tail implant to poll. All body measurements were taken while the animals were standing squarely.

The calves remained with their dams in the maternity barn for 1 week. Thereafter they were kept individually in a calf barn with concrete floor. From 3 weeks to 6 months of age the calves were grouped together in a barn with 4-5 calves per pen, grouped according to breed. After 6 months calves were segregated according to breed and sex. Although they were kept in the same barn, they were allowed to graze in an improved pasture with the cows separated from the bulls. From 9 months onwards they were introduced in the growing herd and bulls and cows were separately confined during night in a corral. During the day animals were allowed to graze in the pasture.

After separation from their dams calves were fed milk at an amount of 10%, 5% and 3% of body weight during the first, second and third month of age, respectively. Forage (generally napier grass) was introduced at 2 months of age. Concentrates, containing 16% crude protein, was given from 4 to 24 months of age at an amount of 1% of body weight. After 24 months concentrates with 14% crude protein was fed at an amount of 0.5% of body weight. In the growing herd the buffaloes were allowed to graze in the pasture for about 8 hrs during the day. At night, the buffaloes were allowed to eat rice straw *ad libitum*. Urea treated hay and molasses-mineral blocks were also provided.

Milk yield data: Lactation records of 14 CBB and 19 PNB cows were obtained from the Dairy Farm of PCC-CLSU. Data consisted of date of calving, lactation milk yield (kg), lactation length (days), parity (first or second) and body weight at monthly intervals during lactation (kg). Calves stayed with their dams for about 2-3 days after birth. Cows were milked twice a day (04.00 and 16.00 h). All cows grazed in the pasture for 8 h per day and were given rice straw ad libitum during the night. Concentrates were fed at a rate of 1 kg per 2 kg milk produced.

Draughtability data: Data for draughtability under wet and dry ploughing conditions were available for 4 CBB and 4 PNB steers. Body weight had been measured before onset of the draughtability test. The draughtability parameters tested were ploughing depth and width (cm), ploughing velocity (m/sec), time needed to plough 2500 m^2 (h), draught force (kg), relative draught force (i.e. draught force as % of body weight) and draw-bar horse power. Depth and width of the cut of the plough were measured by taking random samples from the furrows in the area ploughed. Ploughing velocity was calculated from the time needed to plough a distance of 10 m. Draw-bar horse power (dhp) was calculated as:

$$\text{dhp}=[\text{draught force (kg)} \times \text{velocity of ploughing } (\text{m.s}^{-1})]/[75\ (\text{kg.m.s}^{-1})]$$

Genetic size scaling

To compare the growth performance of CBB and PNB independent of differences in genetic size, all body weight data were scaled by adult body weight (A) according to Taylor (1980a, 1985). Body weights were thus expressed as degree of maturity (μ). To study size scaled growth curves, the metabolic age (θ) was calculated from the chronological age (t), gestation length (gl) and adult body weight (A) as:

$$\theta = ((t+gl)-3.5)/A^{0.27}$$

The adult body weights used for scaling were taken from Ranjhan et al. (1987) and are for the CBB cows, CBB bulls, PNB cows and PNB bulls 475, 530, 400 and 445 kg, respectively. In both CBB and PNB, gestation length is on average 322 days.

Statistical analysis

Data were analysed with the SAS System software for General Linear Models (SAS, 1990). For analysis of body weight, scaled body weight (i.e. degree of maturity), body measurement and growth rate data, the following model was used:

$$Y_{ijkl}= \mu +A_i+B_j+C_k+AB_{ij}+e_{ijkl} \text{ ——— (model 1)}$$

where:

Y_{ijkl} = observation for the trait of interest
μ = overall mean
A_i = effect of the i^{th} genotype (CBB, PNB; i=1, 2)
B_j = effect of the j^{th} sex (j=1, 2)
C_k = effect of the k^{th} season of birth (rainy, dry; k=1, 2)
AB_{ij} = interaction effects for genotype and sex
e_{ijkl} = random error of the $ijkl^{th}$ observation

For the analysis of average body weight during lactation, lactation length and lactation milk yield, the following model was used:

$$Y_{ijkl} = \mu + A_i + D_j + C_k + AD_{ij} + e_{ijkl} \quad \text{———— (model 2)}$$

where:

Y_{ijkl} = observation for the trait of interest
D_j = effect of parity (j=1, 2)
AD_{ij} = interaction effects for genotype and parity and all other effects as indicated for model 1.

For the analysis of lactation milk yield, model 2 extended with the covariable lactation length as well as model 2 extended with the covariables lactation length and average body weight during lactation were also used.

Draughtability was analysed for each ploughing condition separately with a one-way model including genotype only.

RESULTS

Growth

The growth curves for CBB cows, CBB bulls, PNB cows and PNB bulls are shown in figure 1. From birth to an age of 9 months, the breed by sex interaction effects were significant (p<0.05-0.01). From 12 months onwards CBB was significantly heavier than PNB (p<0.01-0.001). After an age of 9 months, the sex difference was not significant, except at 15 months (p<0.05). The average growth rate during the first 9 months was significantly higher (p<0.001) for CBB cows than for CBB bulls, PNB cows and PNB bulls (table 1). The growth rates of the latter three groups were not significantly different. Between 9 and 36 months, the average growth rates of the CBB cows and CBB bulls were both significantly higher (p<0.001) than those of the PNB cows and PNB bulls (table 1). During this period the CBB bulls grew significantly faster than the CBB cows (p<0.05). The growth rates of the PNB cows and PNB bulls were not significantly different.

The scaled growth curves for CBB cows, CBB bulls, PNB cows and PNB bulls, showing the change in degree of maturity with an increasing metabolic age, are shown together with the mean mammalian

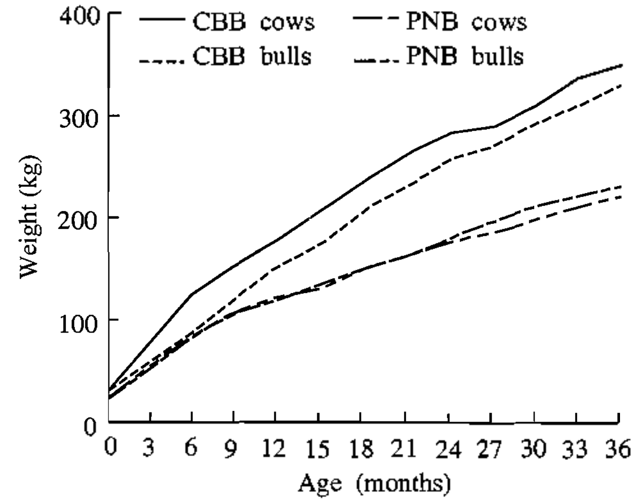

Figure 1. Growth of Murrah×Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB) between birth and 36 months of age

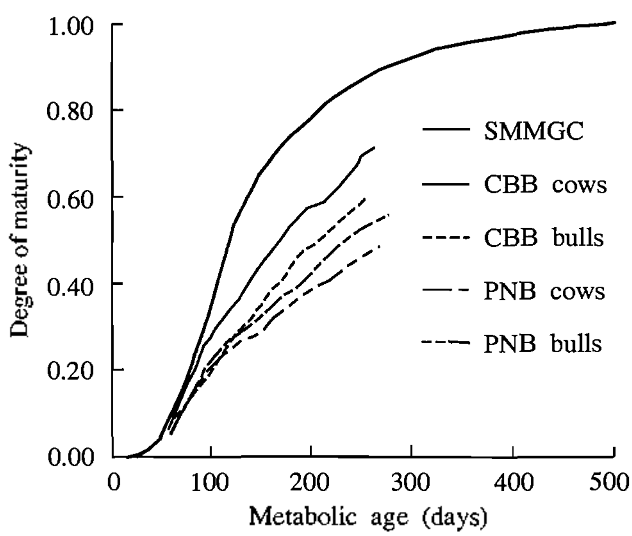

Figure 2. Genetic size-scaled growth curves for Murrah×Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB) in comparison to the standardised mean mammalian growth curve (SMMGC) as given by Taylor (1980b, 1985)

Table 1. Average growth rates (lsmeans±sem) for Murrah×Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB) during the first 9 and subsequent 27 months after birth

	Body weight (kg)			Growth rate (g/day)	
	birth	9 months	36 months	0-9 months	9-36 months
CBB cows	30.4±0.8[a]	149.4±5.1[a]	336.1± 7.8[a]	442±19[a]	227±10[a]
CBB bulls	34.1±1.0[b]	117.9±6.4[b]	317.5±14.2[a]	305±23[b]	282±13[b]
PNB cows	25.1±0.9[c]	106.2±5.8[b]	223.4± 9.8[b]	301±21[b]	147±12[c]
PNB bulls	24.1±0.9[c]	105.0±5.7[b]	216.6±10.1[b]	296±21[b]	138±12[c]

Within columns estimates with different superscripts differ significantly (p<0.05).

growth curve (Taylor, 1980b, 1985) in figure 2. For CBB and, even more obvious, for PNB the rate of maturation was well below the rate that is expected on the basis of the mean mammalian growth curve. Furthermore, for both CBB and PNB, bulls had a slower rate of maturation than cows. At a given *chronological age* the degree of maturity was significantly affected by breed and sex (p<0.05-0.001), with the breed by sex interaction effect only significant up to an age of 9 months.

The correlation coefficients between body weight and body measurements at birth and at 3-month intervals (table 2) indicate that heart girth had a relatively high correlation with body weight, especially in CBB. The results are more variable in PNB. More often than in CBB wither height or body length from tail implant to shoulder had a better correlation with body weight than heart girth.

Based on all data available (birth-36 months of age), the relationship between body weight (BW) and heart girth (HG) for CBB and PNB was BW=3.06*HG - 225.83 (r=0.96, p<0.001) and BW=2.42*HG - 162.80 (r=0.96, p<0.001), respectively. The relationship between body weight (BW) and wither height (WH) was BW=5.48*WH - 383.14 (r=0.94, p<0.001) and BW=4.32*WH - 281.43 (r=0.93, p<0.001), respectively. The relationship between body weight (BW) and body length from tail implant to shoulder (BLTS) was BW=4.43*BLTS - 226.38 (r=0.94, p<0.001) and BW=3.66*BLTS - 174.32 (r=0.93, p<0.001), respectively.

Milk yield

The lactation milk yield of the CBB cows was significantly higher than that of the PNB cows (table 3). Although the lactation length was not significantly different between CBB and PNB cows, within CBB and PNB as well as within parities there was much variation in lactation length (overall range 146-308 days). The linear regression of lactation milk yield on lactation length did not differ significantly between CBB and PNB cows. When differences in lactation length were taken into account, the least square mean estimates (±sem) for lactation milk yield in CBB 1st, CBB 2nd, PNB 1st and PNB 2nd lactation were 1245±132, 1111±111, 377±96 and 529±115 kg, respectively. As was the case without correction for variation in lactation length, lactation milk yield in CBB cows was significantly higher than that in PNB cows, with no effect of parity, neither in CBB nor in PNB.

Table 3. Lactation milk yield (lsmeans ± sem) of Murrah × Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB) during first and second lactation

	Body weight (kg)*	Lactation length (d)	Milk yield (kg)
CBB 1st lactation	431.7±14.4[a]	254±18	1,139±153[a]
CBB 2nd lactation	437.2±12.4[a]	276±15	1,115±132[a]
PNB 1st lactation	367.2±10.5[b]	291±13	450±112[b]
PNB 2nd lactation	365.8±12.8[b]	267±16	488±136[b]

* Average during lactation.
Within columns estimates with different superscripts differ significantly (p<0.05).

Between CBB and PNB cows, a significant difference was found in the relationship between

Table 2. Correlation coefficients between body weight and body measurements at birth and 3-month intervals for Murrah × Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB)

Age (months)	CBB				PNB			
	Wither height	Heart girth	Length t-s[a]	Length t-p[b]	Wither height	Heart girth	Length t-s[a]	Length t-p[b]
0	0.73	0.68	0.62	0.31[c]	0.68	0.39	0.26[c]	0.45
3	0.72	0.77	0.81	0.72	0.72	0.78	0.41	0.51
6	0.85	0.93	0.80	0.68	0.83	0.89	0.64	0.57
9	0.76	0.93	0.82	0.68	0.79	0.71	0.77	0.72
12	0.74	0.90	0.76	0.69	0.67	0.74	0.78	0.65
15	0.73	0.93	0.65	0.58	0.76	0.68	0.84	0.78
18	0.74	0.92	0.68	0.60	0.85	0.85	0.78	0.77
21	0.66	0.87	0.62	0.51	0.79	0.86	0.73	0.73
24	0.59	0.91	0.60	0.52	0.79	0.91	0.78	0.72
27	0.54	0.86	0.80	0.61	0.71	0.86	0.85	0.66
30	0.75	0.85	0.62	0.72	0.78	0.94	0.82	0.69
33	0.61	0.83	0.50	0.53	0.80	0.95	0.62	0.72
36	0.58	0.87	0.62	0.66	0.75	0.85	0.59	0.76

[a] Body length from tail implant to shoulder; [b] Body length from tail implant to poll; [c] Not significant (p>0.05).

lactation milk yield and average body weight during lactation (figure 3). Taking into account differences in lactation length, the lactation milk yield of CBB cows increased significantly with average weight during lactation (+9.66 kg milk/kg increase in average body weight, p<0.001), whereas there was no relationship in PNB cows (-0.27 kg milk/kg increase in body weight, p=0.8).

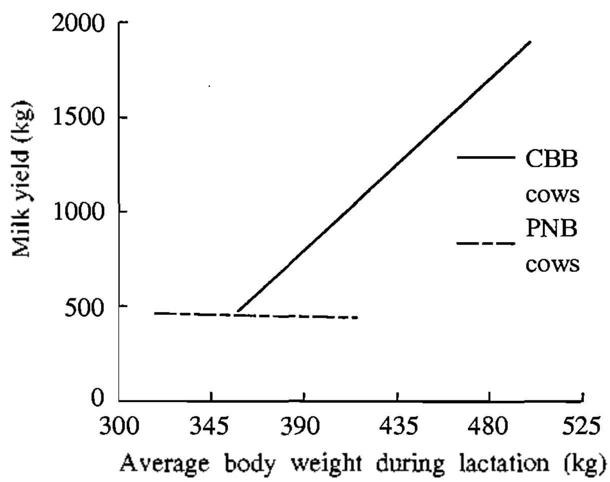

Figure 3. Lactation milk yield corrected for lactation length in relation to body weight in Murrah× Philippine native buffalo F1 crossbred cows (CBB) and Philippine native buffalo cows (PNB)

Draughtability

The weight of the CBB steers that were tested for draughtabilty was significantly higher than that of the tested PNB steers (558.3±9.8 and 445.3±6.0 kg, respectively; p<0.001). The draught performance results (table 4) indicate that PNB steers, in comparison to CBB steers, ploughed significantly deeper cuts and were significantly faster, but only under dry ploughing conditions. Both under wet and dry ploughing conditions, the ploughing force per 100 kg of body weight was significantly higher for PNB than for CBB steers (p<0.01 and p<0.05, respectively).

DISCUSSION

From the comparative evaluation of growth, milk yield and draughtability of Murrah×Philippine native buffalo F1 crossbreds (CBB) and contemporary Philippine native buffaloes (PNB) it can be concluded that the crossbreds grow faster, mature earlier and produce more milk than the native buffaloes, but have an inferior draughtability.

As far as the growth of both CBB and PNB is concerned, the present study indicates that the rate of growth is low in comparison to the growth capacity of the animals. Evidence for this comes from the comparison of the size scaled growth curves for CBB and PNB cows and bulls with the mean mammalian size scaled growth curve as described by Taylor (1980b, 1985). Deviations from the mean mammalian size scaled growth curve have been described (e.g. by Taylor, 1980b, 1985), indicating that certain mammalian species mature faster or slower than the "mean mammal". However, it is not reasonable to assume that the deviations seen in this study indicate that the buffalo is a very slow maturing species, but rather that they were underfed, leading to retarded growth. The sharp decrease in growth rate after 9 months of age correspondingly reduced the rate of maturation. In comparison to the report of Momoñgan et al. (1989) in the present study the mean weights of CBB at birth, 12, 24 and 36 months were lower by 9, 24, 18 and 29%, respectively. Likewise, the mean weights in PNB were lower by 4% at birth and about 28% at 12, 24 and 36 months. This confirms that the buffaloes in this study were apparently undernourished, especially after 9 months of age. Contributory to this was the nutrient deficient pasture from which the buffaloes obtained the bulk of their diet. Although concentrates and rice straw were provided, still it was not enough to support normal growth.

Table 4. Performance of Murrah×Philippine native buffalo F1 crossbreds (CBB) and Philippine native buffaloes (PNB) under different ploughing conditions (mean±SE)

Parameter	Wet ploughing		Dry ploughing	
	CBB	PNB	CBB	PNB
Cut depth (cm)	12.23 ± 0.08	12.25 ± 0.04	10.98 ± 0.25[a]	11.92 ± 0.13[b]
Cut width (cm)	17.69 ± 0.24	17.61 ± 0.22	18.58 ± 0.53	18.95 ± 0.08
Velocity (m/sec)	0.54 ± 0.03	0.50 ± 0.03	0.50 ± 0.03[a]	0.60 ± 0.02[b]
Time for 2500 m^2 (h)	8.29 ± 0.37	8.75 ± 0.60	8.72 ± 0.66	7.15 ± 0.24
Force (kg)	49.2 ± 0.7	54.1 ± 2.6	50.6 ± 3.8	50.2 ± 2.9
Force as % of body weight	8.8 ± 0.2[c]	12.2 ± 0.6[d]	9.0 ± 0.6[a]	11.3 ± 0.7[b]
Horse power (PS)	0.35 ± 0.02	0.36 ± 0.01	0.34 ± 0.03	0.40 ± 0.02

[a,b,c,d] Significant differences within ploughing conditions: [a,b] p<0.05, [c,d] p<0.01.

The adult body weights that were used in the size scaling, were taken from Ranjhan et al. (1987). A limited set of body weight data was available for adult, fully grown CBB and PNB cows and bulls that were kept over a longer period of time at the same location as the presently studied animals (PCC-CLSU). These weights (CBB cows: 471 kg, n=16; CBB bulls: 566 kg, n=4; PNB cows: 390 kg, n=42; PNB bulls: 438 kg, n=10) were highly comparable to the adult weights (475, 530, 400 and 445 kg, respectively) reported by Ranjhan et al. (1987). It may therefore be concluded that the low observed rate of maturation in the present study is not an artefact caused by the use of incorrect scaling factors (i.e. wrong adult body weight estimates).

As far as growth rate is concerned, the crossbred buffaloes were superior to the Philippine native buffaloes. Whereas PNB cows and bulls grew at the same rate, CBB cows grew before an age of 9 months significantly faster and thereafter significantly slower than CBB bulls. In purebred Murrah buffaloes Jogi and Lakhani (1996) have described a similar sexual dimorphism in growth rate. In a study with 587 calves of 169 dams and 47 sires they found that up to 6 months of age cows had a higher growth rate than bulls (478 and 408 g/day, respectively), but from 6-12 months bulls had a higher growth rate than cows (477 and 421 g/day, respectively). Whereas in the present study the weight at birth of the CBB male calves was significantly higher than that of the CBB female calves and PNB calves, the milk produced by the native dams was probably not enough to support the requirements of their heavy crossbred male calves. As such, the growth rate, weight and size of the CBB bulls were just comparable to the PNB animals. This condition poses a high risk of mortality under a smallholder farming system with limited resources to supplement concentrates for lactating cows and nursing calves.

The milk yield of the Murrah×Philippine crossbreds was more than twofold higher than that of the Philippine native buffaloes. Unfortunately no information was available about milk composition. An interesting observation in the current study is the difference in the effect of body weight on milk yield. Whereas milk yield increased with body weight for the crossbreds, milk yield was essentially independent of average body weight for the Philippine native buffaloes. Since in Western breeds of dairy cattle body weight and milk yield are generally positively related (see e.g. Ahlborn and Dempfle, 1992; Brotherstone, 1994; Hietanen and Ojala, 1995), the lack of a relationship in the Philippine native buffalo needs further investigation.

The results of the present study confirm the usefulness of Philippine native buffaloes as a practical source of draught power. The potential draught force largely depends on the live weight of an animal, and is usually expressed as a percentage of live weight. For buffaloes, percentages quoted in the literature range from 9-12% (Hopfen, 1960; Munziger, 1982). In the present study the draught force exerted relative to body weight by PNB (11.3-12.2%) was significantly higher than that of CBB (8.8-9.0%). Despite of the relatively low adult weight of the Philippine native buffaloes in comparison to crossbreds, its overall performance as draught animal is better than that of the crossbreds.

In subsistance farming, buffaloes are the cheapest draught power source available to the farmer. In the Philippines a smallholder farmer maintains only one to three buffaloes because that is the amount of draught power he needs, and it is the carrying capacity of his limited farm land. The decisions of the farmer on increasing the productivity of his buffaloes will always be based on how the draught utility of his animals will be affected. Farmers delay breeding of their buffalo cows because pregnancy reduces the draught performance of these animals. Hence, income from milk is not sustainable. Since meat and milk production are secondary to draught power, the native buffalo is clearly preferable for the smallholder from the point of view of input needed to maintain the number of animals to be kept for the required draught force. In production systems in which the emphasis is on milk and meat production instead of draught power, the crossbred buffaloes will be more productive. However, technically skilled farmers with the financial capability to support the additional cost of maintaining the heavier animals are hereby of crucial importance.

In conclusion, Murrah-Philippine crossbreds grow faster, mature earlier and produce more milk than the Philippine native buffaloes, but have a poorer draughtability. In Philippine smallholder farming systems in which meat and milk production are secondary to draught power the native buffalo is preferable from the point of view of input needed to maintain the number of animals kept for a required draught force.

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