The effect of supplementary feeding on the work output and physiological response of indigenous cattle on an oil palm plantation

Y. M. GOMDA & W. S. ALHASSAN

Animal Research Institute, P. O. Box 20, Achimota, Ghana; (Present Address: Y.M.G.: BNARI, GAEC, P. O. Box 80, Accra, Ghana; W.S.A.: CSIR Secretariat, P. O. Box M.32, Accra, Ghana)

SUMMARY

The effect of supplementary feeding on the work output, respiratory rate and diurnal rectal temperature of Sanga and West African Shorthorn (WASH) cattle working on an oil palm plantation was studied. Supplementary feed intake of the Sanga was 2.8 kg while that of the WASH was 2.4 kg. The average bodyweights of the Sangas and the WASH were 328 kg and 256 kg at the beginning and 348 kg and 262 kg at the end of the trials respectively. Supplementation had no significant effect on work output under the prevailing liberal grazing conditions of the trial. The respiratory rates of the Sangas and the WASH at work when given supplements were 38 and 51 breaths/min respectively and 35 and 41 breaths/min when they were at work without supplementation. The rectal temperature was significantly higher ($P<0.05$) after work in both breeds with and without supplementation. However, no significant difference ($P>0.05$) in the rectal temperature was noticed between the two breeds after work. The average weight of bunches of oil palm fruits carried by a bullock cart per day was 2.03 tonnes while that of a wheel barrow used by human porters was 1.61 tonnes. It was more economical to use bullock carts than wheel barrows.

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RÉSUMÉ

GOMDA, Y. M. & ALHASSAN, W. S. : *L'effet d'alimentation supplémentaire sur le résultat du travail et la réponse physiologique du bétail indigène sur une plantation de palmier.* L'effet d'alimentation supplémentaire sur le résultat du travail, la fréquence respiratoire et la température rectale diurne de Sanga et West African Shorthorn (WASH) bétail dans la plantation de palmier était étudié. La consommation d'alimentation supplémentaire de Sanga était 2.8 kg tandis que celle de WASH était 2.4 kg. Le moyen des poids du corps de Sanga et de WASH étaient respectivement 328 kg et 256 kg au commencement et 348 et 262 kg à la fin d'essai. La supplémentation n'avait pas d'effet considérable sur le rendement du travail sous les conditions actuelles de pâturage libéral. Les fréquences respiratoires des Sangas et de WASH au cours du travail quand ils sont données les suppléments étaient 38 et 51 souffle/min respectivement et puis 35 et 41 souffle/min quand ils étaient au travail sans supplémentation. La température réctale était considérablement élevée ($P< 0.05$) après le travail de deux espèces avec ou sans supplémentation. Toute fois, aucune différence considérable ($P> 0.05$) dans la température réctale n'était notée entre les deux espèces à la suite d'un travail. Le poids moyen de bottes de fruits de palmier portés par un char à boeufs par jour était 2.03 tonnes tandis que celui de la brouette utilisée par les porteurs humains était 1.61 tonnes. Il était plus économique d'utiliser les chars à boeufs que les brouettes.

Introduction

The use of draught animals to haul harvested palm fruits from the interior of oil palm plantations to the roadside for subsequent haulage by motorized vehicles is largely practised in Malaysia (Chin, 1982; Kehoe & Chu, 1987; Bunyavejchewin & Chantalakhana, 1989). The practice has recently been adopted in Ghana, notably at the Benso Oil Palm Plantation (BOPP) in the Western Region in the 1980s. BOPP is an oil palm estate owned by Unilever (Ghana) Ltd.

Studies in the Northern Region of Ghana have shown that investing in draught animals is profitable (Panin, 1988, 1990). However, it has not yet been established whether the use of these animals in southern Ghana to work in cocoa and oil palm

plantations would also be viable. Moreover, the rising cost of fossil fuel coupled with the high cost of maintenance and spare parts of motorized vehicles will probably make the use of draught animals gain importance in agricultural activities. It becomes, therefore, necessary to study the economics of the use of these animals in comparison with the use of human porters on these plantations.

The effect of nutritional status on the work output of draught animals has not been well established. While some workers have shown that the nutritional status of a draught animal positively affects its work output (Ffoulkes & Bamualim, 1989), other workers have reported that nutritional status has no such effect (Francis & Ndlovu, 1993; Osuji, Umuna & Tesfaye, 1993). Pearson *et al.* (1990) noted a significant feed intake in working oxen compared to resting ones. Supplementation is, therefore, thought to provide a greater concentration of energy to the draught animals than forage and can lead to greater work output. This hypothesis must, however, be tested by studying the effect of feeding, general management and health of traction animals on their work output.

The Gudali and the West African Shorthorn (WASH) are examples of cattle breeds in Ghana that seem to be tolerant to heat stress (Okantah, Aggrey & Amoaku, 1993). It would be of interest to know how some of these breeds would perform when put to work under the hot humid conditions of an oil palm plantation.

This paper, therefore, reports on the effect of supplementary feed intake on work output of Sangas and WASH cattle and the physiological responses of these animals to work. The paper also examines the economic viability of using these animals in oil palm plantations.

Materials and methods

Location

The study took place at the Benso Oil Palm Plantation (BOPP) owned by UNILEVER (Ghana) Ltd and situated at Edum Benso near Takoradi in the humid forest zone of the Western Region of Ghana. This area is characterized by a double-peak rainfall of about 1350 mm. The major rainy season occurs between March and July and the minor season from August to October. The dry season occurs between November and February with intermitent and sporadic showers. The vegetation is permanent forest. Grasses constitute flora at ground level most of which show a degree of adaptation to densely shady humid environment sometimes covered by *Pueraria*. A number of small grassy blades isolated in the heart of tall forests, perhaps due to farming activities, are also found in this area. The daily temperature during the year range from 18 to 35 °C with a mean of 26 °C. The mean relative humidity varies from 85 per cent mid-morning to 76 per cent at noon and about 77 per cent late-aftertnoon.

Routine management practice in the plantation

Bullocks and wheel barrows were used in the estate to carry palm bunches from the interior of the plantation to the road side for subsequent haulage to the mill in a system known as "cut and carry". In this system, BOPP contracted workers to harvest the palm fruits and as well carry them to the road side for further haulage by motorized vehicles to the mill. The harvesters in turn hired hands to gather and carry the bunches to the road side by either bullock carts or wheelbarrows. The choice of bullock or wheelbarrow to carry the bunches was exclusively the prerogative of the one doing the gathering and carrying. The choice usually depended on the availability of bunches for transporting to the roadside and also on the efficiency of operators with either haulage method. The study did not disrupt the prevailing system on the plantation.

Feeding of cattle on the estate was done entirely by grazing. The cattle were usually taken out in the morning to work and graze at the same time under the plantation. Grazing normally took place during short intervals when the cutting and gathering of palm bunches were in progress. Watering also took place in a similar manner *ad libitum* in the numerous streams found in the plantation. However, additional watering took place in the pen in

cement troughs filled with water. Sick animals were withdrawn and treated until they were fully recovered to be able to work again.

Care of experimental animals and measurements taken

In the study, 10 bullocks (5 Sangas and 5 WASH) from BOPP's stock, each harnessed to a cart were used to determine work ouput following various levels of supplementary feeding. Four levels (0, 1, 2, 3 and 4 per cent bodyweight) of supplement were fed in a 5×5 Latin Square Design. Each feeding level was for 2 weeks but data on work responses were collected in the 2nd week of feeding. All bullocks had equal access to liberal grazing under the plantation. The amount of grass consumed during grazing was not measured. Watering was *ad libitum*, as mentioned above, in the streams found under the plantations during working hours and in troughs at the pens in the morning before they went out to work and in the evening when they returned from work.

The animals on trial were fed the supplement in the mornings and evenings. The feed supplement consisted of a 3:1 mixture of wheat bran and palm kernel cake as well as 2 per cent (of the mixture) common salt. Daily supplementary feed intake by the animals were recorded. Samples of the supplements were taken for chemical analysis in the laboratory. The quantity taken and chemical analysis of green fodder grazed by the animals under the plantation during the trials were, however, not done. Facilities for estimating forage intake under the grazing situation were not available. The composition of forage eaten by the animals was also not monitored due to the same reason.

The animals were weighed monthly and were put to work between 8.00 a.m. and 5.00 p.m. They pulled two-wheel carts which were loaded with palm bunches from the the interior of the plantations to the road side. They had breaks during the time the workers gathered the palm bunches that were cut. These were the times the animals also grazed and drank water. Although the total duration of rest between 8.00 a.m. and 5.00 p.m. was not measured, this lasted between 20 to 30 min and about 4-5 times each day depending on the efficiency of the worker. The weight of palm bunches hauled per day of work by the bullocks were recorded. The rectal temperatures (RT) of the bullocks were measured using a digital thermometer. The respiratory rates (RR) of the animals were also measured by counting flank movements in a given time. The measurements were done between 7.30 and 8.00 a.m. before the animals went out to work and between 5.30 and 6.00 p.m. when the animals returned from work. Additional measurement of the respiratory rates were made during work in the field.

The cost of the supplementary feed taken by the bullocks during the trials was recorded. From BOPP records, the quantity of palm bunches carried by 6 workers using bullocks and 6 workers using wheelbarrows randomly selected over a period of 53 days, using the "cut and carry" system adopted by the estate, was analysed.

Comparative economic analysis was also carried out. The daily costs in both methods of hauling palm bunches were calculated by dividing the sum of the wages of each individual worker and the repair cost of damaged bullock carts and wheelbarrows by the average number of palm bunches carried by each worker in a day. The repair of damaged carts and wheelbarrows largely consisted of welding of broken pieces of metal, mending or replacing of broken wood as well as replacement or patching of damaged tyres. The data collected from the field were analysed statistically using SPSS computer software package on an IBM computer.

Results

The mean minimum temperatures during the months of October, November and December 1993, when the study took place, were 23.1, 23.1 and 23.7 °C while the maximum temperatures were 30.5, 31.1 and 31.4 °C respectively. The average relative humidities between 09.00 a.m. and 15.00 p.m. when the animals were at work for October, November and December were 79, 77 and 79 per

cent respectively. The rainfall for these months was 94.4 mm, 157.8 mm and 10.5 mm respectively. The frequency, however, decreased from October to December. Except rainfall, the prevailing temperature and relative humidity were normal. The vegetation in the plantation was characteristic of the area. The predominant cover crop was *Pueraria.*

Supplementary feeding and performance

The 3:1 mixture of the wheat bran/palm kernel cake, contained 17.3 per cent crude protein (CP) and had a gross energy (GE) content of 11.2 kJ/g DM (Table 1). The mean daily air dry feed intake of the supplement for the Sangas was 2.8 kg/animal while that of the WASH was 2.4 kg/animal. The intake of the supplement at the four levels (1, 2, 3, and 4 per cent body weight) in both breeds was fairly identical and did not vary with body weight. The larger sized Sangas, however, ate slightly more of the supplementary feed than the WASH (Table 2).

TABLE 1

The Chemical Composition of Supplementary Feed (per cent DM) fed to Sanga and WASH Bullocks on an Oil Palm Plantation

DM	*CP*	*EE*	*CF*	*Ash*	*Ca*	*P*	*GE*
84.2	17.3	0.99	15.6	4.92	0.26	0.82	11.2

GE = Gross Energy (kJ/g DM) calculated from organic matter.

The bodyweights of the Sangas and the WASH at the beginning of the trials were 328 kg/animal and 256 kg/animal respectively. There was a decrease in the bodyweight of the WASH and a slight gain in that of the Sanga at the end of the trial when no supplement were fed (Table 2). The per cent gain in bodyweight in the Sanga during non-supplementation and supplementation were 3.7 per cent and 6.7 per cent respectively. During the period of non-supplementation, the WASH lost 3.9 per cent body weight but gained 2.3 per cent during supplementation.

TABLE 2

The Performance (Mean ± SD) of WASH and Sanga Draught Bullocks with and without Supplementary Feeding

Criteria	*WASH*		*Sanga*	
	Supplement	*No supplement*	*Supplement*	*No supplement*
Liveweight (kg/anim.)	262±34	246±36	348±39	340±61
Supplementary feed intake (kg/anim./day)	2.4±0.1	-	2.8±0.9	-
Daily palm haulage (t/anim./day)	1.83±0.10	1.75±0.40	1.96±0.17	1.76±0.54
Cost of suppl. feeding (¢/anim./day)	62.00	-	72.00	-

$1.00 = ¢750.00 in December 1993

In the trials, no significant differences in the quantity of palm bunches carried due to breed or level of supplementation was noted (Table 2) though trends seemed to favour supplementation and the larger Sanga breed.

The amount of palm bunches from BOPP records, carried by six workers using bullocks and six workers using wheelbarrows randomly selected, over the period of 53 days employing the "cut and carry" system, has been summarized in Table 3. The average daily output of the workers who used bullocks was 2.03 t while that of those who used wheel barrows was 1.61 t.

TABLE 3

Haulage of Oil Palm Bunches per day by Bullock Carts and Wheelbarrows at various periods at BOPP

Period	*Days*	*Bullock cart (t/bull. cart/day)*	*Wheelbarrow (t/whl. barrow/day)*
October '93	14	1.97	1.48
November '93	20	2.01	1.80
December '93	19	2.11	1.55
Average	17.7	2.03	1.61

The average daily cost per man-day between October and December 1993 paid by the estate was the same for the workers irrespective of the method employed in hauling the palm bunches and was ¢3482.69/man/day ($1.00=¢750 in December, 1993). The average repair cost for a bullock cart was ¢362.85/day and ¢81.93/day for a wheel barrow. The cost per unit haulage decreased from October to December. The average cost per haulage for the bullock carts was ¢32.58/bunch/day while that of the wheel barrows was ¢38.58/bunch/day (Table 4).

TABLE 4

Haulage Cost of Palm per Fruit per day by Bullock Carts and Wheelbarrows at various Periods at BOPP

Period	*Average bunch weight (kg)*	*Bullock cart (¢/bunch/ cart)*	*Wheelbarrow (¢/bunch/ whl.barrow)*
October'93	14.04	36.51	47.54
November'93	20.12	35.57	36.93
December'93	18.65	25.65	30.99

Physiological responses

The respiratory rate (RR) was similar within the two breeds during both periods of supplementation and non-supplementation (Table 5). However, the RR during work under the plantation, for both breeds with or without supplementation were significantly ($P<0.05$) higher than the values obtained before the animals went out to work in the plantation.

The average rectal temperatures (RT) of the Sangas in the morning before they went out to work during the periods of supplementation and non-supplementation were 37.78±0.19 °C and 37.52 ±0.11 °C respectively while that of the WASH were 37.67± 0.16 °C and 37.64±0. 23 °C respectively. There was significant ($P<0.05$) rise in the RT in both breeds during work irrespective of nutritional status; however, the rise in RT was higher in the WASH compared to the Sangas (Table 5).

Discussion

The supplementary feed intake of the working bullocks was rather low. This probably was due to a high intake, during liberal grazing of the *Pueraria* cover crop. This could have met the needs for maintenance and work (Crowder & Chheda, 1982).

The reduction in the bodyweight of the WASH during the period of non-supplementation agrees with the observation made by Bamualim & Ffoulkes (1987) in buffaloes, whose bodyweights significantly reduced when they were put to work. The slight increase in bodyweight during supplementation in both breeds also agrees with the observation made by Konanta *et al.* (1986) in which supplementation resulted in increase in the liveweight gain and ploughing ability of bullocks. In this experiment, supplementation did not lead to a corresponding increase in the number of palm bunches hauled during work (Table 2). This

TABLE 5

Diurnal Respiratory Rate and Rectal Temperature changes of Bullocks working on an Oil Palm Plantation

Physiological response	*WASH*						*Sanga*					
	Supplement			*No supplement*			*Supplement*			*No supplement*		
Respiratory rate (breath/min)	a.m.	dw	p.m.	a.m.	dw	p.m.	a.m.	dw	p.m.	a.m.	dw	p.m.
Mean	18	51*	23	17	41*	21	17	38*	22	15	35*	21
SD	1.8	5.1	3.2	1.9	5.5	5.5	4.0	0.7	1.4	1.8	1.8	1.0
Rectal temp. (°C)	a.m.		p.m.	a.m.		p.m.	a.m.		p.m.	a.m.		p.m.
Mean	37.67		39.09*	37.64		39.00*	37.78		38.79*	37.52		38.73*
SD	0.16		0.31	0.23		0.35	0.19		0.17	0.11		0.25

a.m. = morning before work begin s
p.m. = evening after work
dw = during work
* = $P<0.05$

suggests that the nutritional status of the working animals had little to do with their ability to work. This supports the findings of Ffoulkes & Bamaualim (1989) and Osuji, Umuna & Tesfaye (1993). Contrary to this, however, Francis & Ndlovu (1993) observed weight gain and slight improvement in the work output of working cattle when they were fed with cob-sheath and groundnut stover. In the present study, forage was abundant in the plantation and could provide the animals their energy requirements during the period of non-supplementation hence the ability of the bullocks to haul a number of palm bunches comparable to that hauled during the period of supplementation.

The "cut and carry" sytem practised at BOPP could not allow the measuring of the optimal output of the animals and the specific limit of loading of the carts in order to be able to compare the performance of the breeds. The amount of palm bunches hauled, depended largely on the availability of harvested bunches for haulage which in turn depended on the ability of the operators to harvest the bunches. These variables affected both breeds equally. However, it appeared that the Sangas hauled slightly more bunches than the WASH as indicated in Table 2. This is perhaps attributable to the larger size of the Sangas and the tendency of the workers to load carts pulled by Sangas more fully than those pulled by the WASH.

BOPP records indicated that bullock carts hauled more bunches of oil palm fruits than wheelbarrows (Table 3). The records of the workers were randomly selected and this procedure eleminated biases due to inherent efficiency of the workers. There was no limitation in the number of bunches available to both workers using bullock carts and those using wheelbarrows. But as pointed out earlier on, the mode of harvesting bunches on the estate made it difficult to compare the two. The quantity of oil palm bunches carried per day by the bullocks in the present study was slightly higher than what was carried by the workers using wheelbarrows but was similar to that calculated from the BOPP records for the bullock carts (Table 3). Because the study never intended to disrupt the "cut and carry system" which made loading basically dependent on the availability of bunches and the carrying capacity of the carrier rather than specific weights loaded at a time, specific weight limit for both wheelbarrow and bullock cart could not be determined.

Although the estate paid the same amount to the workers in October, November and December, it, however, appeared that the daily cost of haulage per bunch decreased from October to December, 1993 (Table 3). This was probably due to the weather conditions. The rainfall was more frequent in October than November and December and could have affected the harvesting and haulage of palm bunches from the interior of the plantations to the road side for subsequent haulage by motorized vehicles to the mills.

The difference in the cost per haulage using wheelbarrow and bullocks is apparently small and it may appear that the use of bullock carts has no advantage over the use of wheelbarrows to haul palm bunches to the road side for subsequent haulage by motorized vehicle to the mills. Nevertheless, what was practically observed in the field argues well in favour of the use of bullocks in carting palm bunches on such an estate. The wheelbarrow users got tired in relatively short periods of time leading to so much time being used to bring the bunches to the road side. They also avoided relatively large bunches of palm fruits which were left to rot in the field. These constitute economic loss and when one takes into consideration the salvage value of the bullocks, which always appreciates, it will be realized that it is more advantageous to use bullocks to haul palm bunches from the interior of the plantations to the road side for subsequent haulage by motorized vehicles than to use wheelbarrows. In Malaysia, studies have shown that the use of buffaloes to haul oil palm fruits to the collection point is more economical than manually carrying them. Bufalloes also have an added advantage over machines in being able to easily go over rough terrain (Chin, 1982). The use of bullocks is highly commendable in oil

palm estates with cover crops where supplementary feeding may not be necessary.

The respiratory rate of the animals in the morning before they went out to work was within physiological limits. However, work resulted in a rise in the respiratory rate which declined in the evening, but not to the values recorded in the morning. The respiratory rates observed for the Sanga and WASH bullocks after they had been put to work were similar to those reported for lactating crossbred cows exercised on a treadmill (Bhatnagar & Upadhyay, 1991) and Kangayam bullocks employed in traction (Anil & Thomas, 1994).

The increase in the rectal temperature of the bullocks in the evening is similar to that observed by Anil & Thomas (1994) in working bullocks and Bhatnagar & Upadhyay (1991) in exercised cows. However, the increases in rectal temperature in the present study were slightly lower than that recorded by these workers. These differences could probably be due to the differences in breed, sex, intensity of work and the ambient temperature which might have had some degree of influence over the results obtained. The increases in the rectal temperature of the Sangas were lower than that of the WASH. The Sanga is a cross between the WASH and the Zebu and has similar features like the Gudali, with a large body surface area and a well-developed dewlap that could assist in the effective dissipation of heat (Okantah, Aggrey & Amoako, 1993) when they were at work.

The use of bullocks for haulage appears to be more advantageous compared to wheelbarrows and both breeds seem to be suitable for haulage. The physiological changes due to work in both breeds seem to be within acceptable limits and these animals can, therefore, be used for traction without any serious adverse effects in the hot humid forest zone of southern Ghana. When liberal grazing is available as on an oil palm estate with rich cover crop, supplementary concentrate feeding in working animals may not be necessary.

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