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THE EFFECT OF PLANE OF NUTRITION ON REPRODUCTIVE EFFICIENCY OF THE INDIGENOUS SOW

D.H. Holness* *Receipt of MS 12.7.73.*

Chibero Agricultural College, Department of Research and Specialist Services, P. Bag 901, Norton, Rhodesia

OPSOMMING: DIE INVLOED VAN VOEDINGSPEIL OP DIE VOORTPLANTINGSDOELTREFFENDHEID VAN DIE INHEEMSE SOG.

Drie groepe van 20 inheemse varksôe is na spening op een van drie voedingspeile grootgemaak. Daar is van die veronderstelling uitgegaan dat die hoërvlak (100%), die middelvlak (75%) en die laer vlak (50%) aan die behoeftes vir groei en voortplanting sou voorsien. Ses jong sôe, per behandelde groep, is op die 30ste dag waarop hulle die eerste keer dragtig geword het geslag. Die oorblywende sôe is toegelaat om vier voortplantings-siklusse te voltooi alvorens hulle op die 30ste dag, na bevrugting, en hulle vyfde dragtigheids periode geslag is. Die gros energiewaardes van verteenwoordigende karkasse van sowel die sôe as die van agt weke oud varkies van elk van die behandelde groepe is bepaal. Alhoewel die verskil in die aantal varkies wat gebore en per jaar deur sôe tussen die hoë en lae behandelings vlakke gesoog is hoogs betekenisvol was ($P < 0{,}01$), het die aantal werpsels wat per jaar deur 'n sog gespeen is alleen net 'n geringe afname getoon na gelang die daaglikse inname verlaag is. Beide die totale lewende liggaamsmassa van werpsels; gespeen deur 'n sog, en die totale lewende liggaamsmassa van die werpsels wat gespeen is en wat uitgedruk is as 'n persentasie van lewende liggaamsmassa van die sog by spening was betekenisvol ($P < 0{,}01$), hoër ten opsigte van die hoë, as op die lae behandelingsvlak. Voedingsomkeringsdoeltreffendheid was konsekwent laer in die lae dan in die medium en hoërvlakke van behandelde groepe. Die gros doeltreffendheid waarmee die metaboliseerbare energie van die voeding as weefsels energie in die sog en haar werpsel verwerk is, het skynbaar progressief verminder na gelang die voedingsvlak verminder is. Die voortplantingsdoeltreffendheid van die inheemse sog in vergelyking met die van die uitheemse rasse is bespreek.

SUMMARY:

Three groups of 20 indigenous female pigs were reared from weaning on one of three planes of nutrition, estimated to provide 100% (high plane, 75% (medium plane) and 50% (low plane) of the nutrient requirements for growth and reproduction. Six gilts per treatment group were slaughtered on the 30th day of their first pregnancy. The remaining sows were allowed to complete four reproductive cycles and were slaughtered on the 30th day or their fifth gestation period. Gross energy values were determined of representative carcasses of both sows and eight week old piglets from each treatment group. Although there was a highly significant difference ($P < 0{,}01$) in number of piglets born and weaned per sow per annum between the high and low plane treatments, the number of litters weaned per sow per annum only decreased slightly as daily feed intake was lowered. Both total litter live body-mass weaned per sow and total litter live body-mass weaned as a percentage of dam live body-mass at weaning were significantly ($P < 0{,}01$) higher on the high than on the low plane treatment. Feed conversion efficiency was consistently lower in the low than in the medium and high plane treatment groups. The gross efficiency with which the metabolisable energy of the feed was recovered as tissue energy in the sow and her litter appeared to decrease progressively as plane of nutrition decreased. Reproductive performance in the indigenous sow is discussed in comparison with exotic breeds.

In previous reports (Holness; 1972, Holness & Smith, 1973) the effects of plane of nutrition on various reproductive parameters in the indigenous sow have been reported. In this paper, the overall performance of indigenous sows on different planes of nutrition over four parities is assessed and compared. Also, the efficiency with which feed energy was converted into the energy contained in sow and litter tissue is examined.

Procedure

Three groups of 20 indigenous female pigs were reared from weaning at eight weeks of age on one of three planes of nutrition. Each pig was fed individually the same diet at rates estimated to provide 100% (high plane), 75% (medium plane) and 50% (low plane) of the nutrient requirements for growth and reproduction. The ration and rates of feeding were calculated from data presented by the Agricultural Research Council (1967). Six gilts per treatment group, selected at random, were slaughtered on the 30th day of their first pregnancy, and detailed measurements taken of their reproductive tracts and associated endocrine glands. (Holness & Smith, 1970). All the remaining sows were allowed to complete four reproductive cycles and were slaughtered on the 30th day of their fifth gestation period. Measurements were taken of the reproductive tracts of each sow (Holness & Smith, 1973). Details of the feeding, management and slaughter of the sows throughout the experiment have been described previously (Holness 1972; Holness & Smith, 1970; Holness & Smith, 1973).

After slaughter two representative dressed sow carcasses from each treatment group were weighed and then carefully bisected down the mid-line. The left hand side of each carcass was approximately dissected into bone and soft tissue components. These were sealed in separate polythene bags, labelled and stored in a deep freeze. Three piglets from each treatment group, selected from the fourth litter of different sows in order to represent a range of live body-mass within a treatment, were slaughtered on the day that they were weaned. The carcasses were scalded and prepared in the same way as the sows. The carcasses were bisected down the mid-line and the left side of each carcass sealed in

**Present address:* Henderson Research Station, Dept. Research & Specialist Services, P. Bag 222 A, Salisbury, Rhodesia.

a polythene bag, labelled, and deep frozen. When all slaughterings had been completed, the frozen sow and piglet carcasses were transferred to a meat laboratory for chemical analyses and energy determinations.

Using data previously presented (Holness 1972), calculations were made of the total time taken from the start of the experiment until sows were slaughtered on the 30th day of their fifth gestation period; the number of litters produced per sow per annum; and the number of piglets weaned per sow per annum. Total litter live body-mass weaned from a sow was computed as a percentage of sow live body-mass at weaning.

Feed conversion efficiency was calculated as both the ratio of total sow's feed intake to total litter live body-mass at weaning, and the ratio of total sow's feed intake to total litter and sow live body-mass at weaning. The gross efficiency of conversion of energy over the whole experiment was calculated according to the formula:–

$$\frac{(ES_{FW} - ES_{IW}) + E_{LW} \times 100}{E_{FI}}$$

where

ES_{FW} = mean energy equivalent of the sow at slaughter

ES_{IW} = mean energy equivalent of the eight-week-old gilt.

E_{LW} = mean energy equivalent of the litter at weaning

E_{FI} = mean energy content of the feed consumed from the start to the end of the experiment

Results

Differences occurred between treatments in the gross energy content per unit mass of the carcasses of both sows slaughtered on the 30th day of their fifth gestation period and eight week old piglets (Table 1).

Table 1

Mean gross energy content of carcass tissue (sows and weaned piglets)

	Treatment Means		
	High Plane	Medium Plane	Low Plane
Sows. G.E. content Mcal/kg (2 per treatment group)	3,562	2,680	2,052
8 week old piglets G.E. content Mcal/kg (3 per treatment group).	2,906	1,896	1,338

There was a progressive slight increase in the length of the reproductive cycle as plane of nutrition was decreased (Table 2). Thus, the number of litters weaned per sow per annum also decreased slightly as daily feed intake was lowered (Table 2). As these differences were only small, number of piglets born and weaned per sow per annum on each treatment (Table 2) followed the same pattern as number of pigs born and weaned per sow at each parity (Holness 1972).

Table 2

Mean length of the reproductive cycle and number of litters, piglets born and piglets weaned per sow per annum from sows fed on one of three planes of nutrition.

	Treatment Means		
	High Plane	Medium Plane	Low Plane
Mean length of reproductive cycle, days.	179,0	180,7	184,3
Mean no. litters per sow per annum.	2,04	2,01	1,98
Mean no. piglets born alive per sow per annum	14,90	11,98	7,51
Mean no. piglets weaned per sow per annum	13,86	11,01	4,98

There was a significant difference ($P < 0,01$) in total litter live body-mass per sow between each treatment group in each parity (Table 3). The total mass of weaned pig produced per sow per annum on the high plane treatment was over six times that produced on the low plane (Table 3). Also total litter live body-mass weaned as a percentage of dam live body-mass at weaning on the high plane treatment was significantly higher ($P < 0,01$) than on the low plane (Table 4). However, the difference between the high and medium plane groups was only significant at the five per cent level of probability. If figures were only computed from sows that possessed litters, mean total litter live body-mass weaned as a percentage of sow live body-mass at weaning was still lower on the low than on the medium and high plane treatments (Table 4).

Table 3

Total live body-mass of litters weaned from sows fed on one of three planes of nutrition over four parities

	Treatment Means kg.			L.S.D. between treatments P = 0,01 P = 0,05
	High Plane	Medium Plane	Low Plane	
1st Parity	38,24	27,60	6,43	6,37 4,75
2nd Parity	51,60	29,03	1,48	6,60 4,92
3rd Parity	59,26	36,94	15,05	8,56 6,38
4th Parity	60,25	26,77	6,68	9,56 7,13
Total	209,35	120,35	29,64	
Total littermass per sow per annum	106,75	60,46	14,67	

Table 4

Total litter live body-mass weaned as a percentage of dam live body-mass at weaning from sows fed on one of three planes of nutrition

	Treatment Means %			L.S.D. between treatments P = 0,01 P = 0,05
	High Plane	Medium Plane	Low Plane	
1st Parity	100,99	82,71	36,00 (47,13)[1]	24,69 18,40
2nd Parity	113,75	85,44	9,73 (77,83)	21,00 15,65
3rd Parity	113,48	96,19	62,65 (73,04)	27,03 20,15
4th Parity	103,72	68,78	27,59 (77,15)	33,87 25,24

[1] Figures in brackets represent percentage figures for only those sows that prossessed a litter.

In each reproductive cycle, the efficiency of feed conversion was consistently lower in the low than in the medium and high plane treatment groups (Table 5). This effect was due, in part, to the large number of sows on the low plane treatments that did not produce viable litters. Thus, the mass of feed required to produce one kg of weaned litter on the low plane treatment (9,74 kg) was twice that required on the high plane (4,94 kg).

The gross efficiency with which the metabolisable energy of the feed was recovered as tissue energy in the sow and her litter appeared to decrease progressively as the plane of nutrition decreased (Table 6).

Table 5

Efficiency of feed conversion over four reproductive cycles of sows fed on one of three planes of nutrition

	Treatment Means			L.S.D. between treatments P =0,01 P =0,05
	High Plane	Medium Plane	Low Plane	
Start – 1st weaning	3,27	3,36	3,99	0,13 0,09
1st weaning – 2nd weaning	3,88	4,29	5,94	N.S.
2nd weaning – 3rd weaning	3,91	3,63	4,31	0,51 0,38
3rd weaning – 4th weaning	4,07	4,95	6,78	1,16 0,87

Feed conversion efficiency
= kg feed per kg live body-mass gained (sow and litter at weaning).

Table 6

Gross efficiency of conversion of feed energy to tissue energy by the sow and litter in sows fed on one of three planes of nutrition throughout the experiment.

	Treatment Means		
	High Plane	Medium Plane	Low Plane
Gilt live body-mass at start kg	6,74	8,39	7,30
Energy of gilt Mcals (ES_{IW})	19,59	24,38	21,21
Sow live body-mass at slaughter kg	71,64	52,92	38,39
Energy content of sow Mcals (ES_{FW})	255,18	141,83	78,78
Total litter live body-mass produced (4 parities) kg	209,35	120,35	29,64
Energy content of litter (E_{LW})	608,37	228,18	39,66
Total feed intake kg	1034,47	620,86	288,69
Energy intake Mcals ME (E_{FI})	3310,27	1986,13	923,58
Gross efficiency of energy conversion % $= \frac{(ES_{FW} - ES_{IW}) + E_{LW} \times 100}{E_{FI}}$	25,49	17,41	10,53

Discussion

If eight week weaning is practised, it is not possible to have a reproductive cycle, or farrowing index, of less than 175 days. Consequently, it is impossible to obtain more than 2,08 litters per sow per annum, slightly above what was achieved in this experiment. In comparison with figures quoted from surveys on exotic breeds, number of pigs born and weaned per sow per annum in the high and medium plane indigenous sows were below that of British and European figures, but above those quoted for Rhodesian and Zambian herds (Table 7).

Due largely to the large number of weak and non-viable piglets produced on the low plane treatment, and the poor growth rates of those that survived, differences in total litter live body-mass weaned on the different treatments were not in proportion to treatment differences in either feed intake or sow live body-mass. Thus feed conversion efficiency was considerably lower on the low than on the high and medium plane treatments. However, the figures recorded for the efficiency of feed conversion in the high and medium plane sows were similar to those that have been recorded in exotic sows over a number of reproductive cycles (e.g. 3,33 to 4,10 to 1, Parker & Clawson, 1967; 5,1 to 1, Elsley *et al.*, 1969; 3,87 to 4,48 to 1, Lodge, 1969).

In the present study, determinations of the energy content of samples of sows and weaned piglets at slaughter were made for the different treatments. Therefore the estimates of the gross efficiency of conversion of feed energy to sow and litter energy are probably more accurate than those of some other published figures. Salmon-Legagneur & Rerat (1962), for instance, included estimates of milk energy in their calculations, and Smith (1960a) and Bowland (1964) used the same energy value for all eight week old piglets of 2,32 Mcal/kg (as determined by Berge & Indebro, 1954). Furthermore, in studies where sows were not slaughtered, a calculated estimate for the energy equivalent of sow live body-mass changes over the period of assessment has had to be made (Smith 1960 a and b).

It is therefore difficult to make meaningful comparisons between the different studies. Nevertheless, the figures of 25,5 and 17,4 % calculated for the gross efficiency of energy conversion of the high and medium plane indigenous sows are apparently equal or above figures quoted from studies with exotic breeds. Bowland (1964), for example, calculated the gross efficiency of litter energy gain in sows from 20 kg live body-mass to the end of their second lactation to be 11,4 %; Smith (1960 b) reported the energy conversion efficiency of the sow over one reproductive cycle to range from 11,2 to 22,8 % according to the pattern of feeding employed; and Parker and Clawson (1967) also recorded a range, from 14 to 18 % according to feed intake.

The above comparisons between indigenous and exotic types of pig must be regarded with caution, due to the very different conditions under which the data were calculated.

Table 7

Some sow performance figures from different studies with exotic pigs in comparison with high plane indigenous pigs

	No. of pigs born sow/annum	No. of pigs weaned sow/annum
725 herds in U.K. in M.L.C. Pig Feed recording Service (M.L.C., 1971)	18,54	15,80
Czechoslovakia National Figure 1966 (DOSKOCIL, I, 1968)	–	14,19
Sample of above average producers, Rhodesia and Zambia (HARRISON, 1969)		
1965/66	11,97	10,96
1966/67	10,96	8,15
Figure for Rhodesian National Herd (DUNCAN, 1971)		
1968	9,5	8,9
1969	8,8	8,0
1970	10,9	10,1
High Plane Indigenous Pigs	14,90	13,86

Nevertheless, the comparison is between the exotic types, which have been subjected to various degrees of selection for aspects of fertility of commercial importance and the indigenous type which, for the last two or three hundred years, at least, has been subject only to natural selection. In conclusion, it is apparent that the process of reproduction in the indigenous sow is as efficient as in exotic types. In addition, compared to exotic types, the indigenous pig is better adapted to local conditions of climate and vagaries of the diet. Thus, from the viewpoint of reproductive efficiency, there would not appear to be any justification for the introduction of exotic breeds of pig into the Tribal Trust Lands.

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Reference

AGRICULTURAL RESEARCH COUNCIL, 1967. *The nutrient requirements of farm livestock – pigs.* No. 3. London: H.M.S.O.

BERGE, S. and INDEBR, O.T., 1954. Composition of body and weight gain of suckling pigs. *Meld. Norges Landbrukshogsk, 34,* 481.

BOWLAND, J.P., 1964. Influence of source and level of energy and level of protein intake on sow performance during growth, gestation and lactation. *Can. J. Anim. Sci. 44* 142.

DUNCAN, B., 1971. Economic aspects of pig production. *Rhodesian Farmer, 42,* No. 7.

ELSLEY, F.W.H., BANNERMAN, M., BATHURST, E.V.J., BRACEWELL, A.G., CUNNINGHAM, J.M.M., DODSWORTH, T., DODDS, P.A., FORBES, T.J., & LAIRD, R., 1969. The effect of level of feed intake in pregnancy and in lactation upon the productivity of sows. *Anim. Prod. 11* 225.

DOSKOCIL, I., 1968. Pig breeding results. *Zemed. ekon. Praha, 14* 323 *(Anim. Breed Abstr. 39* 115).

HARRISON, J.W., 1969. *Profit from farming.* Salisbury: Rhodesian Farmer Publications.

HOLNESS, D.H., 1972. *Reproductive performance of the indigenous Rhodesian pig, with particular reference to the effects of plane of nutrition.* Ph.D. Thesis. Univ. of London.

HOLNESS, D.H. & SMITH, A.J., 1970. Some effects of plane of nutrition on the development of the reproductive tract and associated endocrine glans in pregnant indigenous gilts. *Rhod. J. agric. Res. 8,* 97.

HOLNESS, D.H. & SMITH, A.J., 1973. Reproductive performance of the indigenous Rhodesian pig: 1. The effect of plane of nutrition on number of ova shed, embryo and foetal mortality, and the distribution of embryos in the uteri of gilts and sows. *Rhod. J. agric. Res. 11,* 103.

LODGE, G.A., 1969. The effects of pattern of feed distribution during the reproductive cycle on the performance of sows. *Anim. Prod. 11,* 133.

MEAT AND LIVESTOCK COMMISSION, 1971. *M.L.C. Pig feed recording service report,* 1971. United Kingdom.

PARKER, J.W. and CLAWSON, A.J., 1967. Influence of level of total feed intake on digestibility, rate of passage and energetic efficiency of reproduction in swine. *J. Anim. Sci. 26,* 485.

SALMON-LEGAGNEUR, E. & RERAT, A., 1962. Nutrition of the sow during pregnancy. In. *Nutrition of Pigs and Poultry,* ed. J.T. Morgan and D. Lewis. London: Butterworths.

SMITH, D.M., 1960 a., The effect of condition at farrowing upon the subsequent milk yield and the efficiency of production. *N.Z.J. agric. Res. 3,* 598.

SMITH, D.M., 1960b., The yield and energy content of milk and the energetic efficiency of sows on different levels of nutrition during gestation and lactation. *N.Z.J. agric. Res. 3,* 745.