International Scholars Journals

African Journal of Pig Farming ISSN 2375-0731 Vol. 4 (7), pp. 001-005, July, 2016. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

The growth performance of growing pigs during feed restriction and re-alimentation in a humid tropical environment

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Accepted 28 November, 2015

Thirty two crossbred (large white x landrace) pigs were used in a 56 days restriction and 56 days re-alimentation study to evaluate the effect of restricting growing pigs at 90, 80 and 70% of the *ad libitum* feed intake of the control. The pigs averaged 35.23 ± 0.560 kg at the start of the study. There were four treatments (control, 90, 80 and 70%). Each treatment had eight pigs allotted to 2 replications of four pigs each. The pigs received a 16% crude protein and 12.08 MJME/kg diet. Results indicated that average daily gains (ADG) of the control pigs were significantly superior to the others during the restriction period. However, at the end of the 56 days re-alimentation, pigs on the 80% and 70% feeding regime had superior ADG than the pigs on the control and 90 percent feeding regime. Data on the body length (BL) and height at shoulders (HS) followed the same trend as observed for ADG. Feed intakes of pigs were significantly affected during the restriction and re-alimentation period. There was a significant ($p < 0.05$) decrease in feed intake as level of restriction increased. Also, during re-alimentation pigs on the 70% level had the highest feed intake. Pigs on the 80% level of restriction had the best feed cost/kg gain values at restriction and re-alimentation. It is concluded that restricting growing pigs at 80% of the *ad libitum* intake of the control yields best performance and economic benefit.

Key words: Growth, restriction, re-alimentation.

INTRODUCTION

One of the major problems of food insecurity is the severe competition between man and farm animals for available food stuffs (Steinbach, 1985). The type of animals mostly affected are the simple stomached species, pig and poultry, which depend on the same food needed by man to survive and produce. Several reasons have been adduced for the short fall in food supply mostly experienced in developing countries and the most prominent appears to be the adoption of inadequate agronomic strategies including unsatisfactory storage programmes. This result in considerable loses in the field and after harvest such that supply of cereals and leguminous grains which are also the backbone of successful monogastric animal production is largely seasonal. To compound this situation is the uncontrolled rise in human population in these countries resulting in continual reduction in food margins for animal feedings. The ultimate effect is the continual increase in feed costs to levels beyond 70% of total cost of animal production (Onyimonyi and Okeke, 2004). Attempts to elevate feed supplies to animals in such countries mostly entailed the utilization of agro- industrial wastes which measure has largely proved not to be very effective due to availability and quality concerns.

The concept of compensatory growth whereby an animal whose growth has been slowed by nutritional deprivation may exhibit enhanced growth after deprivation is stopped (Wilson and Osbourn, 1960; Doyl and Lesson, 2005) may be a reliable option in meeting challenges faced by pig farmers in food deficient countries. Compensatory growth had been reported in pigs (Prince et al., 1983; Mersmann et al., 1987 and Kyriazakis et al., 1991). Prince et al. (1983) restricted pigs to 70 or 80% of *ad libitum* intake for either 2 or 4 weeks.

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Table 1. Daily feed intake feed/gain and feed cost/kg gain of growing pigs during feed restriction and post restriction.

Parameter	Control	90%	80%	70%	SEM
(i) Daily feed intake (kg/d)					
Restriction period	2.36[a]	2.18[b]	1.84[b]	1.57[c]	0.17
Post restriction period	2.34	2.42	2.57	2.65	0.58
Whole period	2.54	2.44	2.36	2.43	0.41
(ii) Feed/Gain					
Restriction period	3.74	3.65	3.57	3.68	0.25
Post restriction period	3.92	3.87	3.76	3.83	0.40
Whole period	3.89	3.68	3.67	3.74	0.37
(iii) Feed cost/kg gain N					
Restriction period	129.40	126.29	123.52	127.33	1.06
Post restriction period	135.63	133.90	130.10	132.51	1.01
Whole period	133.90	127.32	124.91	129.40	1.65

abc: Row means with different superscripts are significantly different ($p < 0.05$).
SEM = Standard error of a mean.

The group restricted to 85% for 4 weeks performed the best. Those restricted to 70% of *ad libitum* intake for 4 weeks were unable to freely compensate suggesting that the restriction was either too severe and/or too prolonged. Mersemann et al. (1987) remarked that the magnitude of increase in growth rate following feed restriction may well be affected by the change in physiological status imposed by the weight loss during restriction.

Kyriazakis et al. (1991) observed that there were no significant difference in growth rate between either male or female pigs upon re-alimentation after feeding a low protein diet. The present study intends to investigate the extent of growth reduction in growing pigs subjected to feed restriction, the rate of recovery on re-alimentation and the benefits accruable to the farmer that may adopt this concept in the humid tropics where prevailing thermal condition may exert negative influence on growth performance of pigs.

EXPERIMENTAL PROCEDURES

This study was conducted at the pig research and teaching unit of the department of Animal Science, University of Nigeria, Nsukka. The study lasted for 16 weeks. The location has a typical humid tropical climate with average day temperature ranging from 28°C in January (Harmattan Period), July and August to 34°C in February, March and April (Hottest months of the year). Humidity values ranged from 78% (November – February) to an average of 80% (March – October).

Thirty two crossbred (large white x landrace) pigs selected from litters of four landrace dams that farrowed within one week were allotted to four treatments made up of the control and three levels of feed restriction (90, 80 and 70% of *ad libitum*). The average live weight of the pigs was 35.23 kg at start of the restriction and they consisted of 16 castrates and 16 females. Each treatment contained eight pigs (4 castrates and 4 females) separated into two replicates of four pigs each housed in a pen measuring 3.2 x 2.5 m equipped with concrete feeders separated into four feeding points with strong wooden planks to ensure that each pig had uninterrupted access to its ration. The pigs were fed a 16% CP and 12.08 MJME/kg diet made up of 20% cassava chips, 5.5% maize, 12% spent grain, 27.5% rice husk, 20.5% palm kernel cake, 10% groundnut cake, 1.5% palm oil, 2% bone meal, 0.5 common salt, 0.15 methionine 0.10 lysine and 0.25 vitamin premix.

All pigs were weighed at the inception of the restriction and latter on weekly intervals. Feed intake/unit of body weight was calculated for pigs on the control treatment (fed *ad libitum*) based on which the restricted levels of intake (90, 80 and 70% of *ad libitum*) were determined at the same average weight. Before the commencement of the restriction phase (RST), pigs were allowed one week adjustment period in their new pens. Thereafter, the restriction phase commenced and lasted for 56d. This was immediately followed by the re-alimentation phase (Post – RST) which lasted for a maximum of 56d. All pigs were fed once per day at 7 h during both stages. Pigs were weighed weekly in post – RST. Other growth measurements taken in both stages at weekly interval were body length (BL); as t he length of pigs body from base of tail to base of skull (Mersmann et al., 1987) and height at shoulder (HS) taken as the vertical distance from the floor of restraining cage to the highest point on the shoulder (Lefaucheur et al., 1991). Daily feed intake (Table 1) was determined as the difference between the amount of feed fed and the amount left over in 24 h while feed/gain was calculated as the ratio of feed intake over weight gain. During Post–RST all experimental measurements were discontinued within treatment when the average body weight of composite pigs reached 100 kg.

All data on performance of animals at RST and Post – RST were processed and analysed statistically according to the procedures of Steel and Torrie (1980) using a stats graphic computer package. Statistically different means were separated by Duncan's new multiple range test (Duncan, 1955) in the same package.

RESULTS AND DISCUSSION

The results of the growth performance of pigs in the two phases of the experiment (RST and Post – RST) are presented in Table 2. There were significant ($P < 0.05$)

Table 2. Performance of growing pigs during restriction (RST) and post restriction (Post – RST) periods.

Parameter	Control	90%	80%	70%	SEM
(i) Body weight kg					
Av. Initial Body wt. (RST)	42.27	41.90	42.32	41.21	
Av. Final Body wt (RST)	76.19[a]	74.64[a]	67.15[b]	60.37[c]	0.97
Av. Daily gain (RST)	0.62[a]	0.57[a]	0.41[b]	60.32[c]	0.03
Av. Daily gain (Post-RST)	0.60[a]	0.62[a]	0.79[b]	0.76[b]	0.06
Av. Age at 100kg (d)	223	225	229	240	3.25
(ii) Body length (cm)					
Av. Initial Body length (RST)	56.13	55.92	56.21	56.87	
Av. Final Body length (RST)	77.25[a]	75.20[a]	73.31[a]	70.19[b]	2.30
Av. Daily gain in body length (RST)	0.38[a]	0.34[a]	0.30[a]	0.23[b]	0.02
Av. Body length at 100kg (Post-RST)	89.65	88.24	88.27	87.46	2.31
Av. Daily gain in body length (Post-RST)	0.30	0.32	0.35	0.33	0.04
(iii) Height at shoulder (cm)					
Av. Initial height at shoulder (RST)	41.81	42.03	42.17	41.72	
Av. Final height at shoulder (RST)	56.04[a]	55.02[a]	53.37[a]	51.80[b]	1.36
Av. Daily gain in height at shoulder (RST)	0.25[a]	0.21[a]	0.20[a]	0.18[b]	0.02
Av. Height at shoulder 100kg (Post-RST)	64.26	63.63	63.65	63.76	1.78
Av. Daily gain in height at shoulder (Post-RST)	0.19	0.20	0.25	0.23	0.04

abc: Mean with different superscripts in a sow significantly ($p < 0.05$) different.
SEM = Standard error of mean.

decreases in body weight (BW), body length (BL) and height at shoulder (BS) at RST. The average gains in BW (ADG), BL (ADGL) and HS (ADGH) also decreased significantly ($P < 0.05$). The control pigs were superior to the restricted groups in these parameters with pigs fed 70% of *ad libitum* growing at the lowest rates. Growth reduction in pigs subjected to various levels of feed or nutrient deprivation has been widely reported in temperate climates (Owen et al., 1971; Wahlshom and Libal, 1983; Donker et al., 1986; Mersmann et al., 1987; Chiba, 1995). The extent of decrease in various components of body growth studied reflected the amount of feed made available to the restricted pigs which decreased significantly ($P < 0.05$) from control to 70% of *ad libitum*. The ADG of 80 and 70% restricted pigs (0.41 and 0.32 kg/d respectively) were lower than 0.59 and 0.48 kg/d reported by Prince et al. (1983) in growing pigs restricted to 85 and 70% of *ad libitum* consumption.

The efficiency of feed conversion was generally low with values recorded for the restricted pigs being slightly lower than that of the control. Steinbach (1985) observed that the exogenous and endogenous heat load affecting pigs in the humid tropics act through the neuro endocrine system to alter digestibility and absorption of nutrients, enzyme activity and metabolism of various nutrients, thereby reducing efficiency of feed conversion and growth rate. It is therefore likely that the lower gains obtained for 80 and 70% restricted pigs may not be as a result of the levels of restriction above but also involved the influence of prevailing environment. The pigs fed 90% of *ad libitum* were minimally affected by restriction with ADG values (0.57 kg/d) differing only slightly from that of control (0.62 kg/d). Cleveland et al. (1983) and Mersmann et al. (1987) described this level as modest restriction since it caused reduction in fat deposition only with no change in gain of lean. When compared with the control, pigs fed 70 and 80% of *ad libitum* respectively lost 15.82 and 9.05 kg of BW respectively during the 56d restriction period while 90% restricted group lost 1.55 kg.

A similar trend was observed in linear body measurements where for BL, pigs fed 70 and 80% of *ad libitum* lost 7.06 and 3.94 cm while the 90% group lost 2.05 cm. For HS, 4.01, 2.44 and 1.62 cm were the losses recorded by 70, 80 and 90% restricted groups respectively. Minimal loss in BL was reported by Mersmann et al. (1987) for growing pigs restricted for three weeks. Significant reduction in BL was not recorded by these authors probably because of the short duration of restriction. It seems apparent that the pigs placed on 70% of *ad libitum* con-sumption received more severe treatment which resulted in significant retardation in growth of bone and lean tis-sue.

Doornenbal (1975) reported that after 12 weeks of age, pigs exhibit rapid lengthening of the backbone which accounts for the increase in body length. It is therefore felt that severe nutritional deprivation as was the case with pigs given 70% of *ad libitum* for 56d in the tropics where growth rate is generally low, could delay development of body length. Similarly, the observed drop in HS measurement of the 70% restricted group may also have

been the result of the prolonged nutritional assault on the pigs which are in the stage (30 – 159 kg) when proportionnal increases in muscle and length/diameter of the limb bones occur.

The pigs exhibited different rates of recovery at Post – RST with 80 and 70% restricted groups recording higher ($P < 0.05$) ADG (0.79 and 0.76 kg/d) than the control and 90% restricted groups (0.60 and 0.62 kg/d). The Post – RST ADG of 80 and 70% groups were twice the RST gains and when compared with the control, the gains were higher by 0.19 and 0.16 kg/d respectively. However, the re-alimentation growth rates reported by Mersmann et al. (1987) for control and restricted pigs (0.864 vs 1.005 kg/d) were much higher than the rates obtained in the present study. The gains reported by Prince et al. (1983) for pigs fed 85 and 70% of ad lib for four weeks (0.83 vs 0.78 kg/d) were also higher than the Post RST gains recorded in the present study. The 80 and 70% restricted groups also made up for lose in BL and HS at RST. The Post – RST rates of increase in BL of 80 and 70% restricted groups (0.35 and 0.33 cm/d) were lower than 0.496 cm/d recorded by Mersmann et al. (1987) for re-fed pigs in the temperate environment. The Post – RST feed consumption of pigs were significantly ($P < 0.05$) affected during restriction. The highest intake was observed in the 70% restricted group (2.65 kg/d) while the lowest was in the control (2.34 kg/d). Feed consumption in 80 and 70% groups were only a little higher than their intake at RST within the first week of re-alimentation but appreciated gradually from the second week reaching stable values from the third week till the end of that phase. This trend was not noticed in the 90% restricted group where the intake increased at the beginning of re-alimentation and following a period of feed restriction took several weeks to develop fully and persisted for some time. It is likely that the initial delay in attaining full consumption immediately on re- alimentation may be due to the inherent mechanism in pigs to adjust voluntary intake in response to previous restriction as earlier suggested by Wilson and Osbourn (1960) . It was also observed that feed consumption of control and restricted groups were low at Post – RST and through the whole period. Post – RST consumption ranged form 2.34 kg/d in the control to 2.65 kg/d in 70% restricted pigs while whole period consumption ranged from 2.6kg/d in 80% restricted to 2.54 kg/d in the control pigs. These rates were much lower than 3.26 kg/d reported by Owen et al. (1971) for restricted re-alimentated pigs and 3.66 kg/d reported by Mersmann et al. (1987) for restricted re-fed pigs in the temperate environment. It does appear that the generally low feed intake may be a defense mechanism developed by the pigs to cope with the high exogenous heat in the tropics and the resultant endogenous heat load which tend to increase to unmanageable levels following increased feed intake by pigs in this climate. Feed intake of exotic pigs reared in the tropics was reported to decline when ambient temperatures exceed 30°C (Steinbach, 1976). The present study was conducted in the late dry season when average ambient temperatures averaged 34^{o}C condition is also felt to be partly responsible for the high Post – RST feed/gain which ranged from 3.76 in 80% restricted to 3.92 in control groups. These values were higher than 2.44, 2.47 and 2.44 reported by Donker et al. (1986) for pigs of similar body weight fed *ad libitum* or re-alimented after restriction at 85 and 70% of *ad libitum* respectively in the temperate environment. It therefore follows that both restricted and *ad libitum* fed pigs in this environment ate more feed per unit gain in weight. Thus, the observed high feed/gain and the accompanying reduction in growth rate at both RST and Post – RST culminated in the observed delay in age at 100 kg. Contrary to 183.5d and 191.0d reported as extrapolated age at 100 kg for pigs fed *ad libitum*, 85 and 70% of *ad libitum* respectively (Prince et al., 1983), the real age at 100 kg for control and restricted groups (90, 80 and 70% of *ad libitum*) were 233d, 235d 228d and 240d respectively. A striking finding of the present study is the feed cost/kg gain. Pigs on the 80% level had significantly better values during restriction and re-alimentation. It follows that this level of restriction will guarantee better economic returns to a farmer.

It is concluded that restricting pigs at 80% of the *ad libitum* intake of the control will ensure better performance and superior economic returns to a farmer.

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