OVERCOMING THE EFFECTS OF HIGH TEMPERATURE ON PIG GROWTH

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SUMMARY

Observations were made on growing pigs under field conditions to determine changes in production associated with shed temperature. Growth rate was reduced by 9.7 g per °C rise in mean shade temperature. Compared with 20°C, there was often a depression in gain of 10-15% at 30°C (mean maximum) of pigs grown to about 90 kg liveweight. Feed conversion ratio (FCR) was influenced by season although in most production units there was no clear effect of temperature. Backfat (P_2) increased with increasing temperature.

In experiments carried out in a hot room (36°C/12 h and 25°C/12 h) and a cool room (22°C), groups of 5 entire male pigs were grown from 45 to 85 or 90 kg on diets offered at close to *ad libitum*. Depression in growth rate was about 35% of that in the 'cool room yet no consistent changes in FCR or backfat could be delineated. It was found that growth rate improved with additions of fat (tallow) and oil (rice pollard) to the diet. Pigs appeared to grow better. in the hot room on high energy. diets irrespective of protein content.

In the cool room pigs grew best on a higher energy-low protein diet. Sprinkling of pigs for 2 min in 30 min when the temperature was 35°C resulted in a similar growth rate to pigs in the cool room. Improvement in gain was observed when pigs in the hot room were offered drinking water at 11°C; mean daily water consumption was 11 *l*/head compared with only 4 *l* when the water was at 30°C.

INTRODUCTION

The depressing effects of high temperatures on appetite are well known. As a consequence growth rate of livestock is reduced; an observation commonly made in Australia. The problem here is that temperature in some regions varies greatly throughout the year, this tends to accentuate effects of high temperature on livestock performance.

The effects of high temperature on biological performance of the pig were reviewed at a previous School (Farrell 1977). As a consequence a submission to the Australian Pig Industry Research Committee resulted in funds being made available to study aspects of high temperatures on pig production and to investigated in what way temperature stress can be alleviated in the growing pig.

There are limited field data on the quantitative effects of high temperature on growth rate, feed intake, feed efficiency (FCR) and carcase fat. An important part of this study was to obtain information from producers located in different climatic regions of Australia. In addition experiments were designed to overcome the effects of high temperature by dietary manipulation and management procedures.

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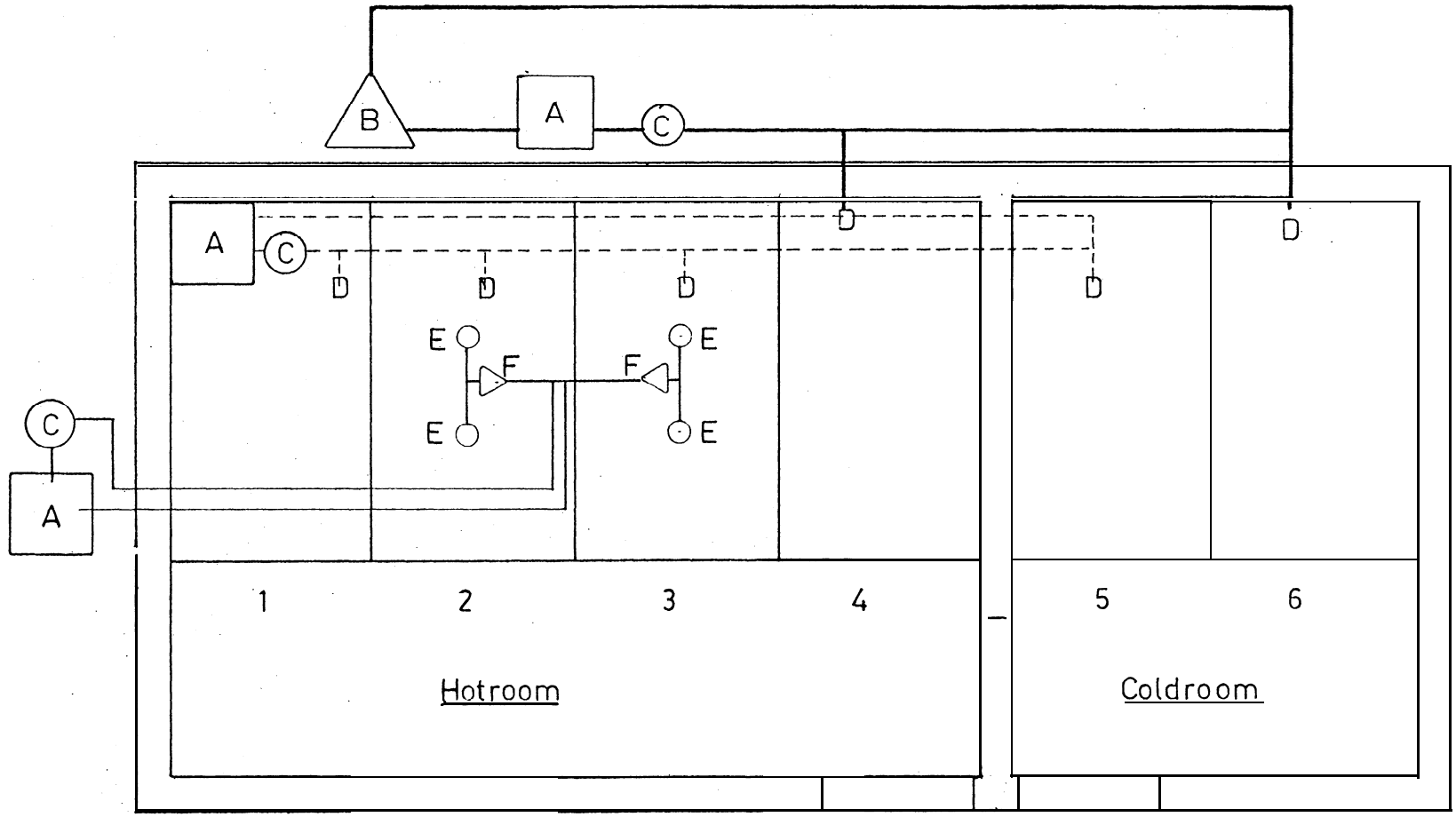


Fig.1. Plan of climate room and cool room (pens 5 and 6) showing systems for automatic sprinklers and temperature-control of drinking water.

A - Hotwater bath
B - Refrigerator
C - Electric pump
D - Drinking nipple
E - Spray nozzle
F - Solenoid valve

These included sprinkling the pigs at intervals and reducing the temperature of the drinking water.

MATERIALS AND METHODS

Field studies

Visits were made to 14 pig producers mainly in southern Queensland and New South Wales. One large producer was located in northern Victoria. Many producers could provide only some data, and it was often necessary to place a thermohygrograph in the pig unit to record variation in shed temperature. One producer agreed to collaborate in an experiment which was set up at two different times of the year to measure growth rate and feed intake of groups of 'pigs.

The data from some individual sources were analysed by analysis of variance and regression analysis. Meteorological data were tested against biological parameters. Biological data were combined into 5 different regions and statistical tests were made. Where appropriate data from all regions were combined and statistical tests were again applied.

Experiments in climate room

(i) Climate room A room that could be maintained at high temperatures with controlled relative humidity was divided into 4 pig pens (183 x 200 cm) with woven-mesh wire floors. Each pen held 5 pigs ($0.73 m^2$/pig)up to 100 kg. Individual feeding stalls were designed such that when not in use each unit of 5 stalls could be raised to a vertical position thereby maximising floor space. Water was provided through nipple drinkers. Provision was made to supply cold or warm water.. A room immediately adjacent to the climate room was fitted with two pens similar to those in the hot room and maintained at 22±2°C. Provision was made for water sprinklers located over two pens. Each sprinkler delivered 800 ml/min at 30 PSI and could be activated for different time intervals. A diagram of the climate room (hot room) and adjacent cool room holding the control pigs is shown in' Fig. 1. Experimental temperature was 36°C for 12 h (day) and 25°C for 12 h (night). Relative humidity was about 60% and lighting was for 12 h each day.

(ii) Pigs Entire male hybrid (Landrace x Large white) pigs were used in all experiments. 'These were introduced to the hot room at 45 kg and allowed several days to become accustomed to the conditions and were slowly introduced to the warmth. When mean weight of groups of pigs reached 85 or 90 kg they were taken off the treatment.

(iii) Measurements Pigs were weighed each week, or more frequently if required. Feed was offered twice daily for at least 30 minutes in amounts that corresponded as closely as possible to *ad libitum* intake. At the end of the experiment pigs were transported to an abbatoir where hot carcase weight and backfat measurements were made. Adjustment was made to backfat measurements to a standard weight (90 kg) by ± 1 mm for each 4 kg above or below 90 kg liveweight.

Analytical procedures

Standard procedures for chemical analysis were followed (AOAC 1975). Digestible energy ('DE) of each diet was determined using Cr_2O_3

in the feed to estimate faecal output. Diets containing Cr_2O_3 were fed for at least 5 d followed by a collection of stools at different times each day for 5 d. Samples were pooled for each pig for 5 d and freeze-dried to constant weight. Faeces were milled and subsamples taken for analyses. The method of Williams *et al.* (1962) was used to measure Cr_2O_3 in samples except acetylene and a nitrous oxide flame were used here.

Experiment 1

In this experiment 4 diets were formulated to give high and low DE contents and high and low crude protein contents. These were calculated to contain 12.5 and 14.6 MJ DE/kg. Crude protein ranged from 115 to 175 g/kg. Composition of diets are given in Table 1.

TABLE 1 Diets compositions (g/kg) in Experiment 1 (air-dry basis)

Ingredient	High energy High protein (HH)	High energy Low protein (HL)	Low energy High protein (LH)	Low energy Low protein (LL)
Sorghum	769	869	42	
Barley			772	931
Bran				20
Sunflower M.			137	
Meat M.	40	40	40	40
Soyabean M.	185	82		
Lysine		3	3	3
Vit/Min	1	1	1	1
Salt	2	2	2	2
Lime	3	3	3	3
Calculated				
energy (MJ)	14.63	14.63	12.54	12.54
protein (g/kg)	175	135	155	115

Experiment 2

Diets were designed to be isoenergetic andisonitrogenous with the same lysine contents. They contained different amounts of fat contributed by tallow or rice pollard (190 g oil/kg). Starch, dextrose 'and rice hulls were used to help achieve equal energy and nitrogen contents of diets. Composition of these diets are given in Table 2.

Experiment 3

A preliminary experiment was undertaken to determine the rate of evaporation of water from the skin surface of the pig to identify optimum sprinkling times. The pig was placed in a metabolism cage enclosed in a plastic tent. The rate of flow and the moisture content of incoming and effluent air were measured using a rotameter and acid trap. 'Measurements of rate of water loss were made at 36°C when sprinkled at 800 ml/min for different periods of time and without spray.

TABLE 2 Diet composition (g/kg) in Experiment 2 (air-dry basis)

Ingredient	A	B	C	D
Wheat	180	242	191	210
Sorghum	261	200	208	200
Oats	300	180	209	267
Triticale	12	53	38	38
Soyabean M.	50	69	45	50
Fish M	60	55	44	45
Cottonseed M.	67	67	50	60
Tallow	50			20
Starch		70		
Dextrose		45		
Rice pollard			211	105
Rice hulls	16	15		
Vit/Min	1	1	1	1
Lysine	0.4	0.3	0.5	0.6
Lime	3	3	3	3
Calculated				
DE(MJ/kg)	14.05	13.60	13.66	13.85
Crude protein	164	166	165	163
Crude fibre	66	54	64	64
Lysine	8	8	8	8

All pigs were given the same commercial pig finisher diet (Fielders Stock Feeds, Tamworth, Table 3). Two groups of pigs were sprinkled every 30 min during the day for either 30 or 120 seconds. The two other groups were given drinking water at 12°C or 30°C. One group in the cold room was provided with water at 30°C and pair fed to the group in the hot room given water at 30°C. The other group in the cold room received drinking water at 12°C. Drinking water was metered to all pens to allow calculation of daily consumption.

TABLE 3 Diet composition (g/kg) in Experiment 3 (air-dry basis)

Ingredient	
Fine wheat	664
Mill run (wheat)	200
Meat Meal	68
Sunflower M.	15
Soyabean M.	40
Lime	6
Vitamin	1
Grower premix	1
Payzone	0.5
Lysine	2
Salt	2

Experiment 4

In experiment 1, the first experiment undertaken in the climate room; the floor mesh size was found to be unsuitable for the pigs during the early stages of growth, leg problems in a few pigs were encountered. This experiment was repeated and the diets were re-formulated- These are given in Table 4.

TABLE 4 Diets composition (g/kg) in Experiment 4 (air-dry basis)

Ingredient	HH	HL	LH	LL
Wheat	298	96	22	
Sorghum	431	656		
Barley		51	691	771
Cottonseed M	27		76	
Sunflower M	44	19	5	
Soyabean M.	39	43	10	
Meat M.	35	32	45	39
Blood M.	30			
Skim milk		46		
Bran	13		53	131
Pollard	35		44	
Rice hulls		16		
Lysine		3		2
Corn starch	37	29	44	48
Vit/Min	2	2	2	2
Salt	1	1	1	1
Lime		3		3
Bone M.	8	3	7	3
Calculated				
DE MJ/kg	15.75	15.70	13.90	13.73
Crude protein	192	153	162	126
Lysine	9	9	7	7
Crude fibre	32	30	71	69

* See Table 1 for details

RESULTS

Field studies

Data were collected from 14 commercial piggeries and one institution. Officers of two state Departments of Agriculture provided data, Most producers could not provide measurements of temperature and humidity. Where necessary meteorological data were obtained for the general area of the pig unit. The seasonal pattern of weight gain and FCR -representing 4,500 pigs at a large production unit in Victoria is shown in Figure 2. Maximum growth rate of pigs was almost 950 g/d from 27 to about 90 kg when killed at the end of May declining to about 860 g/d in September. FCR of about 2.6 was lowest in March- Because these are average monthly values determined when pigs were slaughtered, they correspond to performance during the period prior to the calculated mean value shown in Figure 2. The differences can be largely explained on the basis of expected high and low normal temperatures in

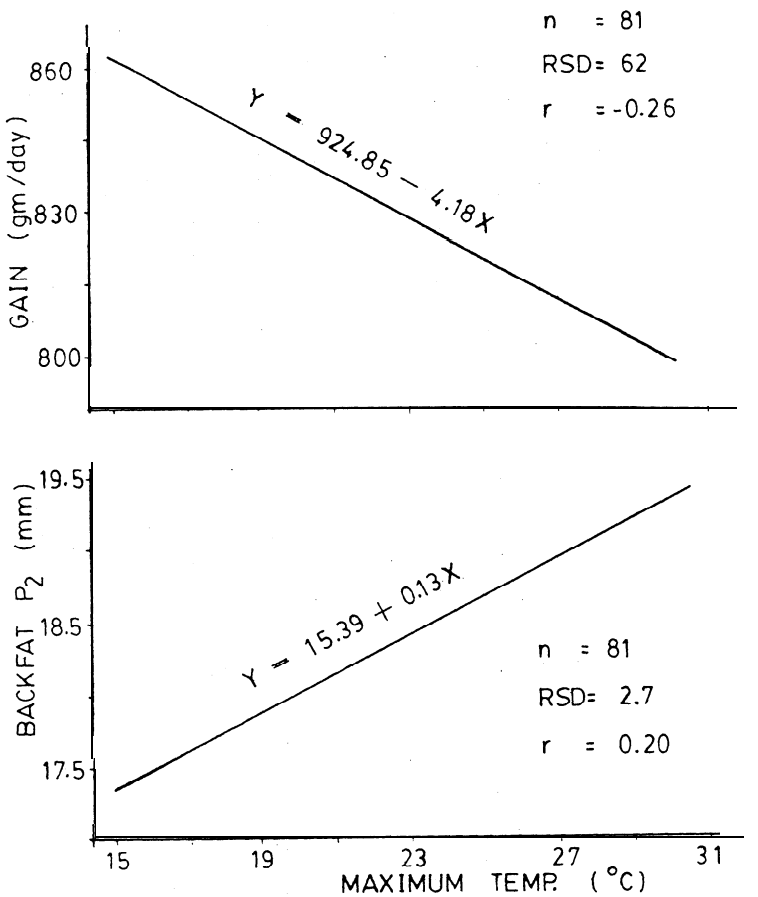


Fig. 3. The relationship between maximum shade temperature and gain, and backfat thickness of groups of pigs kept out of doors at Warwick, Queensland.

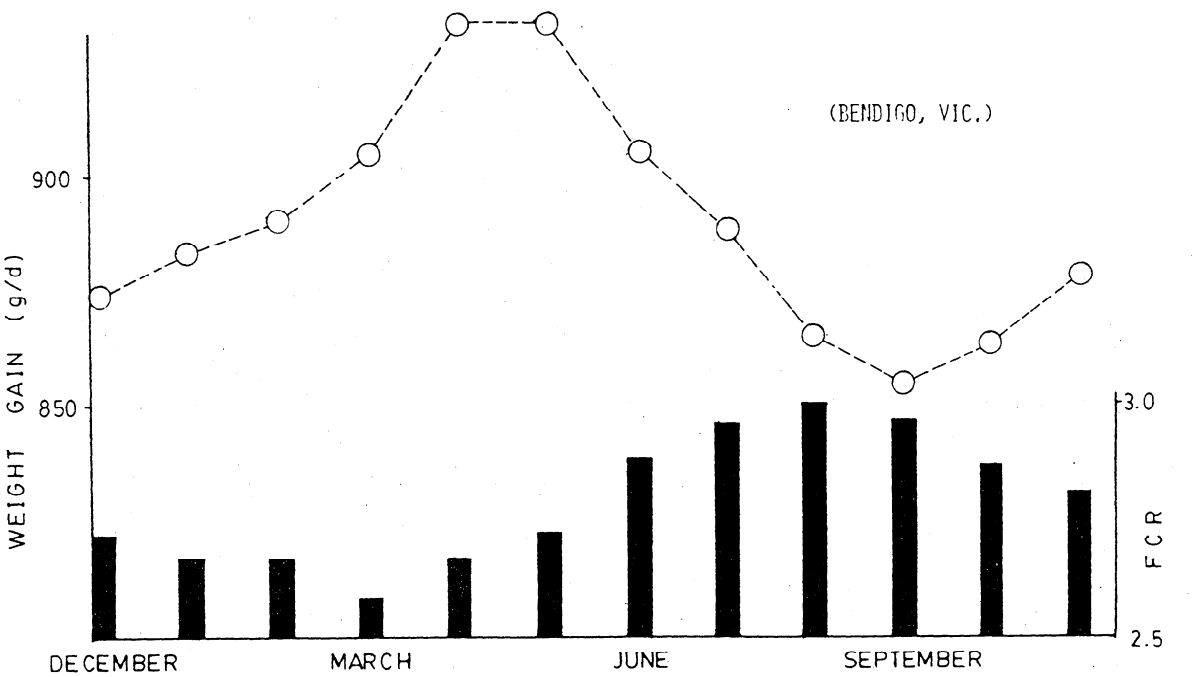


Figure 2. Seasonal variation (1973-1979) in growth rate and FCR of 1581 pigs grown to about 90 kg liveweight at Bendigo, Victoria.

this area. Data represent boars grown for about 5 months from 25 to 90 kg and feed intake from 45-90 kg from 1973-1979. Management practices and diets changed during this period.

Two experiments were set up at Parkes, N.S.W. in a commercial pig unit from June to September and from October to December. Four pens each of 10 pigs were grown from 45 to 90 kg and fed close to *ad libitum*. Intake of a commercial pelleted diet was recorded.

The results are given in Table 5. There were seasonal differences observed in growth rate of about 11% and there was a reduction in adjusted P2 backfat during the cool season. Adjustment was made to backfat for differences in liveweight between pigs of ± 1 mm for each 4 kg difference from the standard 90 kg animal.

TABLE 5 Production of four groups of 10 pigs (45-90 kg) fed *ad libitum* during winter and summer at Parkes, N.S.W.

Shed temperature (min-max °C)	12-21	17-30
Gain (g/d)	661*	598
FCR	3.5	3.4
Backfat P2	17.5	18.2
Backfat P2 (adjusted)**	15.4*	17.7

* Significantly different ($P < 0.05$) between seasons
** See text for details

. Seasonal data for pigs managed extensively, were obtained from a producer at Warwick (Queensland). Shown in Figure 3 is the decline in growth rate with increasing maximum temperature, There was a corresponding increase in P2 backfat. The *depression in growth rate was about 8% between 15 and 30°C. The corresponding increase in backfat was 2 mm- A similar observation was made at Gatton (Queensland) where P2 backfat (mm, y) increased ($P < 0.05$) with increasing shade temperature over the temperature (°C, x) range 20.5 - 31.6°C,

$$y = 15.1 + 0.048\ X,\ RSD = 1.1,\ r = 0.18,\ n = 145$$

Climate room experiments

(i) Experiment 1 The results of experiment 1 are given in Table 6. It is clear from data in Table 1 that pigs held in the hot (35°) conditions for only 12 hours each day showed depressed growth rate compared to those at 22°C for 24 hours each day. For treatments in the hot room there was no difference ($P > 0.05$) in daily rate of gain or FCR due to diet: nor did diet have a significant effect on these parameters in the cool room. However gain was significantly ($P < 0.05$) greater for pigs in the cold room. When data were combined the mean depression in growth rate in the hot room was 36% but FCR was the same. Differences ($P < 0.05$) were observed in growth rate, FCR and dressing percentage of pigs on combined treatment 2 and 4 in the hot room compared with the' corresponding combined groups in the cold room. It should be stressed

that this experiment was preliminary in order to test the facilities.

TABLE 6 Production performance of groups of 5 pigs grown from 45 to 90 kg on four diets (*ad libitum*) at either 24/35°C (hot), or at 22°C (cool)

Diet & treatment	Growth rate (g/d)	FCR (g/g)	Back fat P_2 (mm)	Carcass length (mm)	Dressing out (%)
Hot					
High energy High protein[1]	502[a] ±84	2.87 ±0.1	20.2 ±3.0	804 ±13	72.3[a] ±1.4
High energy Low protein[2]	511[a] ±80	2.90 ±0.2	21.8 ±3.5	813 ±42	75.0[ab] ±2.3
Low energy High protein[3]	548[a] ±51	3.00 ±0.5	20.2 ±3.0	818 ±17	74.6[ab] ±2.6
Low energy Low protein[4]	488[a] ±90	3.25 ±0.2	18.8 ±3.8	819 ±59	73.8[a] ±1.1
Cool					
Low energy Low protein[5]	690[b] ±88	2.92 ±0.3	22.0 ±2.7	789 ±33	75.3[ab] ±2.3
High energy Low protein[6]	716[b] ±103	2.79 ±0.1	23.5 ±2.8	793 ±27	77.2[b] ±1.6

(ii) Experiment 2 Results are given in Table 7 and the pattern of growth rate is in Figure 4. It was not possible to grow all groups of pigs to the mean target rate of 85 kg because of requirements for the climate room for other studies.

TABLE 7 Growth rate, FCR and determined digestible energy of diets in experiment 2.

Diet-base	Treatment	Gain (g/d)	FCR	Digestibility energy (MJ/kg)
Starch + dextrose	Hot	553[bd*]	3.3	13.7[ac]
Tallow (2%) + rice pollard (10%)	Hot	568[bd]	3.1	13.5[bc]
Tallow (5%)	Hot	692[bc]	2.7	14.3[a]
Rice pollard (21%)	Hot	669[b]	3.1	14.4[a]
Starch + dextrose	Cool	805[a]	2.9	14.2[ac]
Tallow (2%) + rice bran	Cool	707[ac]	3.0	13.6[bc]

* Values with the same superscripts (a-d) within a row are not statistically different ($P > 0.05$).

TABLE 8 The effects of sprinkling of pigs and of temperature of drinking water on growth rate and FCR

Room	Treatment	Growth (g/d)	FCR
Hot	Pairfed*	520^{b**}	3.4^{ac}
Hot	Sprinkling 2/30 min	706^{a}	3.0^{bc}
Hot	Sprinkling ½/30 min	595^{b}	3.1^{c}
Hot	Cold drink (11°C)	588^{b}	3.0^{bc}
Cool	Pairfed*	593^{b}	2.8^{bcd}
Cool	Cold drink (11°C)	685^{a}	3.2^{ce}

* Group in cool room offered the same amount of feed as consumed on the previous day by pigs in hot room without sprinkling or cold water.

** Values with the same superscripts (a-e) within a row are significantly ($P < 0.05$) different

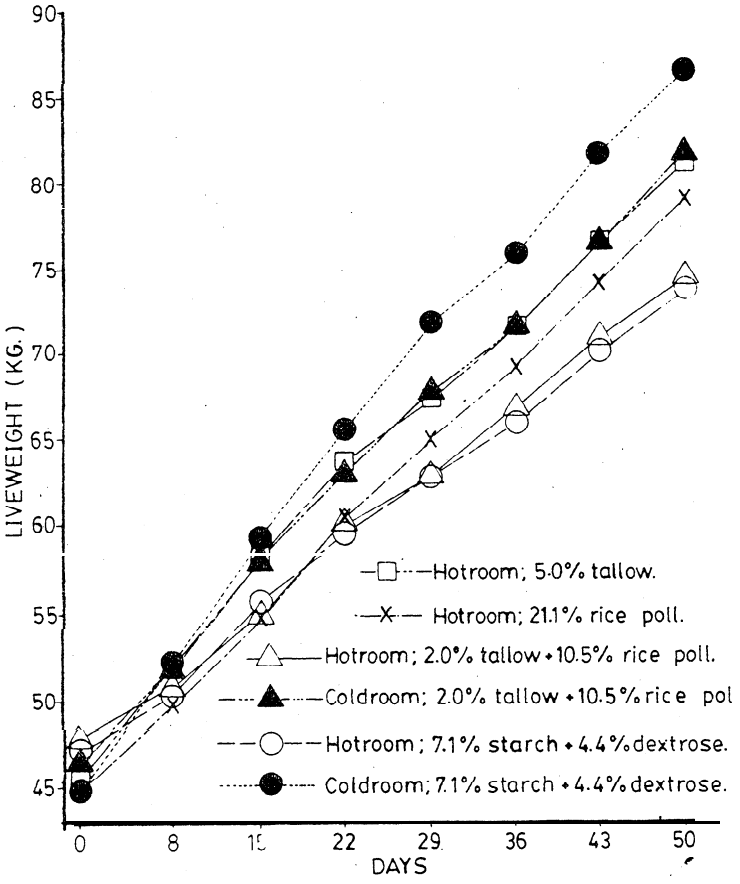


Fig. 4. The effects of different dietary treatments on daily liveweight gain of pigs grown from 45 kg for 50 days.

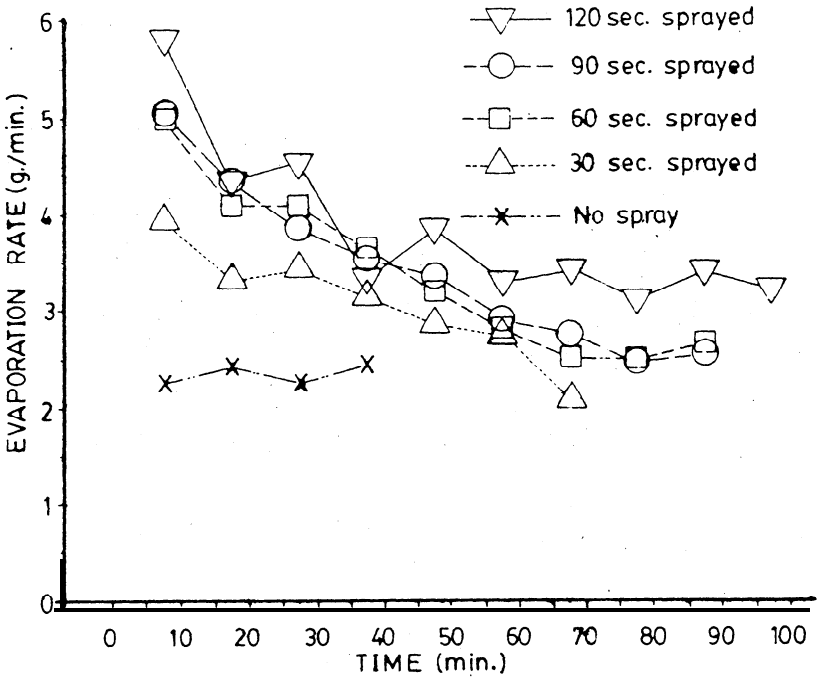


Fig. 5. The effect of sprinkling time on the evaporation rate of water from the skin surface of two pigs. Each value is the mean of two pigs sprinkled twice after each time period.

Although there was wide variation among individual pigs particularly on the hot room treatments, and therefore no significant difference between treatments, some interesting trends were found. There was a marked improvement in growth rate when 5% tallow or 21% rice pollard was added to the diets. On the other hand starch and dextrose' gave the lowest growth rate in the hot room but the highest in the cool room. Mean differences in growth rate in the hot compared with the cool room, when comparisons were made on the same diet, was 35%. FCR was not different ($P > 0.05$). Although diets were calculated to be isoenerqetic, this was not always so. The diet containing tallow and rice pollard had a lower ($P < 0.05$) DE than that containing 5% tallow.

(iii) Experiment 3 The rate of moisture evaporation from the skin surface is shown for two pigs in Figure 5. These data served as a basis for sprinkling times in the hot room. The results of the experiment on production performance are given in Table 8. All pigs were offered the. same diet. Sprinkling for 2 min in 30 min overcame the depression in growth rate due to heat stress, Average daily gain was similar to that observed for the group in the cool room given cold water, Although there was no difference ($P > 0.05$) between the other treatments in the hot room both 'cooled drinking water and sprinkling for 30 sec in 30 min resulted in increased growth rate of about 70 g/d. Pigs in the cool room pair-fed to those in the warmth gained an additional. 70 g/d, with a lower ($P < 0.05$) FCR.

Consumption of water in Fig.6 showed that pigs given water at 11°C in the hot room drank 11 Z/head d compared with. only 3.5 l by pigs in the cool room offered water at 11°C. Pigs in the hot room without sprinkling or cooled water, drank 7 l/d. All pigs consumed more than 80% of their

daily intake between 0600 and 1800 h.

Experiment 4

The results of this experiment are shown in Table 9. In the hot room pigs grew most rapidly on the high energy-high protein diet although performance was similar to the high energy-low protein diet. The two low energy diets did not sustain as good a growth rate as the high energy diets at high temperature. In the cool room the high energy-low protein diet had clear advantage over the low energy-low protein diet.

DISCUSSION

The results of the field observations quantify the depression in growth rate due to high shed temperature. Data presented here do not allow accurate prediction of the depression in growth expressed in g/°C above a set temperature. Clearly such a prediction equation would have to include a number of variables including breed and strain, liveweight feeding regime, and other climatic data such as relative humidity, and air flow within the shed. Despite a lack of information on these variables, combined data for batches of pigs kept largely under commercial conditions and over the range of mean shade temperatures (X) from 8 to 31°C, the significant ($P < 0.01$) equation for predicting gain g/d, Y) was

$$Y = 796 - 9.7X,\ r = -0.29,\ RSD = 169,\ n = 870.$$

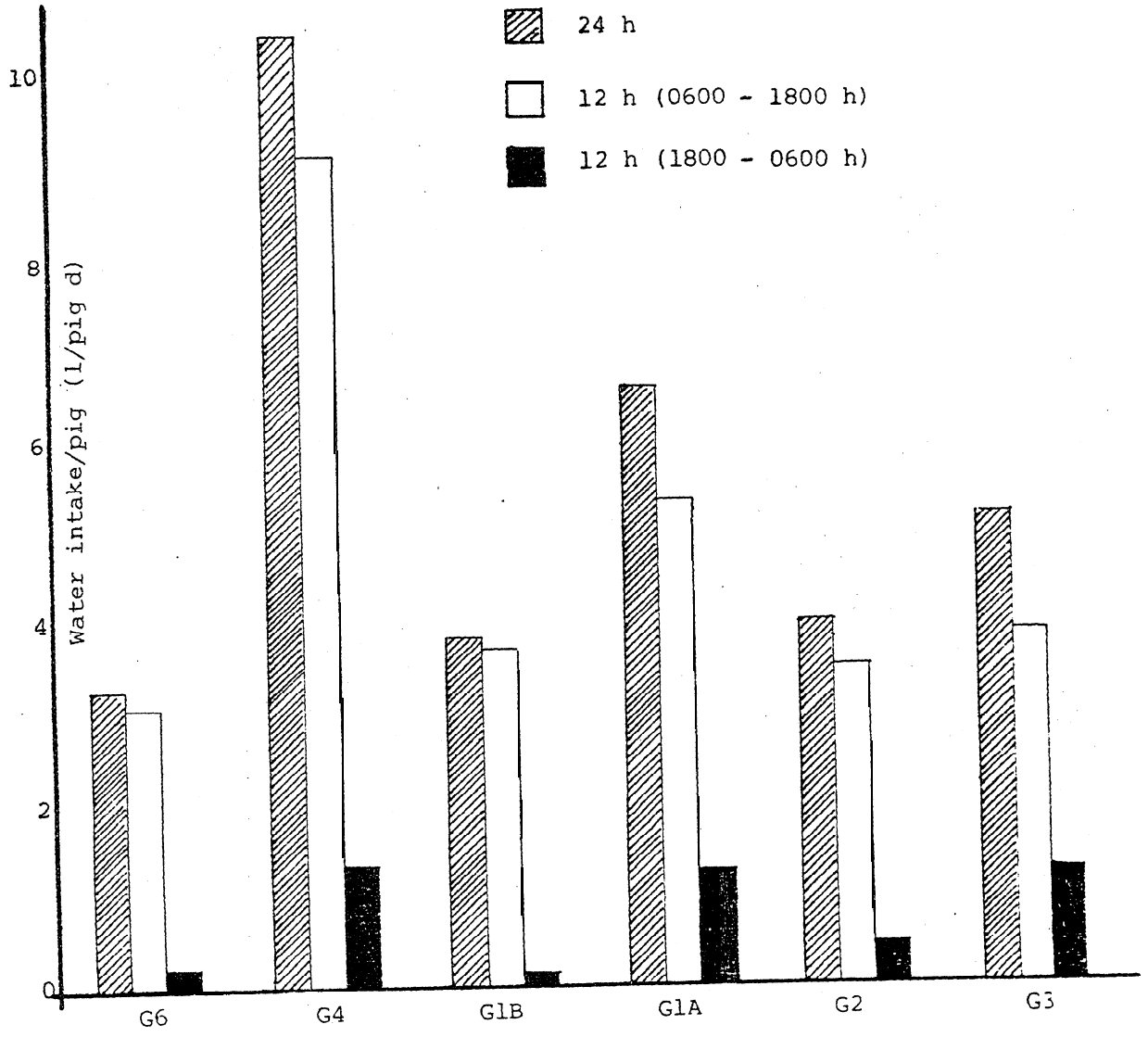
For each increase in temperature of 1°C growth declined by 9-7 g.

In experiment 1, growth depression in the hot room was 36% compared with the cool room. There is still insufficient data on FCR, but it would seem that maximum shed temperature must be well above 30°C before a significant effect occurs. Fuller (1965) showed that over a narrow range of temperature, heat stressed pigs improve FCR. Above that

TABLE 9 Production performance of groups of 5 pigs grown from 45 to 90 kg in four diets (ad libitum) under hot or cool conditions (experiment 4)

Diet & treatment	Growth rate (g/d)	Back fat P_2 adjusted (mm)	Carcass length (mm)	Dressing out (%)
Hot				
High energy	574^{b*}	19.7	804	75.2^{bc}
High protein	±21	±2.7	±14	±1.1
High energy	478^{c}	20.8	804	77.2^{ac}
Low protein	±49	±4.5	±8	±2.8
Low energy	423^{c}	18.7	805	73.6^{b}
High protein	±40	±0.4	±10	±1.4
Low energy	446^{c}	21.0	785	73.2^{b}
Low protein	±82	±3.1	±29	±4.0
Cool				
Low energy	562^{b}	20.8	794	74.7^{bc}
Low protein	±49	±3.0	±19	±1.2
High energy	671^{a}	23.6	815	79.7^{a}
Low protein	±67	±3.8	±15	±3.0

* Values with the same superscript (a-c) are not significantly different ($P > 0.05$)



LEGEND

G6	coldroom, cool drink, no spray
G4	hotroom, cool drink, no spray
G1B	coldroom, warm drink, no spray, paired fed to G1A
G1A	hotroom, warm drink, no spray, paired fed to G1B
G2	hotroom, warm drink. 120 sec/30 min
G3	hotroom, warm drink, 30 sec/30 min

Fig. 6. Mean daily water intake of pigs on different treatments. Data are shown for water consumption during the day □ and at night ■.

range of temperature FCR increases. The data shown in Fig. 2 indicate that FCR chancres with season but it is unclear if this is a response to temperature *per se* or if there are additional factors responsible.

One of the uncertainties prior to these field observations was the influence of increasing temperature on carcass backfat (Farrell 1977). There is large variation in this parameter among pigs and it is therefore necessary to obtain many measurements over a range of ambient temperature. It does appear that heat stress has an adverse effect on P_2 backfat. This was observed in two locations in Southern Queensland (Warwick and Gatton) where pigs were grown under extensive and intensive conditions. In the experiments in the climate room, it was not possible to determine consistent differences in carcass characteristics that were directly a consequence of heat treatment. This was because of the few pigs used per treatment, and to the differences in treatments within the hot and cool rooms.

Sprinkling pigs for 2 min every 30 min appears to be an inexpensive, practical means of overcoming the effects of temperature on appetite and gain. Hsia *et al.* (1974) in Taiwan showed significant improvement in daily gain of pigs (30-50 kg) at 25 and 29°C when sprinkled for 2 min at intervals. An improvement was observed in growth and FCR when sprinkling was every 45 min compared with every 90 min. At 21 and 25°C, finisher pigs showed a similar improvement to sprinkling. In the present experiment application of water was about 300 ml/pig at each sprinkling. It is possible that a higher volume may increase the most effective sprinkling interval.

Studies by Stably et *al.* (1979) showed that pigs grown from 25 to 60 kg at 35°C reduced feed intake by 12-15% compared with control animals at 22°C, and this depressed growth rate by about 20%. These-workers were unable to show a response in growth, FCR or backfat to high- and low-protein diets. Their results are similar to our observation in experiments 1 and 4; but there was in the latter experiment an indication that a high energy diet was effective in partially alleviating the effects of high temperature of feed intake..

In the study of Tonks et *al.* (1972), the influence of high relative humidity and a moderately high temperature (29°C) depressed growth rate of pigs fed *ad libitum* and grown to 90 kg by 26% compared'with pigs kept at 21°C and a moderate humidity. The latter pigs had a higher killing-out percentage but there was no difference in carcase characteristics except pigs in the warm environment had smaller carcass eye muscles than those housed at 21°C.

The usual response by pigs to high shed temperature is to reduce voluntary feed intake. This helps to reduce heat load since a heat increment is observed following a meal, and pigs can thus easily maintain thermal equilibrium. Attempts to reduce the heat increment by manipulation of dietary ingredients in experiment 2 was partially successful. When dietary fat is used for tissue lipid synthesis there is a comparatively low heat increment. It is apparent that pigs were able to maintain a high DE intake on these diets (Table 7). However chemical analysis showed that diets were not isoenergetic and varied from 8% ether extract for the diet containing 5% added tallow, to 5% for the diet with 20% rice pollard. The diet containing starch and dextrose, with no added fat contained 2% ether extract. Althouqh this diet had a DE of

about 14 MJ/kg growth rate was lowest in the hot room and highest in the cool room. The utilization of DE from carbohydrate for tissue synthesis is lower than for fat thus there is a relatively high heat increment. In the cool room this heat would be easily dissipated or even used for thermogenesis if the pigs were cold stressed.. This is unlikely to be the case in the cool room at temperatures around 20°C. Straub *et al.* (1976) observed a marked decline in intake of entire males fed *ad libitum* and grown from 70 to 110 kg liveweight at 35°C compared with boars at 15°C. It would appear from their data presented in histogram form that intake at 35°C was less than 2 kg/d; at 15°C it was about 3 kg/d, Corresponding growth rates were about 600 g and 850 g/d.

Although no fat was added to any of the diets in experiment 4, the two low-energy diets contained 7% crude fibre (calculated) compared. with 3.0% crude fibre on the high energy diets. It is known that utilization ofDE by pigs is reduced on diets high in fibre (Just 1981) resulting in an elevated heat increment. Like carbohydrates, fibre may depress intake of pigs when heat stressed.

It can be concluded from the results presented here that during the warm season pig production isdepressed. Not only is there a reduction in growth rate but there is an increase in backfat. The possibility of an adverse effect on FCR is uncertain and more field data are required. Apart from the obvious ways of reducing heat stress by siting of pig unit, shed design, adequate ventilation, evaporative cooling and appropriate management practises, experiments undertaken here indicate that dietary manipulation offers some opportunity. Inclusion of fat in the diet, or even increasing dietary energy content without the addition of fat, appear to be useful means of helping to maintain appetite under stress-

Sprinkling of pigs for 2 min in 30 min during the hot (35°C) part of the 24 h cycle appears to be a viable and inexpensive method overcoming the effects of temperature stress. Finally it should be pointed out that the study is still incomplete and further field observations and experiments in the climate room are needed before firm recommendations can be made to the producer and feed manufacturer,

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