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AUSTRALIAN Pork

# Effect of novel photoperiod regimes on stimulating weaner performance

**Final Report**
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**Research Organisation**
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## Executive Summary

The reduced feed intake of pigs immediately post-weaning is a serious issue in pork production systems. Despite a plethora of information available to pork producers on management and feeding strategies for rearing weaned pigs, weaner pigs still commonly have a post-weaning growth setback. This setback can have a long standing effect in that a low growth rate during the weaner phase usually persists until slaughter (Dunshea et al. 2003). Possible risk factors that may be contributing to feed intake post-weaning include feeding behaviour, social interactions, lighting regimes (Bruininx et al. 2002) and body weight.

Weaner sheds traditionally are less exposed to natural light due to automatic ventilation systems to control temperature and are therefore reliant on artificial lighting programs. Fluorescent lighting has been widely used in the industry as a cheaper and more energy efficient light source however, the wavelength output from these lights is not optimal for pig eye sight. AquaBeam LED lighting has been developed by BioLumen (United Kingdon) to target the specific light spectrum optimum for pig vision eliminating the extreme blue and red ends of the spectrum.

The aim of this experiment was to assess varying lighting regimes as well as different lighting source on the feed intake and growth performance in the post-weaning period. The hypothesis was that changing the lighting schedule and/or lighting configuration will increase feed intake and improve post-weaning performance.

A total of 4017 commercial weaner pigs split evenly across sexes were followed from weaning at 4 weeks of age until 9 weeks of age. At day 0 pigs were transferred to a conventional weaner facility where they were sorted according to sex and size. Treatments were separated into different sheds, as to not allow interference between lighting treatments. Lighting treatments were (A) fluorescent lighting 8hrs on and 16hrs off from weaning; (B) fluorescent lighting continuously on for 48hrs post weaning, then on for 18hrs, off for 6hrs; (C) BioLumen lighting on for 48hrs post weaning, then on for 18hrs, off for 6hrs. Pigs were weighed at day 0, 7, 21 and 35 with pen feed intakes measured during these time periods. All deaths and removals were recorded. Light intensity (lux) was measured weekly and shed temperatures were recorded in 15 minute intervals throughout the experiment.

Light types did not significantly affect ADI, ADG, FCR or body weight in any duration. Lighting treatment (A) tended to have a greater ADG than (C) during 21-35 days. The percentage of pens in each treatment group with a low ADI 0-7d showed a numerical difference between (A) and (C) (28.9% vs 42.7% respectively) however this was not evident ADI 0-21d (35.6% vs 35.4% respectively). Body weight at weaning significantly affected post-weaning ADI (0-7d) ($P<0.001$); however, a linear regression model showed that body weight only explains the 30.9% variation of post-weaning ADI, suggesting other factors such as susceptibility to weaning stress and adaptions to diets may also influence 0-7d post-weaning ADI. Mortality rate was not different between treatment groups.

The results obtained from this experiment showed no significant improvement in any performance parameters of pigs housed in different lighting environments. The ADI 0-7d was higher across all treatments than intakes observed in previous trials. Given the higher intakes across all treatments, the margin for improvement due to photoperiod treatment may have been reduced.

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# 1. Background to Research

The reduced feed intake of pigs immediately post-weaning is a serious issue in pork production systems, which is having financial ramifications for Australian pork producers and welfare concerns for some weaner pigs. Despite a plethora of information available to pork producers on management and feeding strategies for rearing weaned pigs, weaner pigs still commonly have a post-weaning growth setback, due to low feed intake within 7-10 days post weaning (Whittmore and Green 2001; Bruininx et al. 2001). In addition to low growth rate, approximately 4% of pigs weaned do not survive through to the end of the weaner phase (PigStats 2015).

Failing to eat after weaning has a profound and long-lasting effect on growth as the digestive tract and the body reserves of the pig are affected. When pigs finally begin to consume feed after weaning their already challenged digestive system is rapidly overloaded with partially digested feed which may encourage microbial proliferation and diarrhea (Pluske et al. 1997). Damage to the gastrointestinal epithelium may also occur from allergenic reactions to dietary antigens, which may also lead to diarrhea and nutrient mal-absorption (Kelly et al. 1991). This damage to the gastrointestinal epithelium may remain throughout the life of the pig and result in reduced growth performance throughout life (Pluske et al. 1997).

Furthermore, the growth performance of the pig during the weaner phase is critical, as a high growth rate during the weaner phase usually persists until slaughter (Dunshea et al. 2003). Tokach et al. (1992) demonstrated that pigs that maintained or lost weight in the first 7 to10 days post-weaning required 10 extra days to reach market weight compared to their counterparts who gained more than 250g/day during the same time.

Despite the known phenomenon of the post-weaning growth check, there remains a paucity of published data as to the risk factors which cause poor post weaning feed intake. There is general consensus in the literature that the post-weaning period imposes a myriad of challenges such as social and environmental changes, immunological challenges, unfamiliar feeding systems and diets. However the direct relationships between pig social and feeding behaviour and feed intake post-weaning are not identified. Possible contributing factors that may be related to feed intake post-weaning include feeding behaviour, lighting regimes (Bruininx et al. 2002) and body weight at weaning. Bruininx et al., (2001) have shown that weaning weight influences feed intake and growth performance post-weaning and that heavier pigs at weaning have lower feed intake in the first 24 hours post-weaning. The interrelationships between these factors prior to weaning as well as weaning weight need to be described if post-weaning growth and mortality are to be improved on commercial farms.

A recent weaner study conducted at Rivalea highlighted the low feed intakes of weaners in the first 5 days, with pigs averaging just 122 g/day, increasing to an average of 322 g/day by days 5-12 post-weaning (Brewster, 2016). It is speculated that current lighting regimes that are apparent in the Australian pig industry may be having a negative impact on weaner intake. Weaner sheds traditionally are less exposed to natural light due to automatic ventilation systems to control the temperature requirements of the weaned pig when they are moved from the farrowing environment to a group-housed pen. For example, the current lighting regime in the commercial weaner shed at Rivalea is 8 hours on followed by 16 hours of dark. A study by Bruininx et al., in 2002 compared this same lighting regime with a more extreme 23 hours of light and 1 hour of dark and reported that pigs in the treatment with more light displayed higher feed intakes (additional 116g/pig/day) and higher average daily gains (140g/pig/day) in the first two weeks post-weaning, suggesting that improved lighting can stimulate feed intake post-weaning. The option of 24 hour lighting is viewed as not 'natural' by animal welfare groups and should not be encouraged in the Australian pig industry. The RSPCA Approved Farming Scheme Standards dictates that the minimum photoperiod requirements for pigs are 8 hours of daylight and 6 hours of continuous darkness. Lighting type may also play a role in optimising post-weaning feed intakes. Fluorescent lighting has been widely used in the industry as a cheaper and more energy efficient light source however, the wavelength output from these lights is not optimal for pig eye sight. The lighting spectrum most suited to pigs' falls in the cooler blue and green-yellow range which is representative of the natural foraging habitat of a woodland canopy. AquaBeam LED lighting has been developed by BioLumen (United Kingdon) to target the specific light spectrum optimum for pig vision eliminating the extreme blue and red ends of the spectrum. Control units also allow the BioLumem system to simulate dawn and dusk periods.

The aim of this experiment is to assess varying lighting regimes as well as different lighting source on the feed intake and growth performance in the post-weaning period. The hypothesis was that changing the lighting schedule and/or lighting configuration will increase feed intake and improve post-weaning performance.

## 2. Objectives of the Research Project

The objective of this project was to identify the effect photoperiod has on feed intake at weaning and its subsequent effect on average daily gain throughout the weaner period.

# 3. Research Methodology

## *3.1 Animals*

This study was approved by The Rivalea Animal Ethics Committee (ARA: 17P030) and was conducted in accordance with the 'Code of Practice for the Care and Use of Animals for Scientific Purposes' (NHMRC, 2004). All animal work was conducted at a commercial piggery over three replicates and included a total of 4017 commercial weaner pigs. Pigs were followed from weaning at 4 weeks of age until 9 weeks of age.

## *3.2 Experimental Design*

### *3.2.1 Treatment Allocation*

At day 0 pigs were transferred from the farrowing house to a conventional weaner facility where they were sorted according to sex and size in to group pens each housing 14-15 pigs.. Treatments were separated into different sheds, as to not allow interference between lighting treatments. Pigs were allocated to one of three treatments based on average weight (7.4 kg ± 0.1 kg). The experiment occurred over 3 replicates (n=90 pens/treatment) where the lighting treatment was changed between sheds each time.

### *3.2.2 Lighting Treatments*

Each treatment consisted of different light routines (Table 1). Treatment A followed a conventional lighting strategy of 8hrs on and 16hrs off from weaning with the use of fluorescent lighting. Treatment B also used fluorescent lighting with the following program: continuously on for 48hrs post weaning, then on for 18hrs, off for 6hrs thereafter. Treatment C followed the same light timing schedule of B but used BioLumen lighting – AquaBeam 1500NP White (AgriRay, BioLumen, United Kingdom) within the shed.

*Table 1. Time and type of lighting schedules applied to each treatment*

| Treatment Name | Lighting type | Hours On | Hours Off | 48 hrs on Post Weaning |
|---|---|---|---|---|
| A | Fluorescent | 8 | 16 | No |
| B | Fluorescent | 18 | 6 | Yes |
| C | BioLumen LED | 18 | 6 | Yes |

## *3.3 Measurements*

### *3.3.1 Animal Measurements*

Animal disturbance was minimized during the first week post-weaning. Pigs were weighed at day 0 immediately on entry to the weaner pen, and then at day 7, 21 and 42. Pen feed intakes were measured during these time periods as measured by feed disappearance and pen feed efficiency subsequently calculated. All deaths and removals were recorded and taken into account when calculating feed intake and feed efficiency by the adjustment of the number of days that pigs were on trial. Pigs were provided *ad libitum* access to a commercial feeding program for the entire experimental period, and water was freely available via nipple drinkers within each pen.

*3.3.2 Other Measurements*

Light intensity (lux) was measured once weekly throughout the experimental period with two readings recorded per treatment, representing a north and south side of each shed. Lux measurements were taken during daylight hours and ventilation blinds were closed. The light meter (Model: LX-1108, Lutron Electronics, Taiwan) was held at pig height and the highest lux measurement within a 10 second interval was recorded. North and South shed temperatures were also recorded in 15 minute intervals throughout the experiment using Thermochron (Model: TCS, OnSolution Pty Ltd, Australia) temperature loggers.

### *3.4 Statistical Analysis*

The average performance of a pen was treated as the experiment unit for analysing data on growth performance including average daily intake (ADI), average daily gain (ADG), and FCR (feed conversion ratio). All the growth performance data were analysed by UNIVARIATE procedure in SPSS (IBM SPSS 24$^{th}$ version, Chicago, US) for the main effect of lighting types. Sex of pigs was not included in the statistical model, because no significant interaction between sex and lighting type was detected. The data on light intensity was analysed by UNIVARIATE procedure for the main effects of lighting type, side of shed (north vs. south) and their interaction. Replicate was used as a block factor for the UNIVARIATE analyses. The mortality and distribution of low feed intake group (bottom 33% rank) were both analysed by *Chi*-Square analysis. The relationship between body weight at weaning and ADI was analysis by a linear regression model. A probability of $P<0.05$ was considered as a statistical significance, and $P<0.10$ was considered as a statistical trend. Growth performance data are reported as means and standard error of means for the stratum of lighting types, and light intensity is reported as means and standard error of Lighting types × Side of shed.

## 4. Results

### *4.1 Growth performance and feed intake*

Pigs were allocated into the treatment groups with a similar body weight (7.6 ± 0.107 kg; *P*=0.92). Light types did not significantly affect ADI, ADG, FCR or body weight in any duration (Table 1). Pigs under Fluorescent 8 h lighting conditions tended to have a greater ADG than those under BioLumen 18 h (P=0.09) during 21-35 days.

*Table 2. Growth Performance of pigs housed in different lighting environments during the weaner phase*

| Variables | Fluorescent 8 h | Fluorescent 18 h | BioLumen 18 h | *P*-Value (Univariate) |
|---|---|---|---|---|
| **0-7 d** | | | | |
| Body weight, d 0 (kg) | 7.6 ± 0.172 | 7.6 ± 0.172 | 7.7 ± 0.180 | 0.92 |
| ADI[a] (kg/d) | 0.159 ± 0.003 | 0.153 ± 0.003 | 0.152 ± 0.003 | 0.24 |
| ADG[b] (kg/d) | 0.103 ± 0.006 | 0.112 ± 0.006 | 0.104 ± 0.006 | 0.56 |
| FCR[c] | 1.28 ± 0.200 | 1.60 ± 0.200 | 1.85 ± 0.210 | 0.13 |
| Body weight, d 7 (kg) | 8.32 ± 0.181 | 8.41 ± 0.181 | 8.37 ± 0.191 | 0.90 |
| **7-21 d** | | | | |
| ADI (kg/d) | 0.451 ± 0.008 | 0.453 ± 0.008 | 0.443 ± 0.009 | 0.68 |
| ADG (kg/d) | 0.412 ± 0.006 | 0.416 ± 0.006 | 0.408 ± 0.009 | 0.71 |
| FCR | 1.09 ± 0.009 | 1.09 ± 0.009 | 1.08 ± 0.009 | 0.85 |
| Body weight, d 21 (kg) | 14.1 ± 0.259 | 14.2 ± 0.259 | 14.1 ± 0.273 | 0.93 |
| **21-35 d** | | | | |
| ADI (kg/d) | 0.914 ± 0.011 | 0.909 ± 0.011 | 0.890 ± 0.012 | 0.17 |
| ADG (kg/d) | 0.610 ± 0.007[x] | 0.599 ± 0.007[x] | 0.588 ± 0.007[y] | 0.09 |
| FCR | 1.503 ± 0.013 | 1.521 ± 0.013 | 1.509 ± 0.014 | 0.62 |
| Body weight, d 35 (kg) | 22.2 ± 0.33 | 22.3 ± 0.33 | 21.9 ± 0.34 | 0.85 |
| **0-35 d** | | | | |
| ADI (kg/d) | 0.568 ± 0.008 | 0.566 ± 0.008 | 0.547 ± 0.008 | 0.38 |
| ADG (kg/d) | 0.426 ± 0.005 | 0.425 ± 0.005 | 0.416 ± 0.005 | 0.37 |
| FCR | 1.33 ± 0.008 | 1.33 ± 0.008 | 1.33 ± 0.009 | 0.93 |

[a]Average daily intake; [b]Average daily gain; [c]Feed conversion ratio (feed:gain)

[x,y]Mean values within a row that have different supescripts tended to be different (*P*<0.10)

Feed intake for 0-7d was ranked for all pens to determine percentage of pigs in each lighting treatment where low ADI group was categorised as the bottom 33% of the population across the three treatments. There was a numerical difference observed between Fluorescent 8h and BioLumen 18h with 28.9% vs 42.7% respectively of each treatment group falling into the low ADI category (*Chi*-square =4.451, df=2, *P*=0.108). The same analysis was calculated for ADI 0-21d, however there was no difference among the treatments (*Chi*-square =0.792, df=2, *P*=0.67).

A linear regression analysis was conducted to investigate the relationship between body weight at weaning and post-weaning ADI (0-7d). Body weight at weaning significantly affected post-weaning ADI (0-7d) (P<0.001); however, the linear regression model (ADI (kg)=0.075+0.010×BW(kg), R2=0.309; shown in Figure 1) showed that body weight only explains the 30.9% variation of post-weaning ADI, suggesting other factors such as susceptibility to weaning stress and adaptions to diets may also influence 0-7d post-weaning ADI.

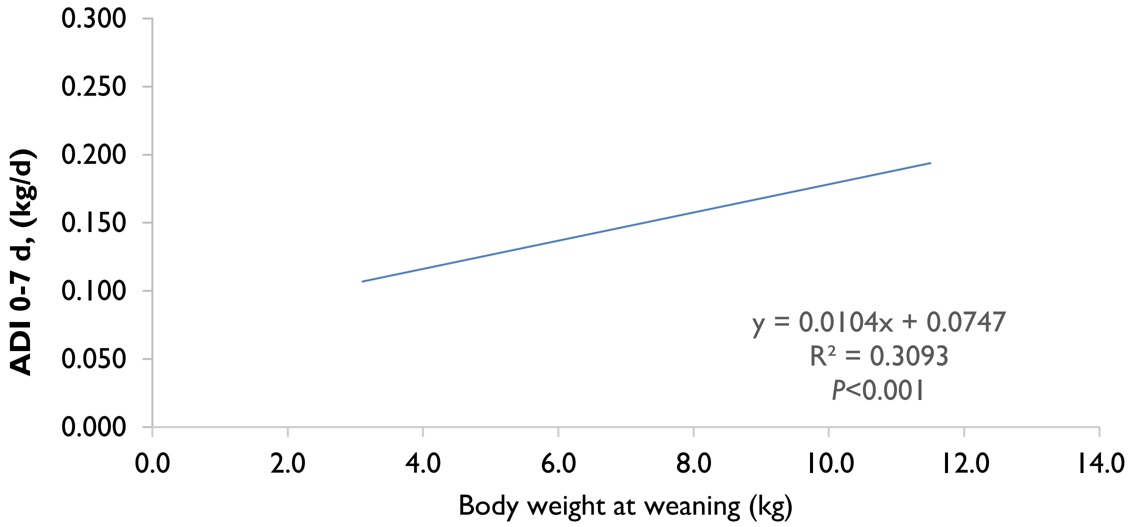


*Figure 1. Relationship between body weight and post weaning ADI (0-7d)*

#### *4.2 Light intensity*

As shown in Figure 2, the north side of the weaner shed was brighter than the south side (47.5 vs 32.6 Lux unit, P<0.001). There was a significant interaction between side and lighting type (P=0.010), such that Fluorecent 8 h lighting was brighter than Fluorecent 18 h and BioLumen 18 h lighting (both *P*<0.05) in the north side of the shed but not in the south side of the shed.  This did not translate into any differences in production outcomes.

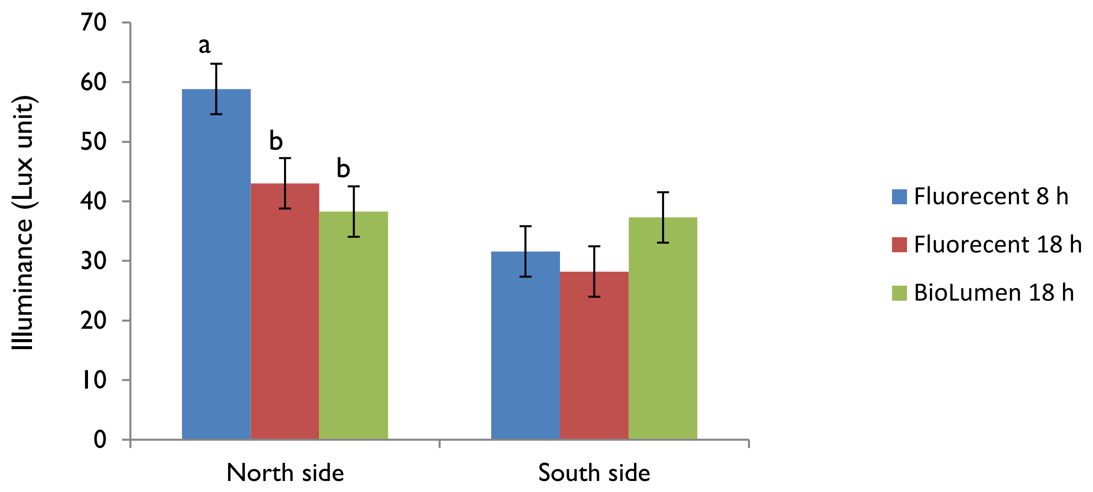


*Figure 2. Lighting intensity measured using a light meter held at pig level*

*[ab]Bars with different superscripts differ significantly (P<0.05) within the north side of the shed. Values are similar between treatments in south side of the shed.*

### ***4.3 Temperature***

Temperature was averaged for each treatment across the three time replicates.

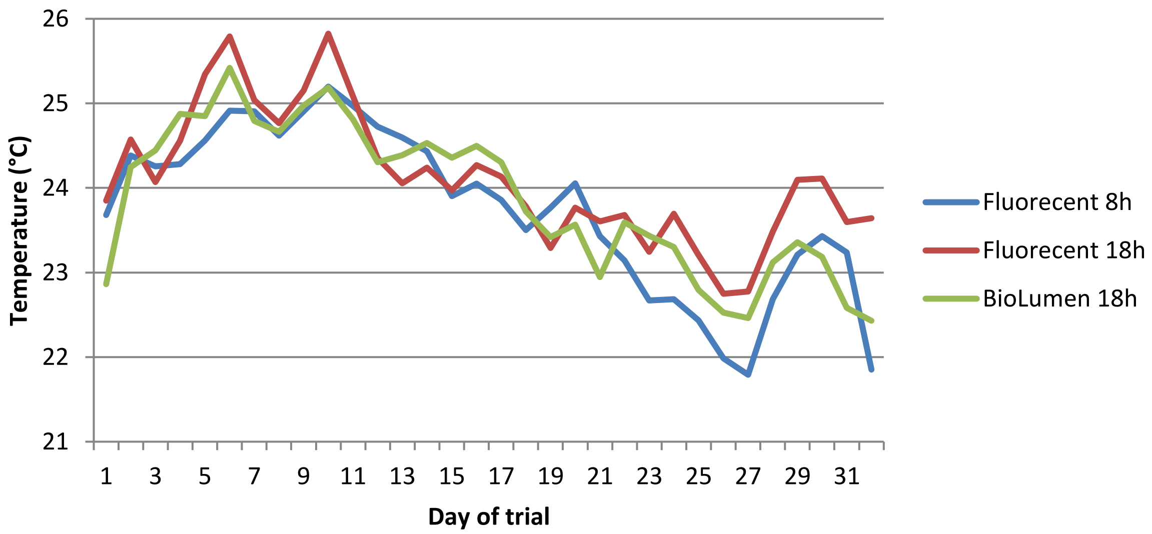


*Figure 3. Average temperature readings recorded at 15 minute intervals for the duration of the weaner phase*

### *4.4 Mortality rate*

Fate of piglets over the 35 experimental days was categorised as two groups - alive and deaths plus removals. Lighting type did not affect the distribution of the fate of the piglets (*Chi*-square=1.92, df=2, P=0.38).

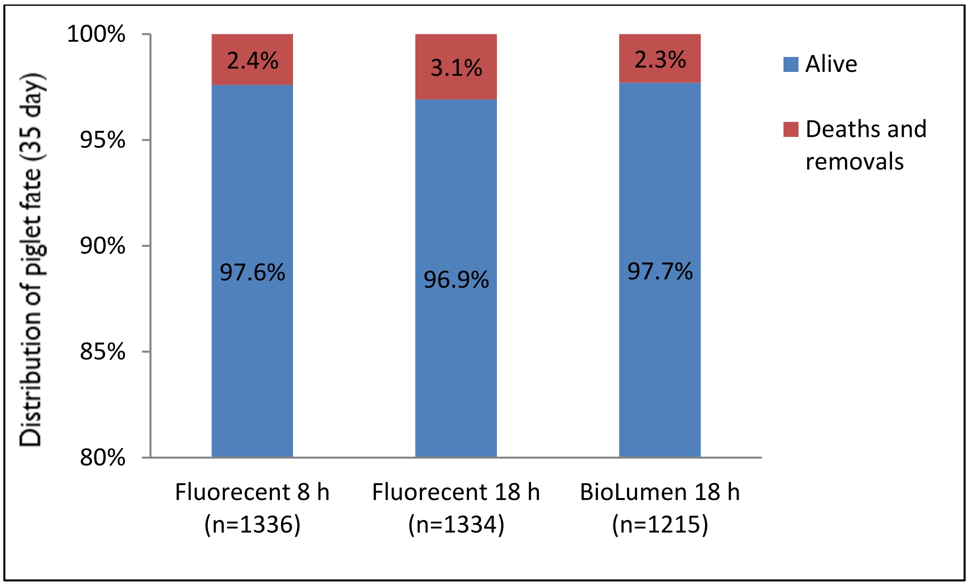


*Figure 4. Distribution of piglet fate during the 35-day experimental period*

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## 5. Discussion

The results obtained from this experiment showed no significant improvement in any performance parameters of pigs housed in different lighting environments.

Feed intake was not different between treatments in the post-weaning growth check period of 0-7d as supported by Bruininx et al. (2002). However, unlike Bruininx (2002) who described a significant difference in ADI during the second week, there was no treatment effect on ADI 7-21d in the current study. It was noted that ADI was lower in the study reported by Bruininx (2002) than observed in this study (302g/d vs 447g/d, respectively) but entry weight was heavier (8.0 kg vs 7.6 kg respectively).

The intake in the first seven days was significantly higher across all treatments than intakes observed in previous trials. The previously observed intake of 122 g/day (Brewster, 2016) was surpassed by more than 30 g/day to 154 g/day in the current study. Given the higher intakes across all treatments, the margin for improvement due to photoperiod treatment may have been reduced. This was again evident in the 7-21d period with an average of 447 g/day as opposed to 322 g/day recorded in 2016. The coefficient variance (ratio of the standard deviation to the mean) for ADI is 21.3%, 20.2% and 13.5% for the duration of 0-7d, 7-21d and 21-35d respectively, suggesting that the feeding behaviour varies to a greater extent in the first 21d post-weaning.

Daily gain was not different between treatments 0-7d, 7-21d and 0-35d overall. There was a trend for increased ADG in the Fluorescent 8h treatment compared to BioLumen 18h for the 21-35d period however, this did not translate into an increased body weight at 35d.

Light intensity was different between sides of the shed (north side vs south side), however, this may be due to the natural light entering the shed at the perimeter of ventilation blinds. The guidelines of the Model Code of Practice for the Welfare of Animals - Pigs states that natural or artificial light of at least 20 lux during periods of daytime is suggested to be made available at pig level for which all treatments exceeded this minimum standard.

As there were no significant differences between treatments, the hypothesis that the use of BioLumen lighting wavelength to improve feeding behaviour was not supported.

## 6. Implications & Recommendations

Based on the results of this study, there was no effect of lighting type or duration on the feed intake or growth performance of weaner pigs. There may be some benefit when feed intakes are lower, such as with earlier weaned pigs or lighter weaned pigs, however this could not be quantified in this study. It is concluded that the low intakes immediately following weaning are not significantly caused by lighting issues in Australian weaner sheds. Other factors such as mixing and social behaviours relating to feeding are worth further investigation.

## 7. Summary Snapshot

***Novel photoperiod regimes did not to make post-weaning feed intakes 'shine'***

A commercial evaluation of different lighting configurations was conducted to target improving post-weaning performance. A comparison was made between traditional fluorescent lighting and novel BioLumen lighting which targets the specific light spectrum optimum for pig vision. Lighting treatments were (A) 8hrs of fluorescent light, (B) 18hrs of fluorescent light and (C) 18hrs of BioLumen light.

- Lighting treatment did not significantly effect ADI, ADG, FCR or body weight
- Feed intakes were higher than expected therefore, the margin for improvement due to lighting treatment may have been reduced
- Other factors such as reducing mixing stress and understanding social behaviours relating to feeding require further investigation to attempt to increase post-weaning feed intake.

## 8. Literature cited


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## 9. Publications Arising

Expect to submit one page paper for APSA 2019.