



Evaluation of the optimal space allowance for nursery pigs

- **Jennifer Brown, Yolande Seddon, Ravneet Kaur**
 - **University of Saskatchewan**
 - **And Prairie Swine Center**

RESEARCH TEAM

- Jennifer Brown- Prairie Swine Centre
- Yolande Seddon- University of Saskatchewan
- Dan Bussieres- Groupe Ceres
- Sandra Edwards- University of Newcastle
- Ravneet Kaur- MSc, University of Saskatchewan





INTRODUCTION

How much space do nursery pigs need?

- Significant research on grow-finish pigs
- Code of practice recommendations for nursery pigs:
 - Based on stocking density research on grower-finisher pigs (NFACC, 2014)
- The floor space allowance provided to pigs is important for economic and welfare reasons (Kornegay and Knotter, 1984)



- In grow-finish pigs a ***k* value** of **0.0335** is recommended below which productivity (ADG) **decreases**
- **Relatively little** is known about the effects of space allowance in nursery pigs
- The ***k* value** for finishing pigs may **overestimate** the space requirements for nursery pigs, due to their **propensity to overlie**



Allometric growth model

- Converts body weight into a two dimensional concept:

$$A = k \times BW^{0.667}$$

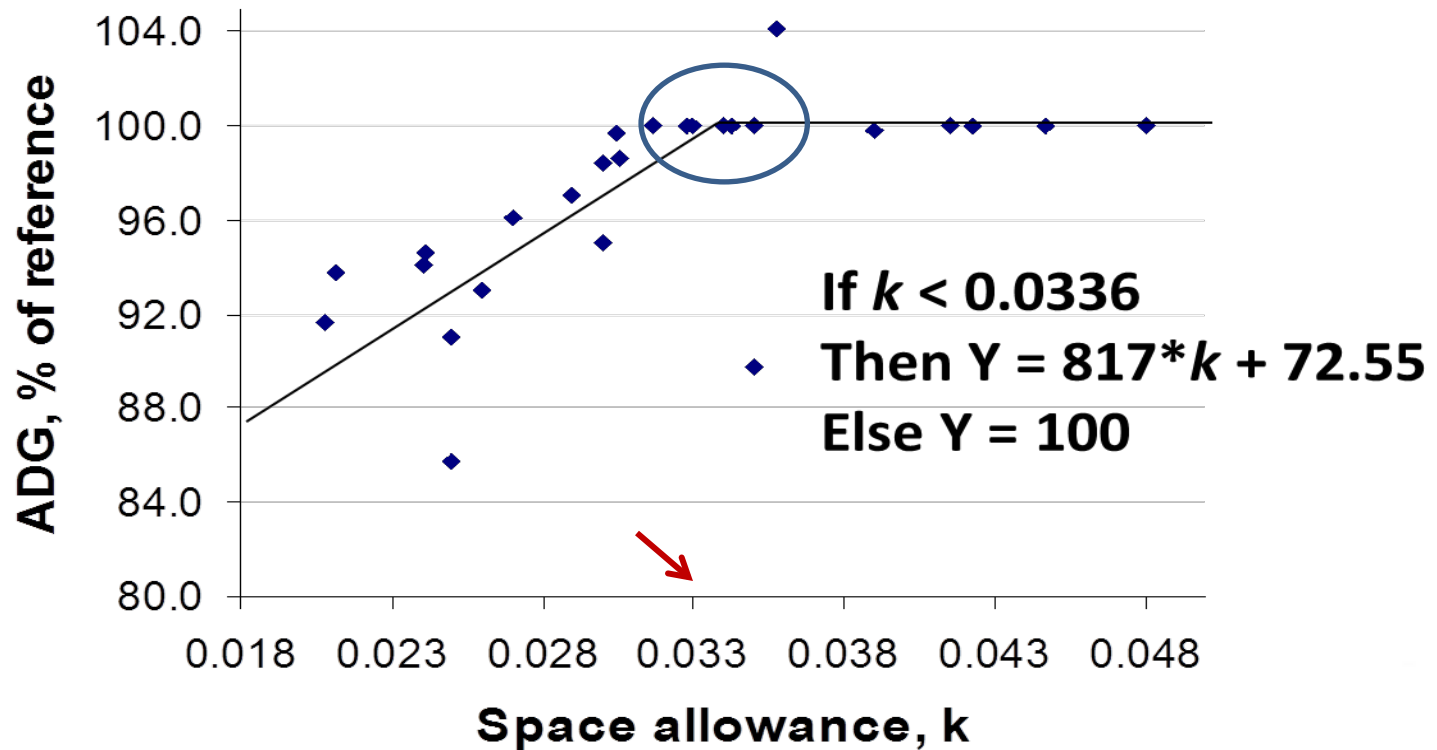
- A = space allowance (M²)
 - k = space allowance coefficient
 - BW = body weight (kg)
- Can be applied over a wide range of weights, and allows better comparison across studies

(Gonyou et al., 2006)



ALLOMETRIC GROWTH MODEL

'Broken line' meta-analysis of the relationship between k and ADG



(Gonyou et al., 2006)

OBJECTIVES

1. To determine the effects of **space allowance** and **group size** on:
 - Piglet growth and feed efficiency
 - Behaviour and welfare
2. Compare the effects of *controlled studies* and *commercial trials*
3. Evaluate costs, growth and welfare to determine the minimal space allowance for nursery pigs





METHODS

Two major studies were completed:

Phase 1

- Controlled trials at PSC- 4 replicates
- Small and large groups (10 and 40 pigs/pen)
- Density adjusted weekly

Phase 2

- Commercial trials in Manitoba and Saskatchewan
- Density adjusted by changing pig numbers
- Summer and winter trials



PHASE 1: METHODS



- The study spanned **4 seasons**
 - summer, fall, winter, spring
- 1200 newly weaned pigs were housed at six space allowances
 - ***k* values: 0.023, 0.027, 0.030, 0.034, 0.037 and 0.039**
- Two group sizes: **10** and **40** pigs/pen
- Equal feeder and drinker access
- Pigs weighed weekly and pen size was adjusted to maintain *k* constant



WEEK 1 (10pigs / pen)



$k = 0.023$ (0.10 m²/pig)

$k = 0.039$ (0.16 m²/pig)



WEEK 5 (10 pigs / pen)



$k = 0.023$ (0.18 m²/pig)

$k = 0.039$ (0.30 m²/pig)



DATA COLLECTION- PHASE 1

➤ Production Data

- Morbidity and mortality
- ADG, ADFI, FCR





DATA COLLECTION- PHASE 1

➤ Behaviour Data

- More sensitive than ADG
- Time lapse cameras recorded pig behavior for **24 hours** in weeks 1, 3 and 5
- 30 min intervals: recorded percentage of pigs standing, sitting, feeding, lying and overlying
- Feeding and drinking time budgets for four focal piglets per group (all female)



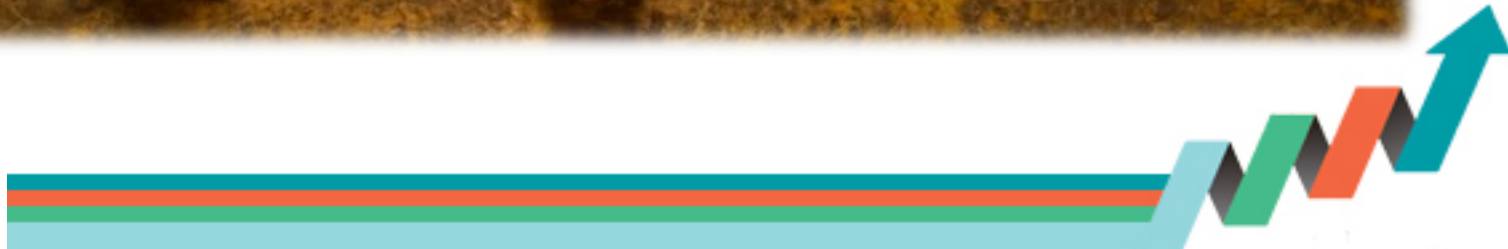
DATA COLLECTION- PHASE 1

- Aggression, stress and immune function
 - Skin lesion score
 - All pigs: Days 0, 2, 7, 14, 21, 28, 35
 - Salivary Cortisol
 - 4 focal pigs: Collected weeks 1, 2, 4, 5
 - Immune response to an inactivated virus of *Mycoplasma hyopneumoniae*
 - 2 large, 2 medium, 2 small pigs
 - Blood samples collected weeks 2, 4, 5





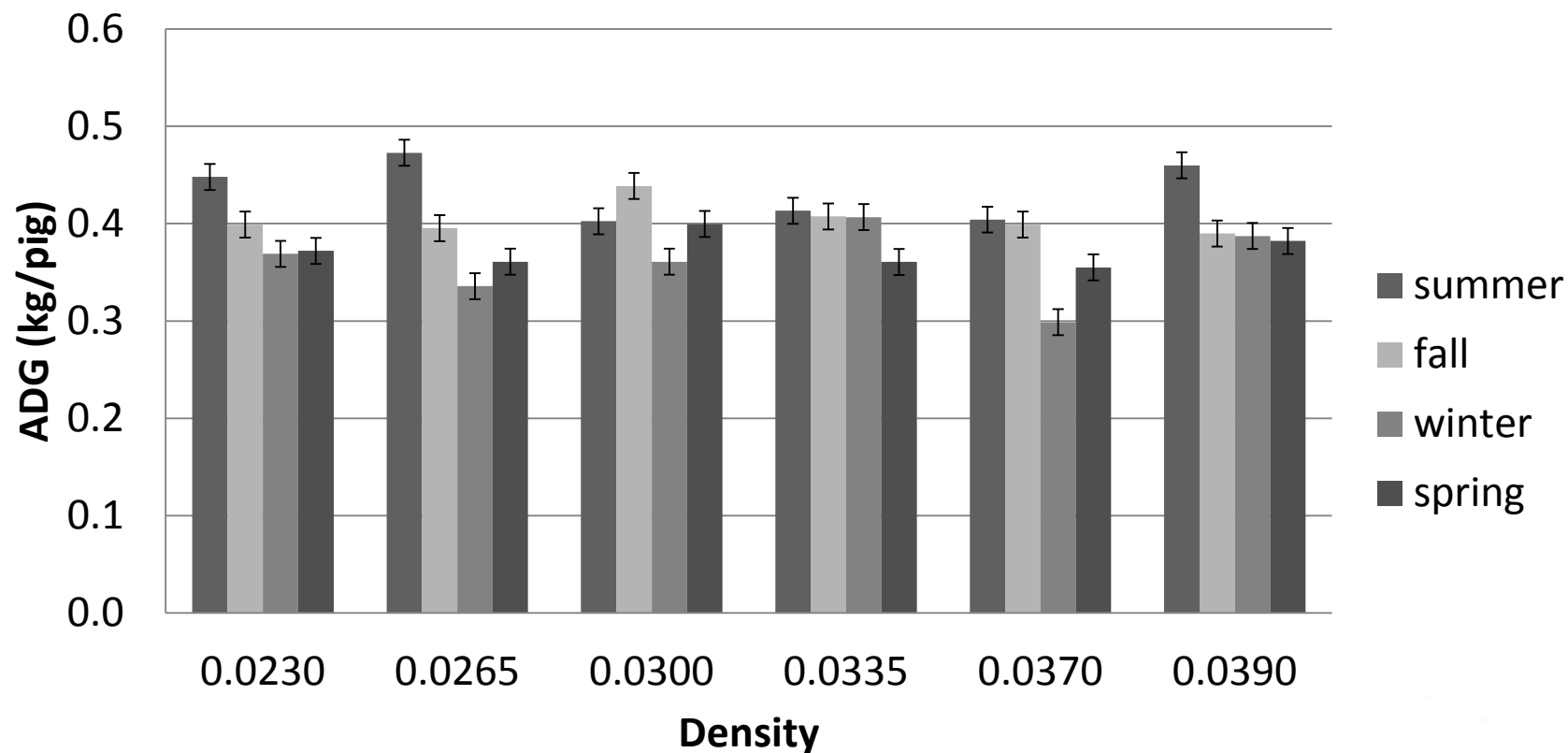
Results :Phase 1





Results-Growth

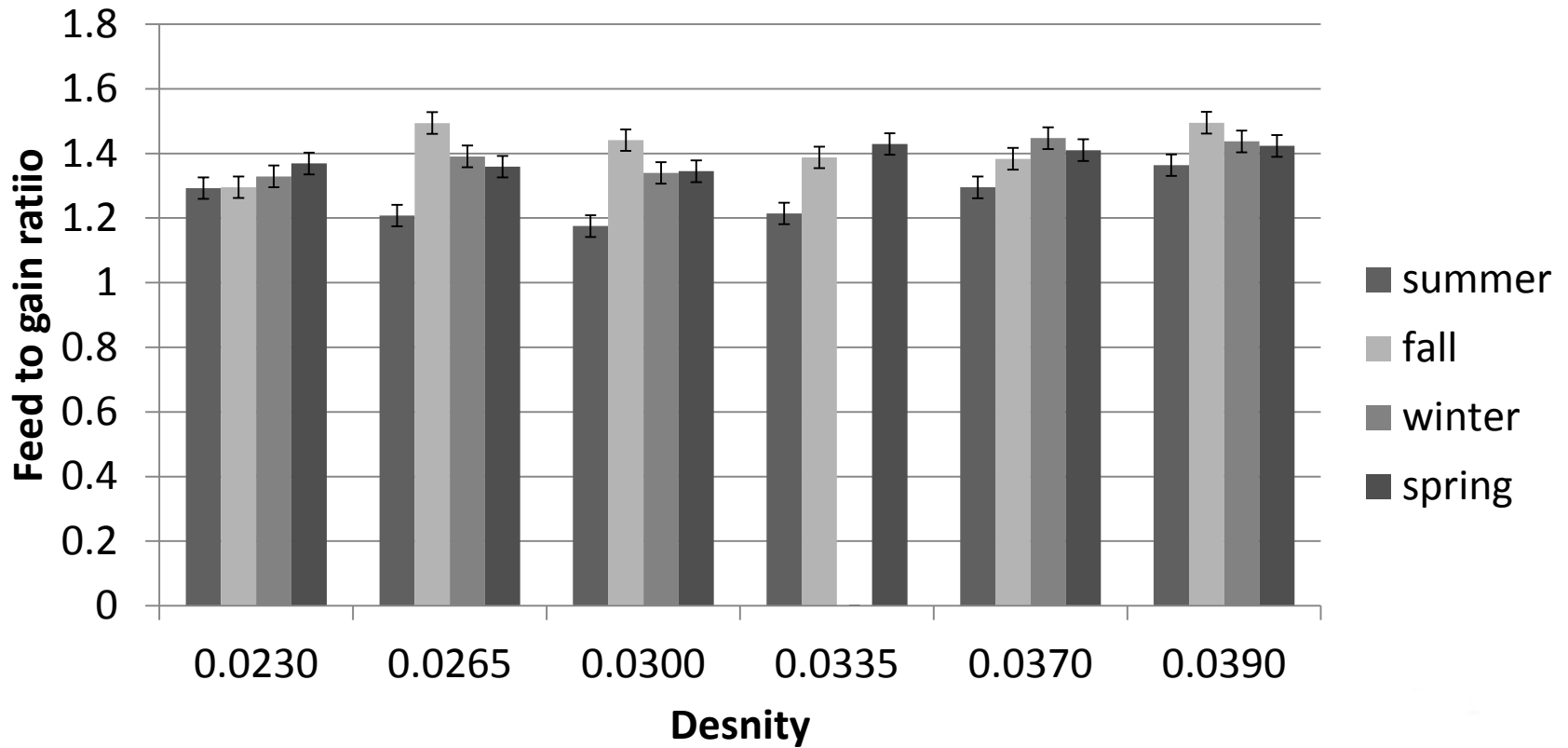
Average Daily Gain





Results-Growth

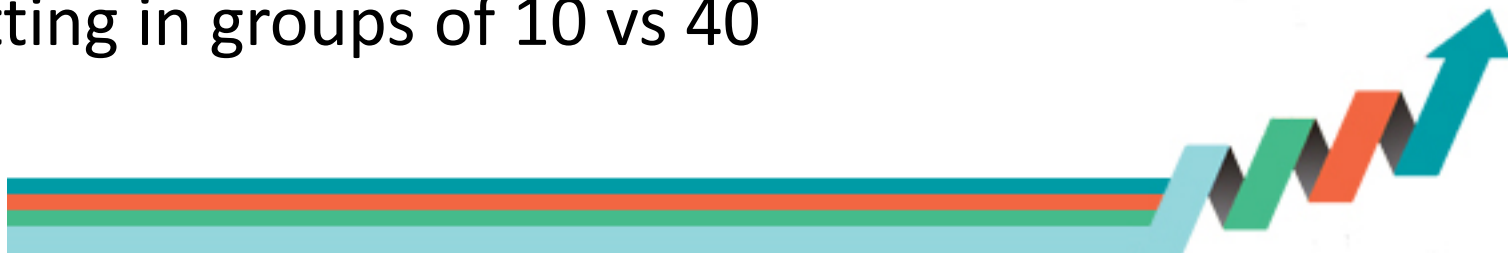
Feed to Gain



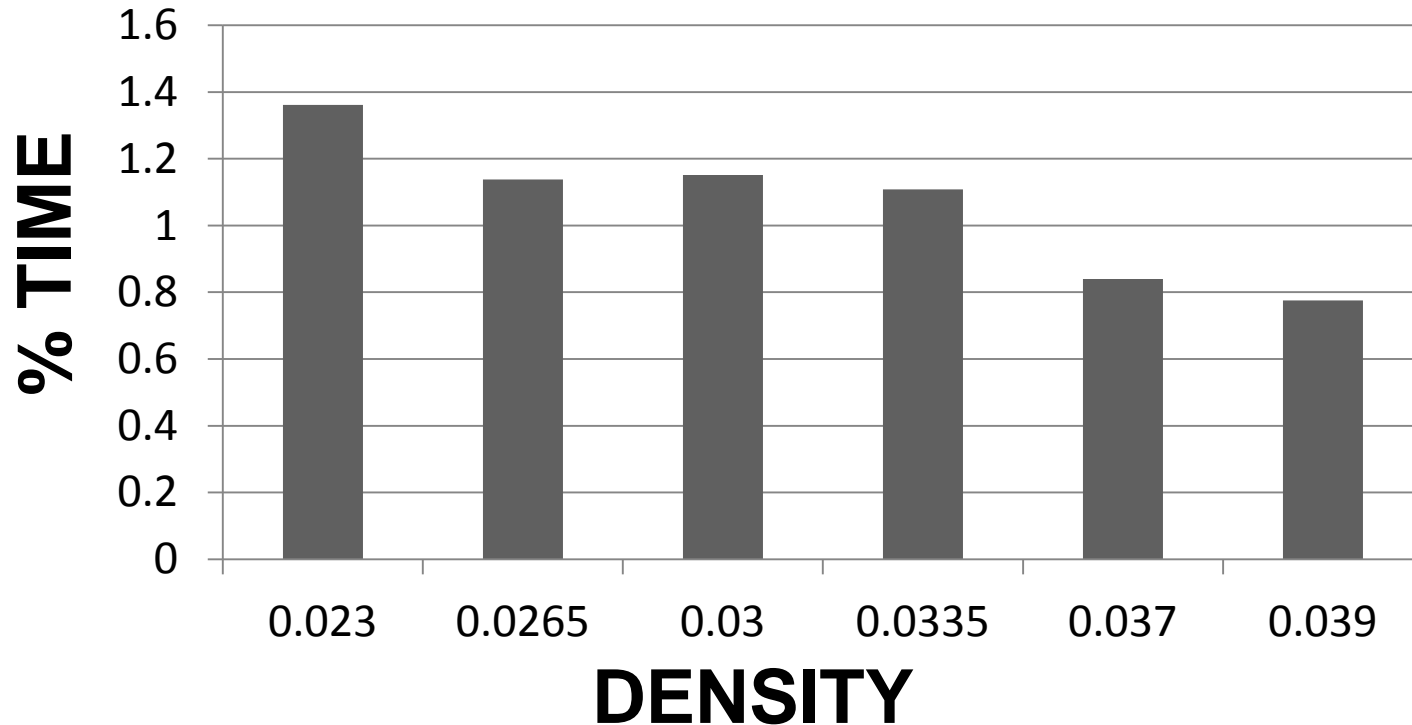
Density and Group effects on behaviour

Variable	Density						Group		SEM	P value	
	1	2	3	4	5	6	10	40		Density	Group
Behavior (%):											
Standing	3.07 ^f	2.79 ^a	2.96 ^c	3.04 ^e	2.98 ^d	2.84 ^b	2.92	2.97	0.055	0.012	0.270
Sitting	1.36 ^f	1.14 ^d	1.15 ^e	1.11 ^c	0.84 ^b	0.78 ^a	1.31 ^a	0.81 ^b	0.117	0.023	<0.001
Feeding	1.91 ^e	1.91 ^e	1.87 ^d	1.75 ^c	1.71 ^a	1.74 ^b	1.77	1.73	0.071	0.040	0.459

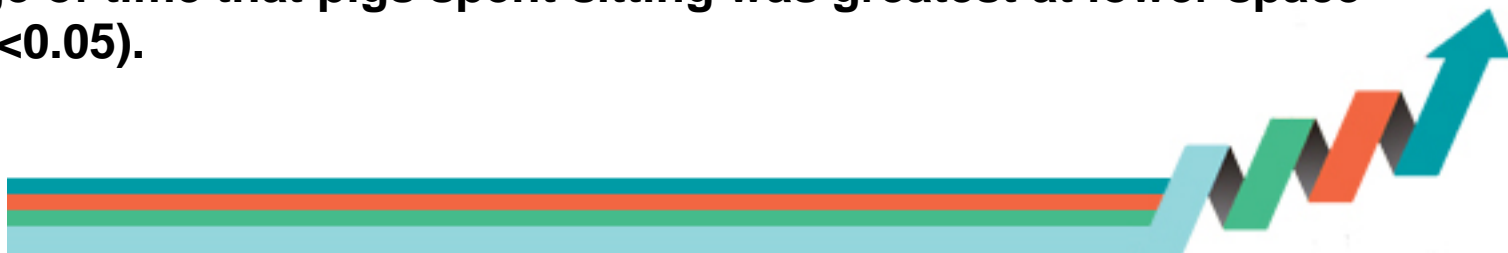
- More pigs observed sitting and feeding at low densities
 - *Proximity to feeder?*
- More sitting in groups of 10 vs 40



% TIME SITTING



The percentage of time that pigs spent sitting was greatest at lower space allowances ($P < 0.05$).





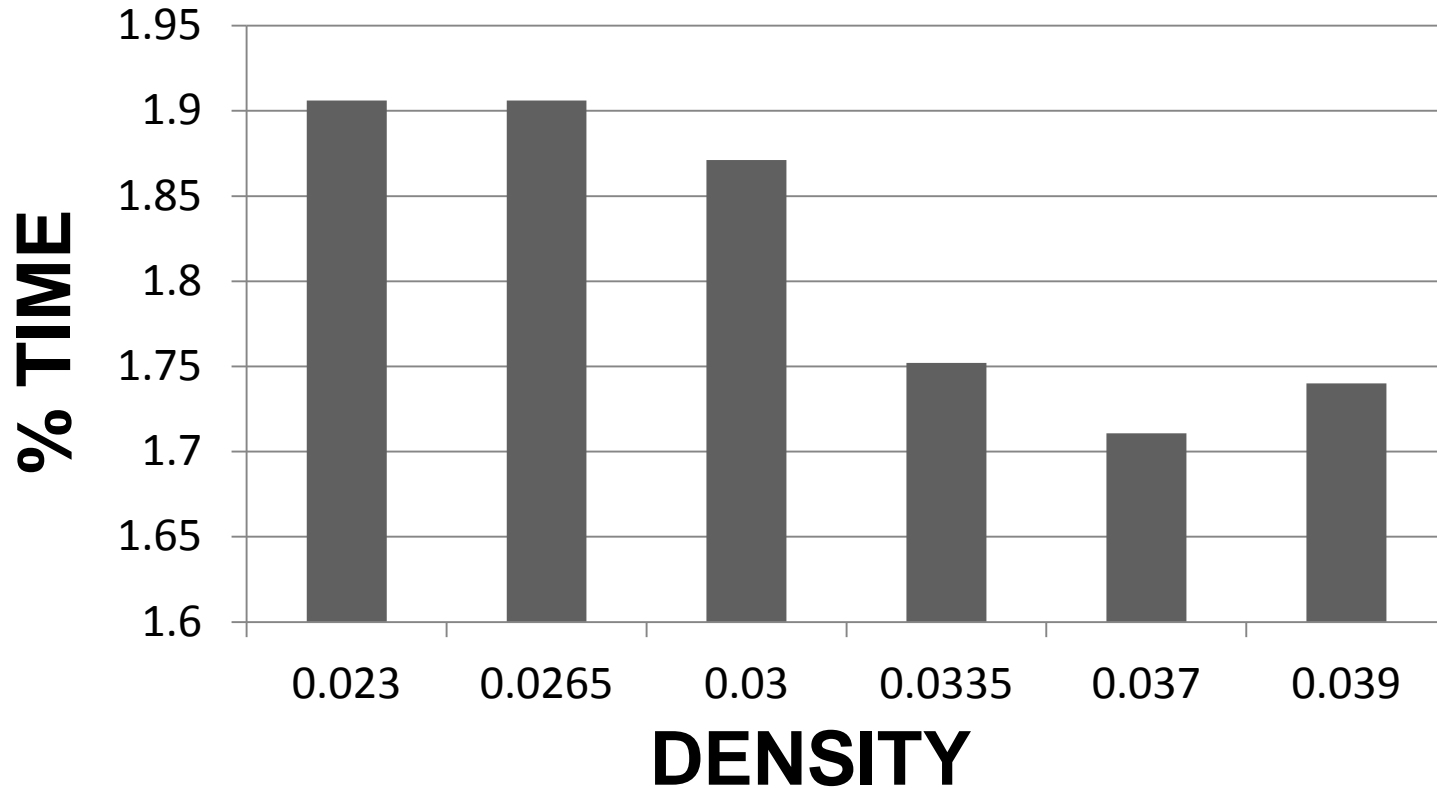
Is sitting an indicator of stress?

- **Defined as:** *piglet sitting on its posterior with the fore limbs stretched and head free from any support, lasting for more than 5 s, and without performing any other behaviour* (Dybkjaer, 1992)
- Passive sitting has been suggested to be an inactive 'cut off' strategy, by which pigs may protect themselves from the physiological consequences of unpleasant handling, lack of floor comfort (Pearce et al., 1989; Fraser, 1975)
- Sitting behaviour is an indicator of stress in early weaned piglets (Dybkjaer, 1992)





% TIME FEEDING



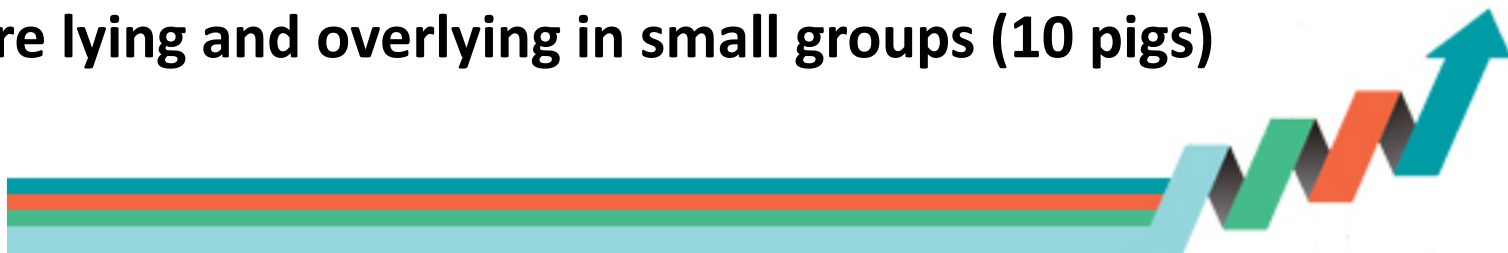
Pigs at lower space allowances spent more time feeding (P<0.05).



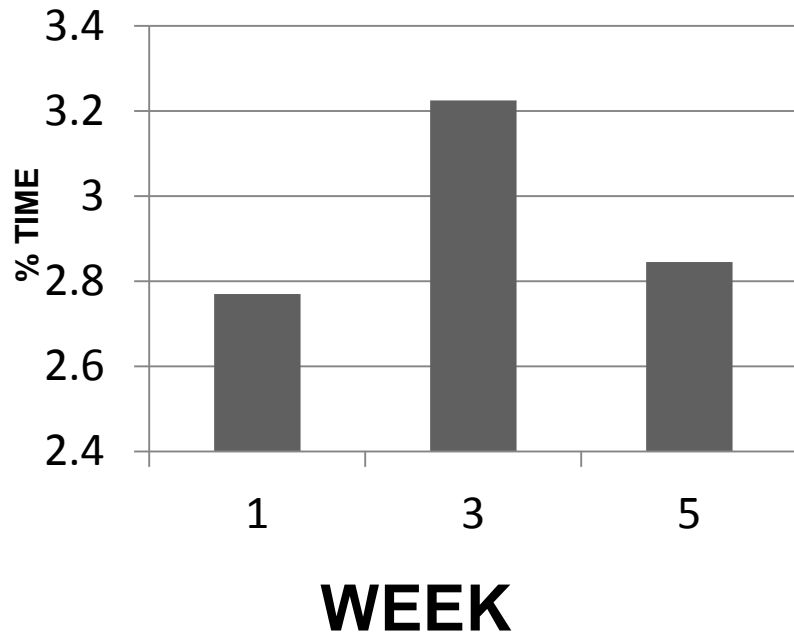
Density and group effects on lying behavior

Variable	Density*						Group		SEM	P value	
	1	2	3	4	5	6	10	40		Density	Group
Sternal	3.95	3.98	3.98	4.01	4.06	3.95	4.05 ^b	3.93 ^a	0.033	0.278	<0.001
Recumb	1.96 ^d	2.17 ^e	1.75 ^c	1.72 ^a	1.74 ^b	2.37 ^f	2.23 ^b	1.66 ^a	0.150	0.031	<0.001
Overlying	4.05	4.12	4.11	4.08	4.10	4.04	4.18 ^b	3.99 ^a	0.033	0.577	<0.001

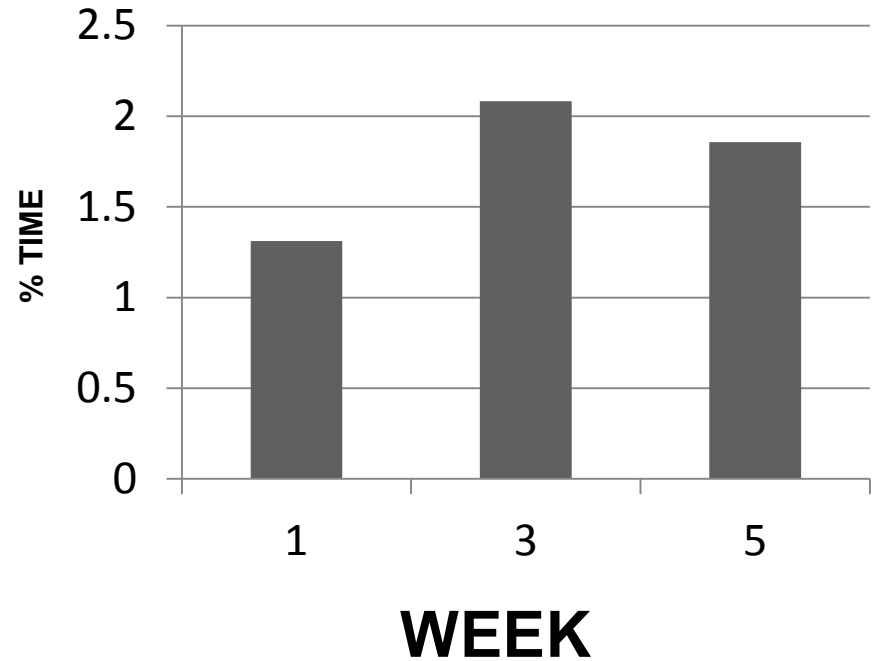
- No clear effects of density
- More lying and overlying in small groups (10 pigs)



STANDING



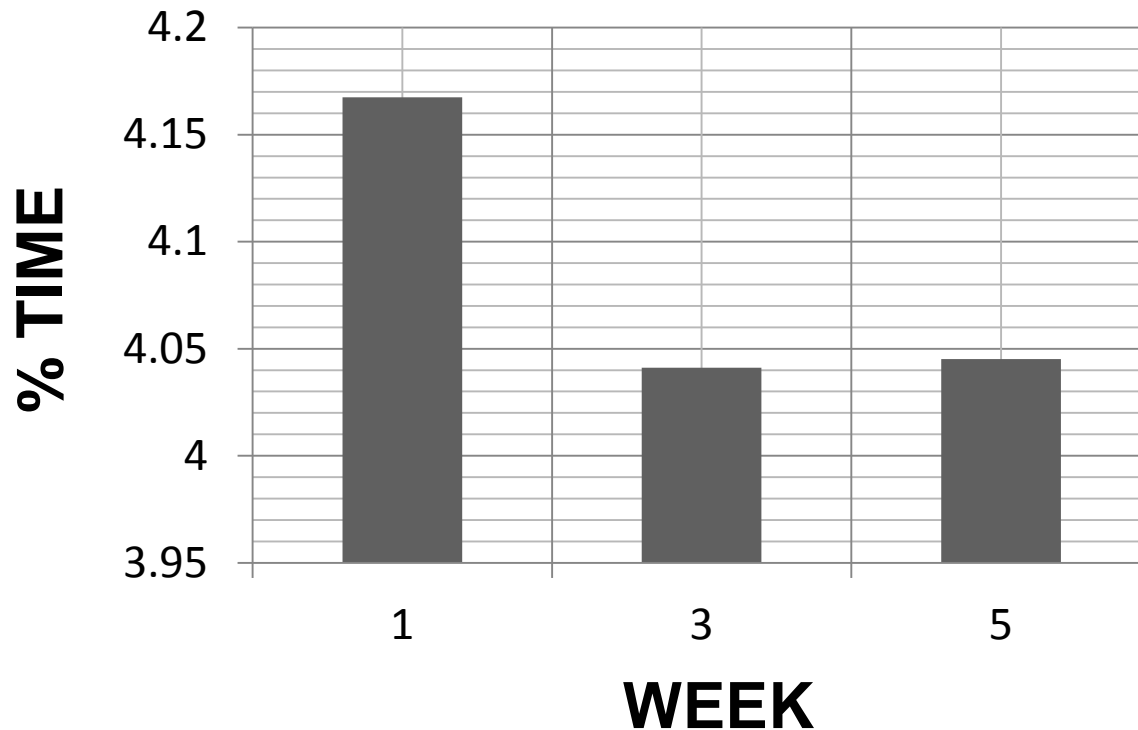
FEEDING



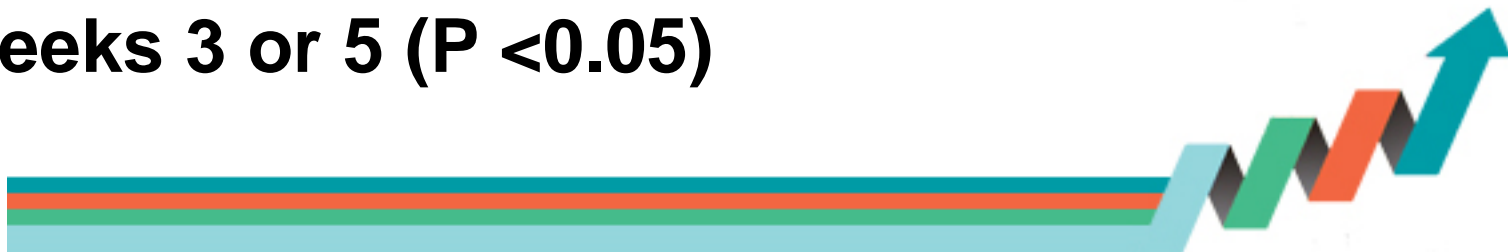
Pigs were observed standing and feeding more in week 3, compared to weeks 1 or 5



% TIME OVERLYING



Pigs were observed overlying more in week 1 than in weeks 3 or 5 ($P < 0.05$)



Time budgets for feeding behavior: Density effects

Variable	Density						P values
	1	2	3	4	5	6	
Feeding behavior							
Bouts/day	6.13 ^e	5.72 ^d	5.43 ^b	5.24 ^a	5.78 ^d	5.51 ^c	0.045
Total duration (min)	44.49 ^b	45.51 ^c	38.77 ^a	38.77 ^a	48.77 ^d	49.05 ^e	0.018
Avg bout duration (min)	0.82 ^b	0.87 ^d	0.81 ^a	0.85 ^c	0.90 ^e	0.98 ^f	0.004

- Total time feeding was greater at larger space allowances



Time budgets for feeding and drinking: Week effects

- Feeding and drinking increase **over time**
 - **More time** feeding & drinking per day
 - **Longer** meals & drinking bouts



Means and SD for salivary cortisol (ng/ml)

Sample	N	Mean	Range	Std Dev
Week1	187	20.7	(5.5 - 73.1)	13.09
Week3	187	9.59	(5.5 - 40.6)	5.06
Week5	192	8.38	(5.5 - 29)	4.36
Week6	168	7.73	(5.5 - 22.4)	3.29





Salivary cortisol results (ng/ml)

	Density						SEM	
Variable	1	2	3	4	5	6		Density
Cortisol (ng/ml)	8.18 ^a	8.28 ^c	8.19 ^b	8.41 ^d	9.23 ^e	9.91 ^f	0.02	0.005

K values; 1= 0.023; 2= 0.0265; 3= 0.03; 4= 0.0335; 5= 0.037; 6= 0.039.



CONCLUSIONS

- Lower space allowances resulted in pigs feeding more frequently and for a shorter duration, but did not have an obvious impact on growth or welfare
- Pigs at higher space allowances had higher cortisol levels, possibly as a result of higher activity levels
- Overlying was greatest at nursery entry and reduced over time





Summary: Phase 1

- **Density and ADG**
 - No clear effect of density on growth
 - Seasonal effects
- **Density and Behaviour**
- Behaviour changes over time
 - Overlying decreases
- Some effects of density



PHASE 2

- **Commercial nursery barns located in Saskatchewan and Manitoba**
- Four pens of each density in summer and winter
- Behaviour and growth recorded in weeks 1, 3, 5





Phase 2: Commercial Trials- Methods

- Number of pigs/pen adjusted to meet space allowance
- Calculated so the space allowance is reached at nursery exit weight, and accounting for % mortality
- Feeder spaces adjusted so a consistent ratio of pigs to feeder spaces (5 pigs/feeder space)





Phase 2: Commercial Trials- Methods

Number of pigs/pen in density treatments (25kg exit weight)

Exit weight (kg)	Area in pen (m2)	0.023	0.0265	0.030	0.0335	0.037	0.039
25	6.08	31	27	24	21	19	18
Additional pigs required to account for 3% mortality		0.9	0.8	0.7	0.6	0.6	0.3
Total pigs per treatment		32	28	24	22	20	19

Pen area is minus the floor space taken up by feed trough



Phase 2: Methods- Pig Health Measures

- Skin lesions
- Ear tip necrosis
- Tail biting lesions
- Pig cleanliness



All scored at entry, mid-point and exit



Score 0 – blemish free ears



Score 2 – lines indicates scab coverage on tip and/or base of ear



Score 3 – lines indicates scab coverage on tip and /or base of ear



Phase 2: Methods – Behaviour measures

- Camera over each pen – birds eye view
- Photos taken at three time points
 - Day after entry
 - Day before mid-point
 - Day before nursery exit
- Pictures at 15 min intervals for seven hours each observation day



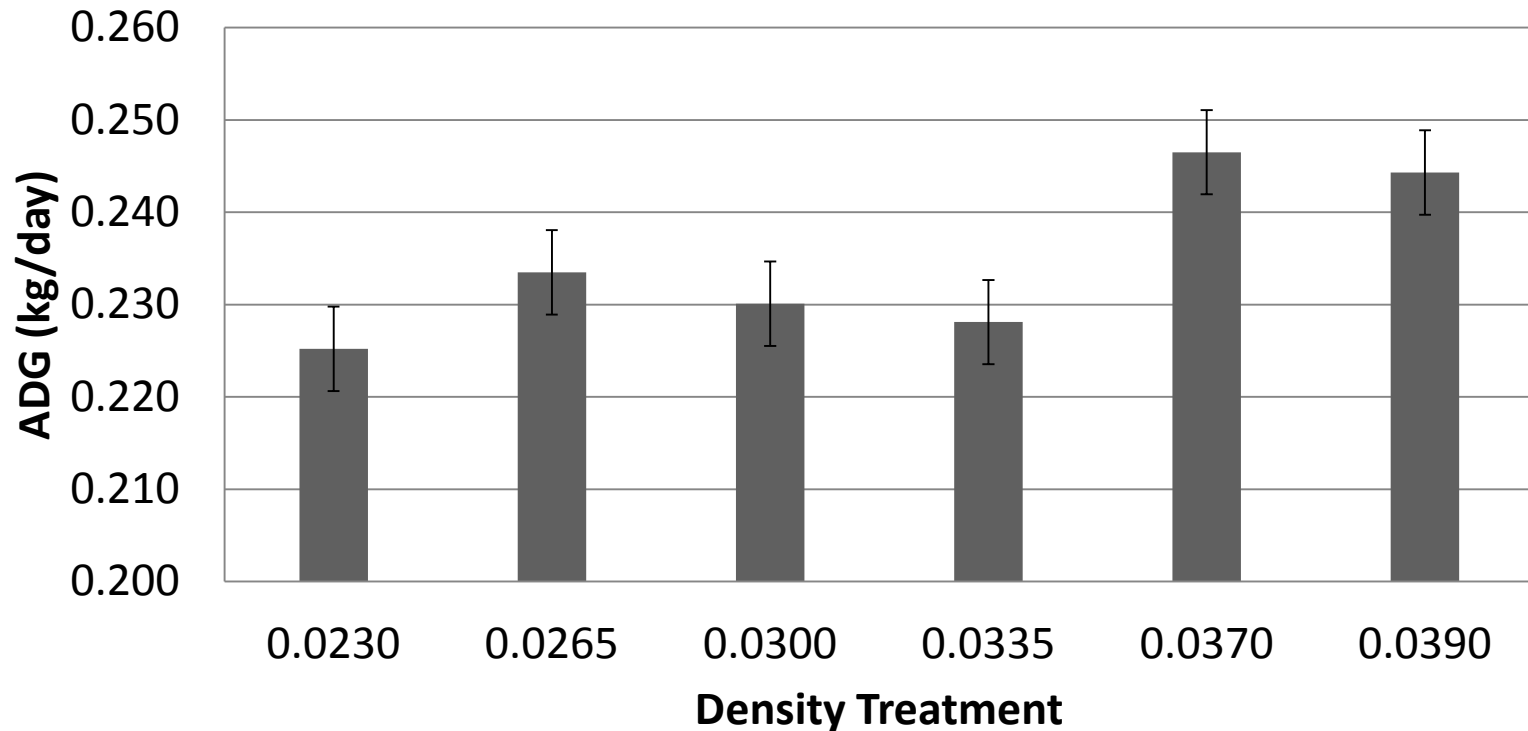


Results :Phase 2



Results: Average Daily Gain

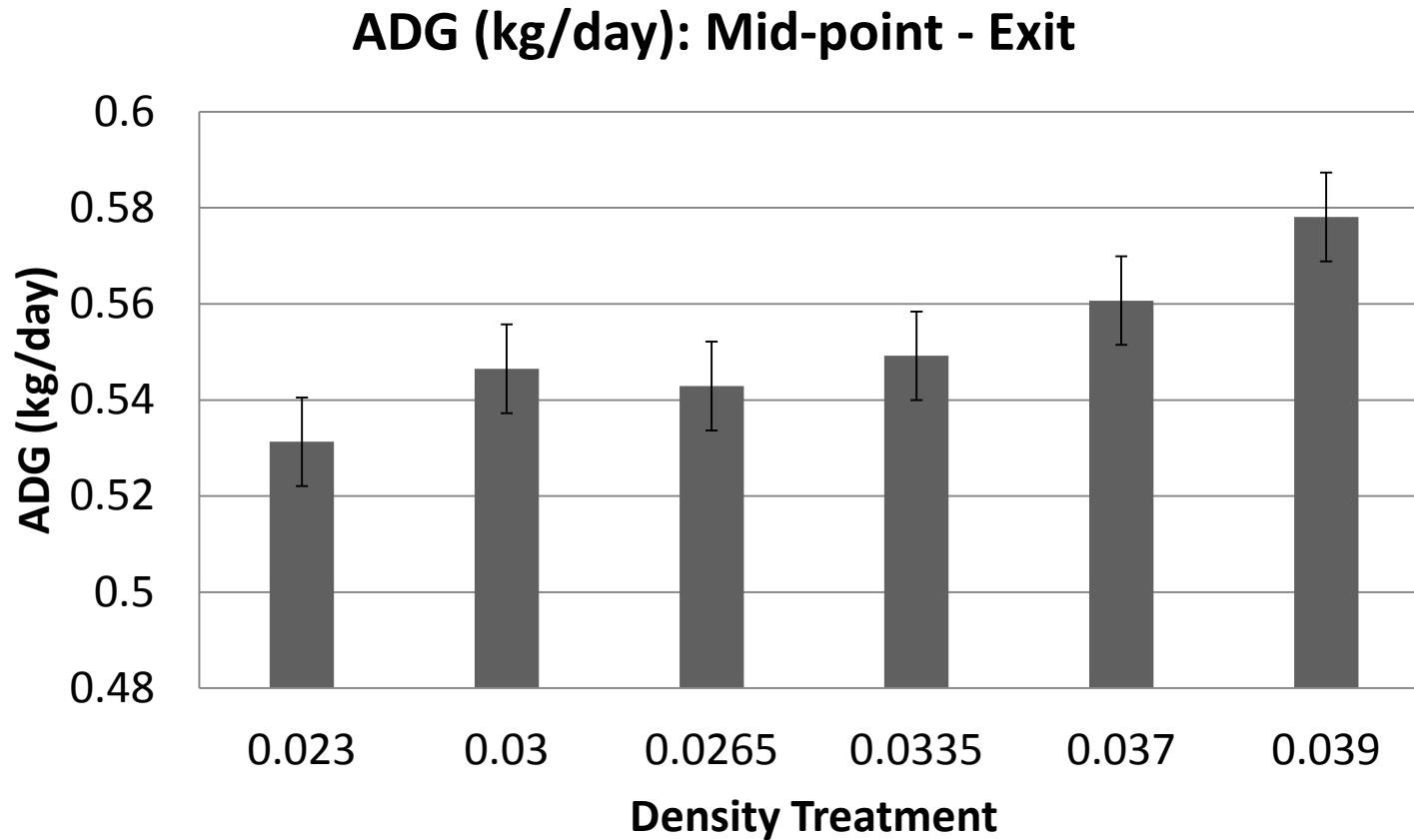
ADG (kg/day): Entry to mid-point



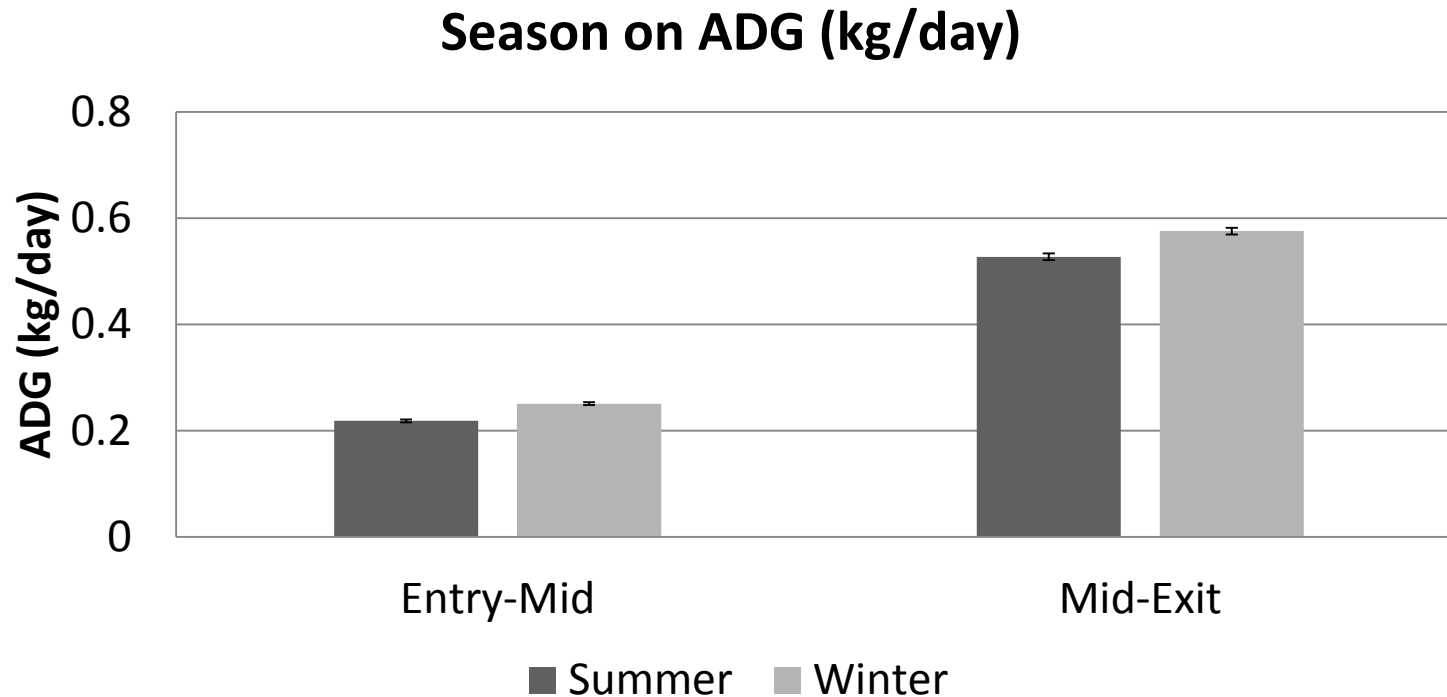
- Effects of density treatment (average of two commercial sites)



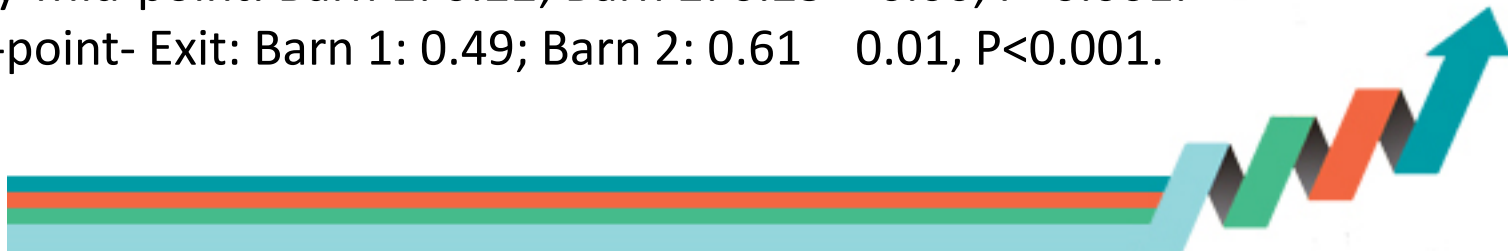
Results: Average Daily Gain



Results: Season & Barn

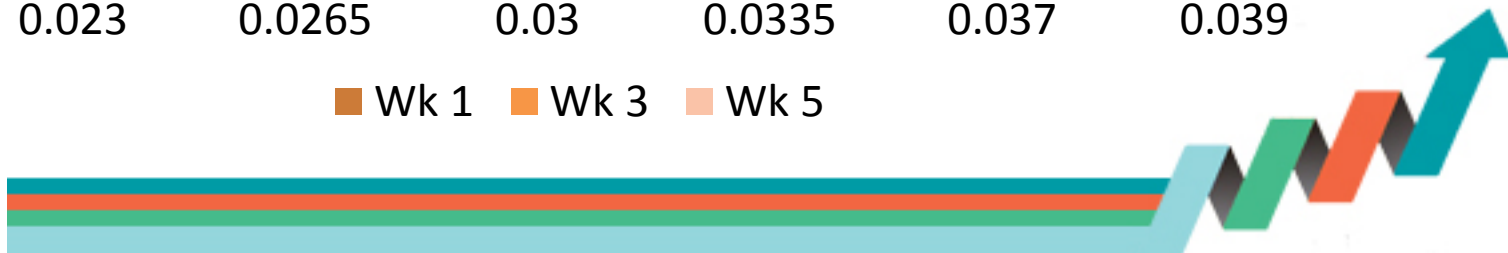
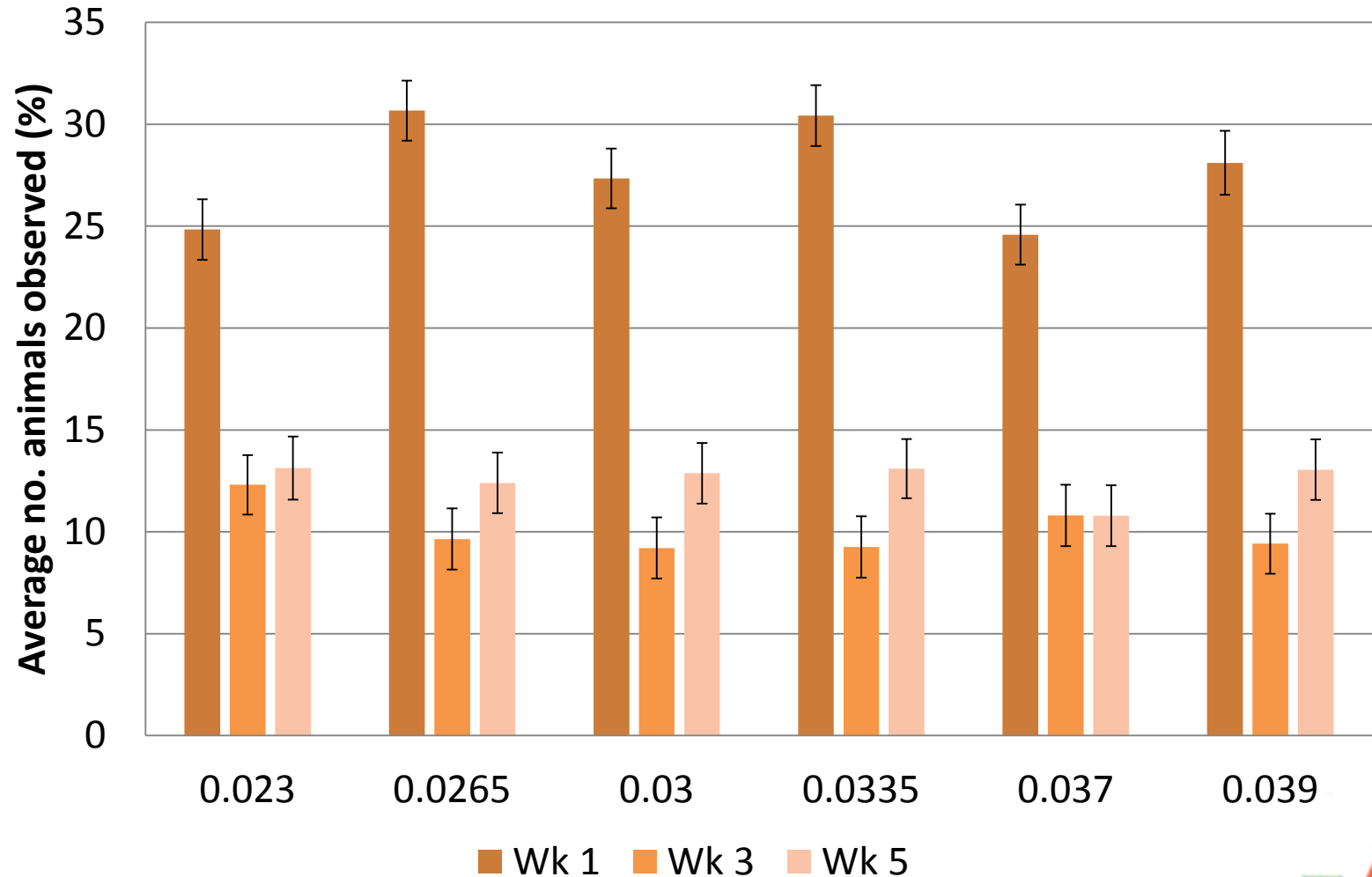


- Growth rate lower in Barn 1 than Barn 2
- Entry-Mid-point: Barn 1: 0.22; Barn 2: 0.25 0.00, P<0.001.
- Mid-point- Exit: Barn 1: 0.49; Barn 2: 0.61 0.01, P<0.001.

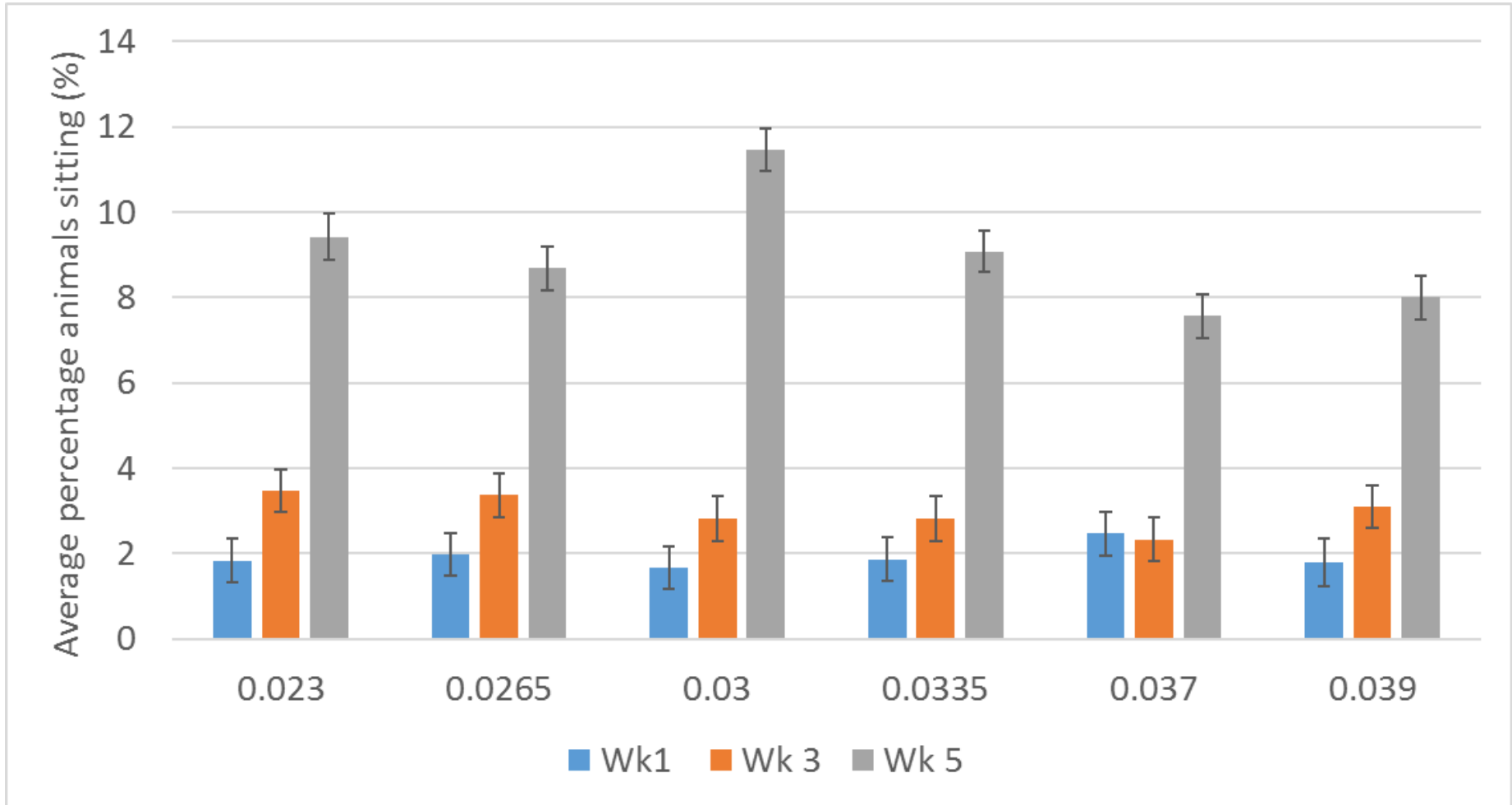


Overlying behaviour

- More animals overlying in week one of nursery ($P < 0.001$)

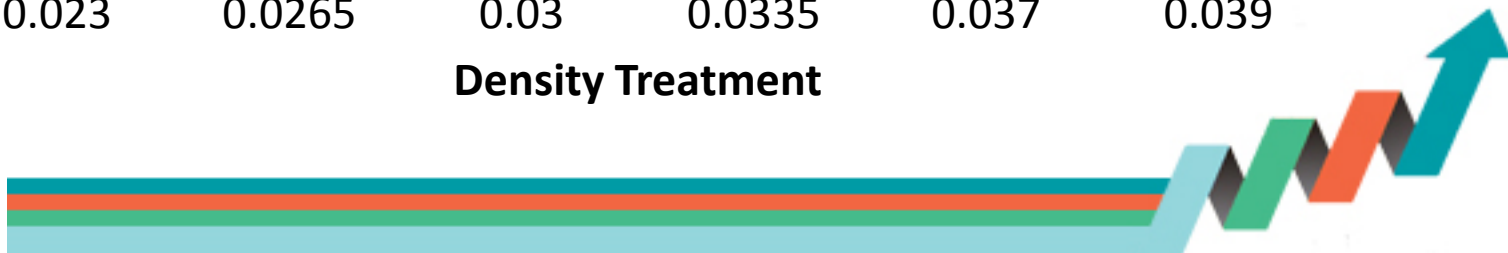
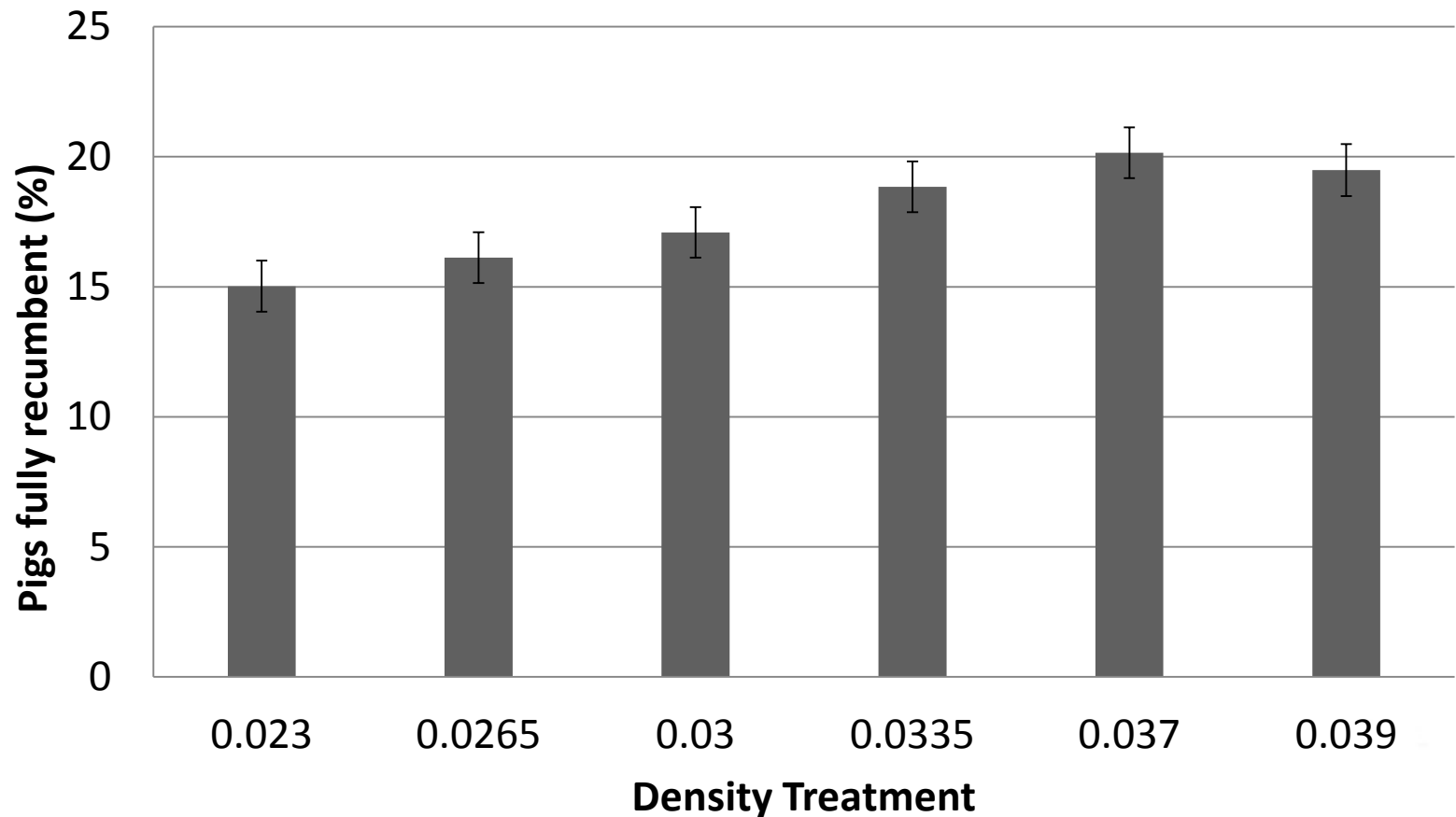


Results: Sitting



Results: Fully recumbent

Effect of density on percentage of pigs lying fully recumbent





Summary: Phase 2

Density and ADG

- Effects clearest at nursery entry
- Seasonal effects
- Barn effect: highlights different health status

Density and Behaviour

- Behaviour changes over time
- Some effects of density

Analysis with temperature data needed for final interpretation





Conclusions

- **Phase 1-** limited effects found in PSC trials
 - Some effects of space on behaviour
 - Effects of group size on behaviour
- **Phase 2-** commercial trials show density effects on growth and behaviour
- General agreement with Code values
- ADG reduced at lower space allowances

- ***More analysis needed!***



Acknowledgements

Thank you to AAFC, SIP
and project partners for
your support!



Swine Innovation Porc



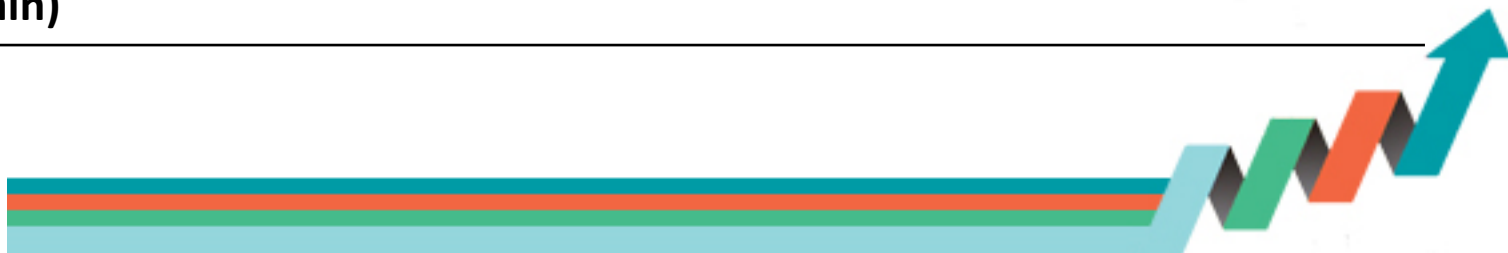
ONTARIO PORK





Average time budgets for feeding and drinking

Variable	N	Mean	Range	Std Dev
Feeding				
Feeding bouts/day	407	34.89	(1 - 112)	20.51
Total duration (min)	407	47.01	(0.07-142.75)	25.26
Average bout duration (min)	407	1.48	(0.07-7.49)	0.73
Drinking				
Drinking bouts/day	405	23.65	(1 -81)	14.26
Total duration (min)	405	6.44	(0.18-55.42)	6.45
Average bout duration (min)	405	0.25	(0.09-1.15)	0.12



Phase 2: Commercial Trials- Methods

Required feeder space relative to pen group size

Space allowance (k)	Group size	Feeder spaces/pen	Average pigs/space
0.023	32	6.4	5
0.0265	28	5.6	5
0.030	24	4.8	5
0.0335	22	4.4	5
0.037	20	4.0	5
0.039	19	3.8	5

