Improving the Barn Environment: Does it Make Cent$

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ONTARIO PORK

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Equipment Provided By:

harvest measurement

MAXIMUS

MAXIMUS SOFTWARE

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Background

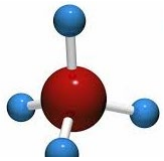
- Most farms typically manage livestock environmental conditions through monitoring of temperature only
  - The temperature relative to a set threshold controls ventilation and heating rates

- Other environmental parameters can have a significant impact on air quality
  - Affects animals and barn workers
  - Some gases can lead to barn fires
  - Other gases can be deadly to pigs and people

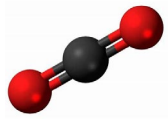
- Measurement of other environmental parameters can be a challenge
  - Sensor placement
    - Different gases should be measured at different heights and locations
  - Reliability of sensors can be problematic
  - Wireless technology vs. wired
    - Reliance on WIFI can be a challenge for many farms

Barn Gases of Interest

Methane [CH_4]
Explosive Range: 5% to 15%

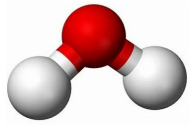


Carbon Dioxide [CO_2]
MOL TWA Limit: 5000 ppm

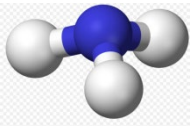


Hydrogen Sulphide [H_2S]
MOL TWA Limit: 10 ppm

Relative Humidity [H_2O]
Limit: 80%



Ammonia [NH_3]
MOL TWA Limit: 25 ppm



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Development of a Barn Gas Monitoring System

- Designed to measure temperature, relative humidity, methane, carbon dioxide and hydrogen sulphide in real time
- Wireless system
  - Sensor batteries last 2 years +
  - Settable reading frequency
  - Data stored on sensor as a backup if communication with base station is lost
  - Sensor communicates with Base Station by Radio Frequency up to 200 meters
  - Base Station captures data from all sensors and uploads to the cloud using cellular communication, WIFI or Ethernet (whatever barn has available)
  - Alarms can be programmed
  - Graphical display on website and base station

Methane Sensor

Temp. Sensor

Base Station

Website on Cloud

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Project Objectives

- Improve the overall air quality in a nursery room by monitoring a variety of barn gases and adjusting the ventilation settings

- Measure the effect of improved air quality on pig performance, morbidity and mortality

- Determine the cost of production in the improved room vs. a control room within the same barn
    - Can the potential costs associated with increased ventilation be off-set by animal performance?

Barn Setup

- 2 Nursery Rooms
  - 4 pens per room (~40 pigs per pen)
    - 1 feeder per 2 pens
  - Consecutive week starts
  - Room 7 – test room with improved ventilation
  - Room 8 – control room with standard ventilation for facility

- Multiple Nursery Cycles
  - Initial cycle was used to collect baseline data allowing for adjustment of room 7 ventilation
  - 2 nursery cycles with full data collection
  - Currently collecting additional cycles with reduced data collection

- Pigs weaned at 28 days of age and kept in nursery for 61 days

- 4 phase feeding program
  - Phase 1: day 1-5 (hand fed)
  - Phase 2: day 6-13 (hand fed)
  - Phase 3: day 14-27 (auto system)
  - Phase 4: day 28-61 (auto system)

Barn Facility Updates

Entire Barn

- Stacks on ventilation fan outlets
- Maintain pit fan ducts
- Relocate ceiling inlet orientation

Test Room (Room 7)

- Actuate ceiling inlet
- Program ceiling inlets for reduced static pressure at high temperature

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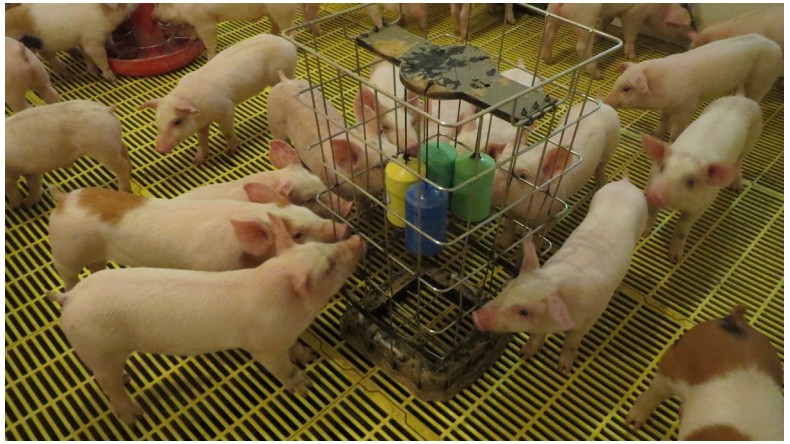
Data Collection in Room 7 & 8

Harvest Measurement	Maximus Solutions	OMAFRA Team + Farmer
• Temperature (in pen) • Relative Humidity • Carbon Dioxide Concentration • Methane Concentration • Hydrogen Sulphide Concentration	• Fan Stage • Static Pressure • Temperature (setpoint) • Temperature (room) • Kg feed per feeder (phase 3 and 4) • Electricity Consumption • Gas Heater Run Time	• Kg feed per feeder (phase 1 and 2) • Pen weights at entry, each diet change, exit • Incidence of tail biting and ear tip necrosis every other week • Mortality records • Treatment records

Air Quality Equipment Setup



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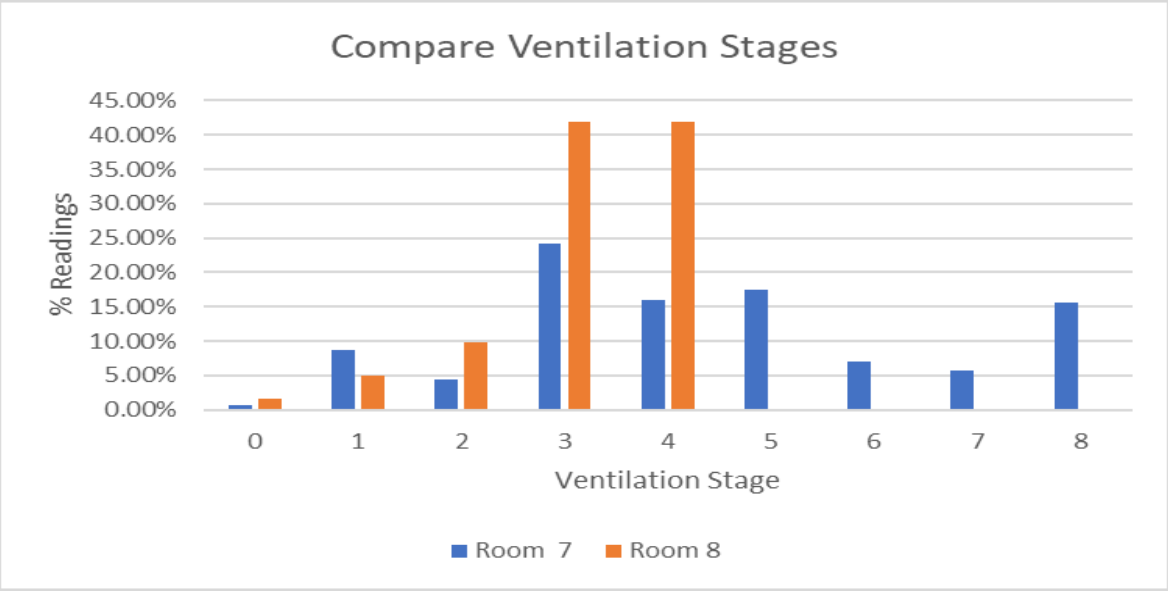
Room 7 (Test Room) Ventilation Scheme

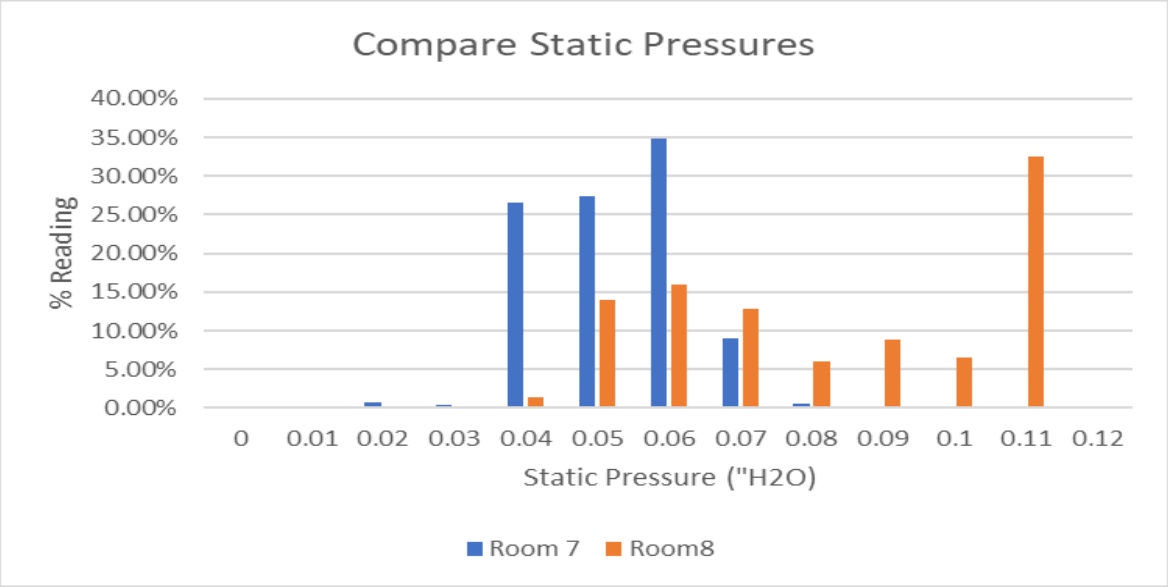
	SP	Inlet Setting (% Open)			Temperature Bandwidth (°C)	
Stage	(in. w/c)	Min	Mid	Max	Start Temp	Stop Temp
3	0.07	26	40	65	20.2	19.2
4	0.06	26	50	75	21.2	20.4
5	0.05	26	60	85	22.2	21.4
6	0.04	26	70	95	23.2	22.4
7	0.03	26	70	100	24.2	23.4

Results

Data shown is for first full data collection cycle which occurred from July 9, 2020 until September 15, 2020

Ventilation System Operation





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Air Quality Results

Parameter	Room 7	Room 8	Units
Average Temperature difference (T_{pen} - $T_{setpoint}$)	3.6	4.1	˚C
Average Relative Humidity	63.9	61.2	%
Maximum Relative Humidity	82.0	73.3	%
Average Carbon Dioxide	946.1	2412.0	ppm
Maximum Carbon Dioxide	2370.0	5060.0	ppm
Average Methane	0.00001	0.12	% by volume
Maximum Methane	0.02	0.3	% by volume
Average Hydrogen Sulfide	0.0	0.0	ppm
Maxumim Hydrogen Sulfide	0.0	0.0	ppm
Average Static Pressure	0.053	0.083	inches H_2O

Energy Consumption

Parameter	Room 7	Room 8	Units
Total Electricity Consumption	422.49	338.1	kWh
Unit Cost of Electricity	$ 0.13	$ 0.13	$/kWh
Total Electricity Cost	$ 54.92	$ 43.96	

Additional Electricity Consumed in Room 7	84.4 kWh
Additional Cost of Electricity in Room 7	$10.97

Pig Performance: Growth

Parameter	Room 7	Room 8	Std. Dev.
Number of Pigs at Room Fill*	174	168	-
Initial Average Pig Weight (kg)	7.28	7.60	1.26
Final Average Pig Weight (kg)	37.09	35.45	2.74
Average Total Weight Gain Per Pig (kg)	29.81	27.85	2.02
Average Daily Gain (kg/pig/day)			
Phase 1	0.10	0.14	0.02
Phase 2	0.26	0.28	0.03
Phase 3	0.52	0.39	0.08
Phase 4	0.58	0.56	0.03

*Pig numbers were thinned down part way through trial to prevent crowding

Pig Performance: Feed Intake & Feed to Gain

Parameter	Room 7	Room 8	Std. Dev.
Average Daily Feed Intake (kg/pig/day)			
Phase 1	0.14	0.15	0.002
Phase 2	0.36	0.37	0.01
Phase 3	0.75	0.56	0.11
Phase 4	1.13	1.12	0.03
Total Feed Consumed (kg/pig started)	47.32	44.62	-
Feed To Gain Ratio (kg/kg)			
Phase 1	1.40	1.00	0.23
Phase 2	1.38	1.30	0.14
Phase 3	1.45	1.40	0.10
Phase 4	1.96	2.00	0.13

Pig Performance: Morbidity

Parameter	Room 7	Room 8
Tail Biting (Total % of Pigs Observed on 5 Days Combined)		
Score 1 & 2 Combined	17.82	10.71
Score 3 & 4 Combined	4.60	7.74
All Scores Combined	22.41	17.82
Ear Tip Necrosis (Total % of Pigs Observed on 5 Days Combined)		
Score 1 (mild)	6.32	12.64
Score 2 (moderate)	9.77	15.52
Score 3 (severe)	1.15	7.47
All Scores Combined	17.24	35.63

Tail Bite Scoring:
0 = no tail biting
1 = healed/minor scratches
2 = obvious chewing or puncture wounds
3 = Score 2 + swelling or infection
4 = partial or total loss of tail

Ear Tip Necrosis Scoring:
0 = no necrosis
1 = superficial scratches covered with thin, dry, brown crusts
2 = thick brown moist crusts covering deep ulcers
3 = extensive necrosis with partial loss of tips or pinna

Pig Performance: Morbidity & Mortality

Parameter	Room 7	Room 8	Avg. from 8 Non-Test Rooms
% Mortality	4.02	7.14	5.7
Treatments			
% of Pigs Requiring Treatments	5.75	16.67	9.4
# of Combined Treatment Days	15	27	22
Cost per Pig ($)	0.10	0.56	0.26
Cost per Room ($)	18.17	94.33	38.7

- Vaccines are not included in treatment costs
- The 8 non-test rooms are all managed in the same way as Room 8 but did not have full data collection (barn records were provided for treatments and mortality). Included rooms weaned between Apr and Sept 2020.

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Cost of Production (Partial Budget)

$/Pig Started	Room 7	Room 8	Room 7 – Room 8
Feed Costs	$21.10	$19.74	$1.36
Medicines (excluding vaccines)	$0.10	$0.56	-$0.46
Electricity Costs	$0.32	$0.26	$0.05
Labour Costs for Treatments	$0.07	$0.31	-$0.24
Total Costs	**$21.59**	**$20.87**	**$0.72**

$/1000 Kg Gain	Room 7	Room 8	Room 7 – Room 8
Feed Costs	$952.24	$980.56	-$28.31
Medicines (excluding vaccines)	$4.71	$27.89	-$23.18
Electricity Costs	$14.24	$13.00	$1.25
Labour Costs for Treatments	$3.08	$15.27	-$12.19
Total Costs	**$974.28**	**$1,036.71**	**-$62.44**

- Input costs that were the same for both rooms are not included
- Labour costs for treatments were estimated using $14.25/h wage

Estimated Revenue Opportunity Loss: Potential Value of Pigs Lost to Mortality

	Room 7	Room 8	Avg. from 8 Non-Test Rooms
Pigs at Entry	174	168	150
Mortality (%)	4.0	7.1	5.7
# of Pigs Lost	7	12	9
Estimated Revenue Opportunity Loss	$524.61	$899.64	$641.25
Difference (Rm 7 vs. Rm 8)		**$375.03**	
Difference (Rm 7 vs. Barn Average)			**$116.64**

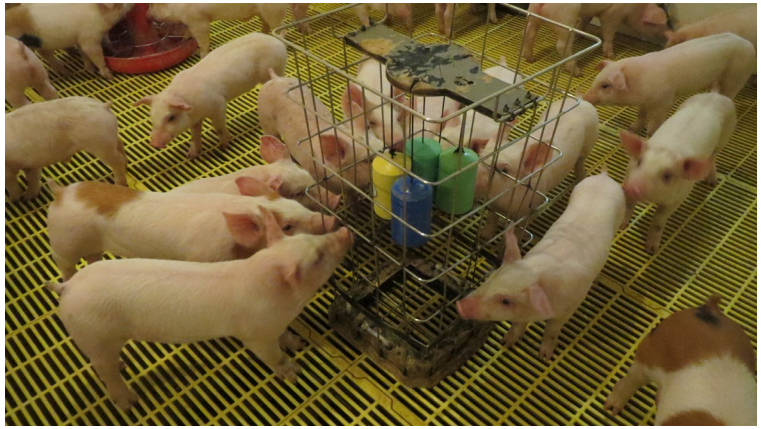
- Estimated Feeder Pig Value in September 2020 was $75.00
- The 8 non-test rooms are all managed in the same way as Room 8 but did not have full data collection (barn records were provided for treatments and mortality). Included rooms weaned between Apr and Sept 2020.

Summary

- Morbidity and mortality rates were lower with improved ventilation
  - % of pigs with tail biting was higher in Room 7 but severity was higher in Room 8
  - % of pigs and severity of ear tip necrosis was higher in Room 8
  - Mortality was lower in Room 7 compared to Room 8 and barn average
  - Treatment requirements were lower in Room 7 compared to room 8 and barn average
- There were cost increases associated with running improved ventilation
- Increased costs were more than offset by pig performance, morbidity and mortality
  - On a per pig basis, it cost slightly more to run room 7
  - On a per 1000 kg of pig produced, it was significantly cheaper to run room 7
  - Improved mortality in room 7 means higher potential revenue opportunity
- People working in the barn reported noticeable differences in air quality when working in Rooms 7 and 8 and preferred to work in Room 7

Lessons Learned and Next Steps

- In summer months, based on this side-by-side comparison, it does make Cent$ to improve ventilation!
- Carbon Dioxide appears to the be the key marker for air quality in warmer weather
- Inlet adjustment is the easiest control methodology
- Investigation during colder weather and shoulder seasons is currently underway
- Ammonia sensor development is nearing completion



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