Mitigation of accelerated deterioration of pig buildings

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When we look across the Canadian pork industry it becomes apparent that due to the age of most facilities a large percentage will need to be replaced or renovated over the next few years - as most buildings average between 20-30 years old. The majority of production units are completely enclosed utilizing a negative pressure ventilation system to maintain pig comfort. In order to reduce heating costs during winter months ventilation is generally turned down to a minimum ventilation rate. The combination of minimum ventilation and, in some areas high winds, causes exhaust air to recirculate within the facility leading to poor air quality. This in turn increases deterioration due to increased exposure to moisture and corrosive gases. This project set out to determine Canadian specific strategies for decreasing the current pace of barn deterioration.

With the overall focus of this project being to combat the rate of deterioration of swine facilities the first step was to conduct a critical literature review was under taken that identified solutions that were applicable to Canadian conditions. The second phase of the project included a survey of various stakeholder groups across Canada. The survey included producers, builders, material and equipment suppliers and academic and research and development organizations. The survey revealed that approximately 60% of producers struggle with rapid deterioration. Specifically, the structural components that they had issues with were: roofing (50% of the respondents); penning/ stalls (50%); exterior walls (40%); ceilings, trusses and/ or attic, and feeding and drinking system (30%). No significant issues with accelerated deterioration have been identified in partition walls between two rooms, manure and drainage system, and barn foundations.

Table 1. Summary of responses from producers, builders and equipment supplier on current status of pig barns in terms of barn degradation and their recommendations to mitigate them.

Structural components	Issues encountered (% of respondents reporting the issue)	Mitigation strategies
1. Roofing	- corrosion/rusting (100%)	- use of a thicker gauge of tin - better screws - application of paint on both sides of tin - modification of ventilation system so that barn air does not get in contact with the roof
2. Penning/stalls	- corrosion/rusting (86%) - cracks (29%)	- stronger support, use of heavier anchors (1/2" rather than 3/8") - use of solid rod; avoid welds in wet areas - use of stainless steel for first 6" of post or anything that has contact with manure or the floor - use of plastic (if not costly) instead of concrete or steel
3. Exterior walls	- corrosion/rusting (100%)	- plastic walls filled with concrete - thicker tin - concrete construction - better exhaust fans; proper ventilation
4. Ceiling	- corrosion/rusting (60%)	- use of screws, not nails - application of paint - use of plastic or fiberglass products
5. Trusses	- corrosion/rusting (80%) - moisture decay (60%)	- installation of ridge ventilation - use of galvanized or stainless steel, protective coatings and insulation - better ventilation to avoid back drafting
6. Feeding and drinking system	- corrosion/rusting (40%) - cracks (40%) - thicker PVC for drinking system	- use of steel feeders - use of plastics above pig level and steel at pig level - all intake hoppers and drive units should be stainless steel

Results:

Table 1 summarizes the issues encountered by producers and builders related to barn deterioration and their recommendations for mitigation. The most common issue was corrosion/ rusting of barn roof, penning/ stalls, exterior walls, ceiling, trusses, and feeding and drinking system. Some respondents have pointed out issues related to moisture decay in trusses, and cracks in penning/stalls, and feeding and drinking system.

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Mitigation Strategies

Among the solutions to improve the building life span such as surface treatments, new material, ventilation system, control and maintenance (guide information), the latest has been pointed out by the participants as the least expensive one and the easiest to adopt by producers. However, few consider maintenance improvement as the best option to improve building life span. If the cost would not be considered as a decision parameter, new building material and ventilation system improvement should be the priorities. For producers, when the cost of the technology is not considered, an adequate ventilation system, sufficient insulation and high durability wall materials are the most attractive solutions to improve building life span.

Conclusion:

When considering all the potential strategies to mitigate building deterioration, it was apparent that considering appropriate ventilation, environmental control and air treatments, improvement of corrosion protection efficiency of building materials, and adequate building maintenance would have the greatest impact within Canadian swine facilities. These strategies still need to be evaluated in a barn to determine their full potential in increasing the lifespan of Canadian swine facilities.

Table 2. Summary list of potential solutions to rapid barn deterioration and their applicability to Canadian swine barns based on literature review and survey.

Category/Potential Solution	Description	Applicability
A. Building Design		
1. Wood		
Durable design	- use of timber with bigger dimensions,well-seasoned and with good detailing	Applicable
2. Metal		
Durable design	- rigid or batt insulation (e.g. 4-6 mil polyethylene) plus vapour barrier especially on truss assembly - appropriate design gap between insulation and wall or ceiling for moisture drying in the event of penetration - good vapour barrier on areas in close proximity to fasteners	Applicable
3. Ventilation (in general)	- use of stacks or discharge tubes to release exhaust air away from the animal building - extension of insulation and vapour barrier from inside the building to underside of vented overhangs - chimneys installed intermittently between trusses for ridge ventilation - separate ventilation for barn interior and the attic	Applicable; extent of current application in Canadian swine/ livestock buildings not confirmed
B. Building Material Selection and Treatments		
1. Wood	- use of naturally durable wood	
Chemical preservation	- oil-based preservatives (Creosote oil) - fixed water soluble preservatives - organic solvent preservatives	Applicable
Impregnation of wood with polymers	- improve the physical and mechanical properties of low grade wood species - use of copolymer derived from allyl alcohol and methyl methacrylate (optimum compatibility and compressive strength perpendicular to fiber increased by approximately 100 times while water absorption was reduced by 50%; biodegradation did not occur)	Applicable; Further investigation of effectiveness against deterioration needed
Bio-control	- wood treated with urea and ureolytic bacteria (Proteus sp. and Bacillus sp.) - combination of Proteus sp. and Trichoderma viride to inhibit growth and kill fungi	Further investigation of effectiveness needed
Titanium dioxide nanoparticles	- used to prevent fungal Hypocrea lixii (white-rot) and Mucor circinelloides (brown-rot)) growth in wood - applied on surfaces by spraying or simple brushing	Further investigation of applicability/ feasibility for use in livestock buildings needed

Category/Potential Solution	Description	Applicability
2. Metal		
Stainless steel	- known resistance to dry corrosion (oxidation) and attack of acidic condensates	Applicable
G90 hot-dip galvanized (G90 HDG)	- treated with zinc phosphate - recommended by U.S Steel for metal connectors in animal housing, G90 zinc coating are typically used in Canada (G60 for US)	Applicable
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Duplex System	- e.g. G90 Duplex = G90 connector + paint and G185 Duplex = G185 connector + paint - G90 duplex or G185 connectors with vapour barrier and separate ventilation for attic space is recommended in animal buildings	Applicable
Avoidance of galvanic corrosion	- e.g. using stainless steel nails for stainless steel hangers and galvanized nails for galvanized hangers	Applicable
Use of other materials such as ceramic materials and polymers		Applicable
Galvanizing	- zinc layer application on steel and iron structures	Applicable
Coatings	- epoxy coating that is lead and chromate-free recommended for metal truss plates	Applicable
Repair of corrosion	- attacked metals - cleaning as a de-rusting method remains the advised method over use of rust converters	Applicable
3. Concrete		
Concrete mix composition	- use of sulphate-resistant binder-like type 50 Portland cement (equivalent to CEM IIIB concrete based on CSA A3000, 1998) as most effective among 8 concrete treatments - use of other supplementary cementing materials such as slag, fly ash and silica fume to minimize tricalcium aluminate (C3A) content of concrete mix - use of additives for concrete top layers (e.g. product "S" based on ground tuff) to increase life of concrete compared to regular sand-cement mix for top layer of animal housing flooring - also applies for protection of steel reinforcements	Applicable; feasibility and cost analysis needed for application in livestock buildings
C. Building Management/Production Practices		
Interior cleanliness and maintenance	- proper cleaning and disinfection; high pressure washing and use of cleaners to effectively remove aggressive residues and manure on surfaces - periodic inspection for leaks through vapour barriers and corrosion on connectors and fasteners - removal of corrosive agents from the attic and additional protective coatings must be provided to connectors	Applicable
Feeding method	- wet feeding method can make the degradation problem on barn floors worse - greater feeder-drinker distance to minimize lactic and acetic acid attack on concrete by the feed-water mix	Applicable
Others	- putting concrete or brick bin underneath nipple drinkers - protection of concrete floor itself by fibre cement-board, metal plate, rubber sheet, or a top layer "product S"	Applicable