Financial Perspectives on the Use of Vegetative Environmental Buffers for Swine Odor Management

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Summary and Implications

This multi-scale financial analysis begins at the farm level using discounted cash-flow methods to examine the costs of establishing and managing Vegetative Environmental Buffer (VEB) systems for swine odor mitigation in Iowa. Using a random sample of existing hog confinements throughout Iowa (n=60), site specific VEB systems were designed for each production site. Assuming each VEB was designed as a retrofit system, the full costs of establishing and managing VEBs were calculated for each facility. The effects of the cost share program, Environmental Quality Incentive Program (EQIP), were then examined.

On average for the state of Iowa, excluding all potential land rent costs, the present value of VEB costs comes to just under $4,200 over a 20-year period. This cost assumes that the VEB was planted with relatively low-cost seedling stock. If the operator chose to plant a VEB with older, larger (but more expensive) planting stock in an effort to "buy time", the present value cost more than doubles to almost $9,100 over a 20-year period. Across Iowa, upfront costs (costs associated with tree stock, site preparation and VEB establishment) ranges from 37% to 45% of total costs; the remainder costs are in the form of long-term maintenance of these tree systems. Across all of Iowa, the total costs per pig produced (over 20 years) comes to $0.04 per pig for the lower cost seedling options and $0.08/pig for the higher cost plant stock options. The cost share program, EQIP, can reduce total costs between 18% and 54% (low cost option and high cost option, respectively). The overall effects of EQIP are more pronounced when upfront costs are higher. For analytical purposes the effects of land rent (@ $177 per acre; 2008 state average) was factored in. On average, factoring in annual land rent for the area under trees on each site, total 20-year costs increase by 60% for the low cost position and by 23% for the high cost position.

Introduction

Tree-based Vegetative Environmental Buffers (VEBs) can be a cost-effective way for livestock producers to incrementally mitigate odors, particulates and ammonia emanating from their sites. Research supports the possibility of 6-15% reduction in odor and in certain situations possibly up to 50% reduction in ammonia and particulates. As air moves across vegetative surfaces, leaves and other aerial plant surfaces remove some of the dust, gas, and microbial constituents of airstreams while increased mechanical turbulence can boost the vertical mixing of air streams, thereby enhancing dilution.

Very little, however, is known about the financial requirements for installation (i.e. site preparation and planting) and long-term management of VEBs designed for air quality management. This lack of information has been identified as one of the chief barriers to swine producer adoption of this air quality technology.

Materials and Methods

A regionally stratified sample of Iowa hog production sites (n=60) was drawn from a 2006 Iowa Department of Natural Resources database listing confinement feeding operations in Iowa with registered manure management plans. Iowa was stratified into four quadrants (northeast, northwest, southeast, southwest) and a random sample proportional to the total number of facilities in each quadrant was drawn (n=60; NE = 17, NW = 25, SE = 10, SW = 8). A 2007 aerial photo of each sampled facility was obtained from the Iowa State University Geographic Information System orthophoto database and analyzed. A "to scale" site-specific VEB system was designed for each facility taking into consideration site-specific animal and out building configurations, roads, visible permanent vegetation, and manure storage facilities yet also following a general design template featuring common design standards for analytical consistency. A two-dimensional linear representation of that VEB system was then over-laid on each orthophoto. Each VEB design was then carefully measured to scale for total length and area under trees so that total trees required (by species) and total land area to be managed over the long-run (e.g., 20 years) could be calculated and financially analyzed. Additionally, in order to express costs on a per animal produced basis, the pig space capacity of each facility was estimated by measuring the dimensions of the animal buildings and dividing the area by 6 feet/ pig of growing space.

For each VEB design, there were at minimum two tree species used: Austree willow (*Salix matsudana x alba*) and Eastern Red Cedar (*Juniperus virginiana*). The shrub species Red Osier Dogwood (*Cornus stolonifera*) was also included in several designs. All VEBs were in two-row arrangements with a standard of 9 feet between trees and 20 feet between row planting configurations. No tree rows were located < 100 feetto the north of all buildings and/or roads to account for winter snow deposition; no tree rows were located < 100 feet to the south of all buildings to account for

needed summer wind-flow (this is particularly critical for curtain walled or otherwise naturally ventilated facilities).

See Figure 1 below for a general example of a modeled VEB system. Table 1 displays average designed VEB parameters and average sampled production site parameters across all four regions in Iowa. These measurements served as the chief parameters for the farm level economic analysis.

In general, total costs for VEB systems designed for odor mitigation are highly variable and site/VEB specific. Still, there are consistently four main categories of expenses associated with VEBs: 1) Site prep costs, 2) tree stock and establishment costs, 3) long-term maintenance costs, and 4) land rent (opportunity costs). All costs used in this analysis were determined using recent IDNR State nursery prices, farm custom rate surveys (from ISU Extension), and when needed, transaction evidence. Additionally the financial analysis consisted of two planting stock cost options: 1) planting stock at seedling prices (e.g. 2-3 year old stock); and 2) older planting stock prices (e.g. 6 + year old stock). The cost-reducing impact of the Environmental Quality Incentive Program (EQIP) was factored into the analysis.

The farm level analysis considered a time horizon of twenty years. Twenty years is considered reasonable, as the average life span of typical hog facility ownership has been estimated to be between 15 and 20 years. The analysis was carried out across a range of discount rates (5%-8%), however the costs presented in table 2 below reflect a 7% real alternative rate of return (RARR). It is also assumed that each facility accepts the same level of investment risk regarding the use of trees.

All costs were discounted using standard discounting formulation. The general cost model is:

$$PVC = PVSB^{SP} + PVSB^{E} + PVSB^{M} \qquad [1]$$

Where PVC = Present value of total costs; $PVSB^{SP}$ = Present value of VEB site preparation costs (includes tilling or otherwise preparing land for tree planting); $PVSB^{E}$ = Present value of VEB establishment (includes all planting stock, actual planting and other related actions); and $PVSB^{M}$ = Present value of VEB maintenance needs (includes activities such as: weed management and tree/shrub replacement).

For the purpose of presenting the costs in multiple ways, the total discounted costs for each scenario are then converted into equivalent annual value (EAV) of costs using a capital recovery factor:

$$EAV = PVC * CRF \qquad [2]$$

$$CRF = [\, i(1+i)^{N}] / [(1+i)^{N} - 1] \qquad [3]$$

Where CRF is the capital Recovery Factor, i = annual real discount rate, N = number of years in the evaluation. The EAV annualizes all costs and allows pork producers to examine costs more easily across a long term planning horizon. Dividing the EAV of each VEB scenario by the number of pigs produced annually presents total costs as per unit of production costs (per pig) and spreads the costs out across all the pigs produced in a twenty-year period. This method is deemed appropriate because the VEB systems are designed to mitigate swine odor over an estimated ownership span and, therefore, costs are spread over all the pigs produced at that facility over a 20-year period.

The calculated costs of the various VEB models were aggregated and averaged across the four Iowa regions and then presented in a number of ways. The average present value of costs (at 7% ARR) for each region was calculated to capture the total costs of establishing and maintaining the VEB over a 20-year period. This was calculated with and without land rent factored in. Additionally, because across Iowa, upwards of 45% of the total cost to producers comes during the site preparation and establishment phase (primarily from the costs of the planting stock), "up-front" costs are isolated and presented. Moreover, costs per pig produced over a 20-year period are presented. Finally, total costs were calculated to display the effects of existing EQIP funding. It should be noted that currently not all EQIP programming at the county level in Iowa accepts VEBs as a Best Management Practice for air quality and those counties that do may have different EQIP payment parameters. Because of this, the EQIP program established by Crawford County was used for analytical purposes; Crawford County pays out 50% cost-share for average VEB establishment costs (assuming practice Code 380 – "Shelterbelt").

Results and Discussion

Examining first the low-cost scenarios (based on seedling prices for planting stock), producers in SE Iowa would experience the lowest average costs of $3,896 total for establishing and managing a VEB system over a 20-year period (Table 2). Producers in SW Iowa would face the highest costs of $4,500 per site. In terms of upfront cost only, there is just a $229 difference between high and low costs ($1,671 versus $1,447). Across all of Iowa the total costs per pig produced (over 20 years) comes to $0.036 per pig. Overall, EQIP reduces total 20 year costs by 18% and upfront costs by just under 50%. Per pig costs are lowered by almost a penny per animal. As yet another way to think about costs, with the low-cost situation, the total costs come to about $1.40 per linear foot of VEB.

As compared to the lower cost scenario, the high price scenario (based on older, more expensive planting stock) raises total costs by an average of 118% (for an Iowa wide average of $9,080 per site) and upfront costs by over 167% (to an Iowa wide average of $4,122 per site). The overall effects of EQIP are more pronounced when upfront costs are higher with the cost-share benefits reducing total costs by 54% (upfront costs are consistently reduced by just under 50%). In the high-cost situation, per pig costs more than double on average to about $0.08 per pig; EQIP cuts the

cost per pig roughly in half. With these higher plant costs, the VEB itself comes to about $3.05 per linear foot.

It should be noted that ultimately with VEBs, the total costs are contingent upon the initial choice of planting stock, the relative long-term health and maintenance of the system, and the choice of long-term weed control (i.e. chemical or mechanical weed elimination; use of organic or synthetic mulches, etc.). With drier soils, a drip irrigation system may be necessary and would add roughly $0.01/ per pig produced.

For most swine producers in Iowa, the land for the production site is not considered active cropland and land rent is therefore not a constant financial factor, however for space limited facilities (e.g., not enough room on the production site for planting trees) surrounding land area (likely cropped) may need to be rented or if owned by the producer, forgone. For analytical purposes, the effects of land rent were factored in; the 2008 state average of $177 per acre was used. On average, factoring in annual land rent for the area under trees on each site, total 20 year-costs increase by 60% for the low cost position and by 23% for the high cost position. Table 2 below displays the full range of costs per scenario for all four regions in Iowa.

Previous research has determined that the mean willingness to pay (WTP) for the use of VEBs among Iowa hog producers is $0.14 per pig produced annually. Therefore based on this cost analysis all of the calculated expenses are considerably under what Iowa producers are WTP. For the low-cost scenario the costs are about $0.10/ pig under producer WTP ($0.11/pig with cost share); for the high-price scenarios the costs are between $0.05 and $0.06 below producer ($0.10/pig with cost share). This result suggests that VEBs would be a financially feasible technology for Iowa producers to utilize to incrementally mitigate odors.

Acknowledgements

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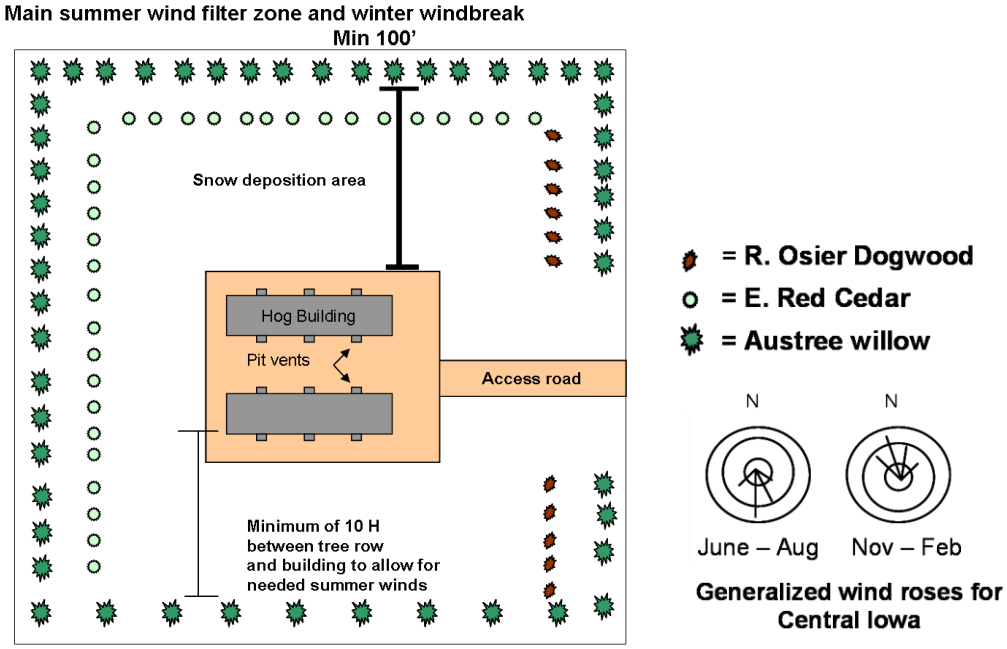

Figure 1. Example general VEB design for a two building swine finishing unit. All model VEBs were designed for Central Iowa wind patterns. Ultimately, VEB designs (e.g. planting patterns and on-site location, species used) will be variable and site specific.

Table 1. Average designed VEB parameters across all four Iowa regions (n=60).

	NE	NW	SE	SW
Average total length of tree rows (ft)	2,678	2,721	2,631	2,979
Average total length of shrub rows (ft)	227	305	127	236
Average area under trees & shrubs (ac)	1.28	1.32	1.24	1.42
Average # of trees per site	300	302	292	331
Average # of shrubs per site	64	34	42	30
Average sampled production site parameters				
Average number of animal head per site	5,200	6,600	4,800	7,500
Average number of buildings on site	2.4	2	2.6	3.8
Percent of sites with existing trees	50%	43%	28%	13%

Table 2. Summary of the total VEB costs at 7% (real ARR) for each region in Iowa. All costs are in 2008 dollars US.

Low cost scenario [1]					
Costs without cost-share	**NE**	**NW**	**SE**	**SW**	**Iowa**
Present Value Costs w/o land rent	$4,064	$4,149	$3,896	$4,519	$4,157
Present Value Costs with land rent [2]	$6,821	$6,970	$6,514	$7,593	$6,975
Upfront costs (Site prep & establishment)	$1,507	$1,539	$1,442	$1,671	$1,540
Total costs per pig [3] produced (20 yr period)	$0.039	$0.036	$0.035	$0.035	$0.04
Costs with cost-share (EQIP) [4]					
Present Value Costs w/o land rent	$3,329	$3,399	$3,193	$3,704	$3,406
Present Value Costs with land rent	$6,086	$6,220	$5,811	$6,778	$6,223
Upfront costs (Site prep and establishment)	$773	$789	$739	$857	$789
Total costs per pig [3] produced (20 yr period)	$0.033	$0.029	$0.028	$0.028	$0.03
High cost scenario [1]					
Costs without cost-share	**NE**	**NW**	**SE**	**SW**	**Iowa**
Present Value Costs w/o land rent	$8,878	$9,063	$8,522	$9,881	$9,086
Present Value Costs with land rent [2]	$11,635	$11,884	$11,140	$12,955	$11,904
Upfront costs (Site prep & establishment)	$4,025	$4,103	$3,889	$4,473	$4,123
Total costs per pig [3] produced (20 yr period)	$0.086	$0.079	$0.076	$0.076	$0.08
Costs with cost-share (EQIP) [4]					
Present Value Costs w/o land rent	$4,588	$4,681	$4,416	$5,105	$4,698
Present Value Costs with land rent	$7,345	$7,502	$7,035	$8,179	$7,515
Upfront costs (Site prep and establishment)	$2,032	$2,071	$1,963	$2,258	$2,081
Total costs per pig 2 produced (20 yr period)	$0.045	$0.041	$0.039	$0.039	$0.04

[1] Low price scenarios: 15" cuttings of Austree = $1.00/tree; 12"-18" Eastern red cedar = $ 2.50/tree, 12"-18" red osier dogwood = $1.50/shrub; High price scenarios: potted Austree = $ 7.50/tree; 18" – 24" potted Eastern Red cedar = $ 12.50/tree, 4 year old Red Osier dogwood = $3.50/ shrub.

[2] The 2008 average (Iowa) land rental rate was used at $177 per acre.

[3] It was assumed that for each modeled facility there are 2.2 turns of animal stock per year.

[4] The EQIP parameters modeled were from Crawford County, Iowa - NRCS Practice code 380, windbreak establishment for air quality (objectionable odors, particulate matter), payment equals 50% cost share on average cost.