Title: Evaluation of the Effectiveness of the ISU Community Assessment Model in the Siting of Swine Production Units **- NPB#07-231** (revised)

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Industry Summary: It's neither fun nor wise for rural communities to experience ongoing conflict related to odors from farming. The example of hog farming in Iowa provides a look at a conflict resolution tool called CAM (Community Assessment Model for Odor Dispersion). The model takes into account local conditions (weather, neighbors, other sources, etc), and provides a process by which rural residents and farm operators come to terms on decisions to expand or build a new facility. The actual cost of running the CAM model is roughly $1,000 per site, mainly ISU extension and faculty salaried time. 75% of the producers surveyed rated the modeling as "useful" to "very useful" in their risk management process. The evaluation showed that the CAM model influenced producers' decision on whether to build new facilities. For the majority of producers who used CAM, the potential impacts to their neighbors factored heavily into decisions. To that end CAM was believed to be very important to their siting process. A high majority (95%) of the producers clearly understood the model results. Over half of the producers in turn communicated these results to their neighbors of which one third were considered positive interactions. Overall, for producers who went on to build at sites that were modeled there was a significant improvement in neighbor relations.

Rural residents were surveyed about their attitudes about the swine industry and modeling. It was found that people acknowledge the importance of the pork industry but have concerns about the environment and impact on property values. In general they believe that rural residents should have tolerance of odors and that large facilities, with proper management, can be environmentally benign. There are some concerns for the rights of rural property owners. The willingness to tolerate odors is a key model input. More than one third of those surveyed (39%) thought that an exposure to strong odors should be less than1/2%, or 30 minutes every 4 days. When asked about moderate odors, 22% felt it should be less than 30 minutes, with 34% feeling that over 2 hours every 4 days would be acceptable.

Scientific Abstract: The community assessment model (CAM) for odor dispersion is a tool to help site hog production facilities. CAM considers the size and type of a swine production system, local historical weather conditions, and odor control implementation. It predicts the number of hours of exposure to various levels of odor, by month, for each receptor in a given community. A follow-up

survey of all CAM users since 2005 was conducted. The survey was designed to provide: 1) formative feedback for programming adjustments to improve extension efficiency, usability and reduce costs, and 2) summative feedback used to provide an indirect baseline assessment of the broader impact that CAM has had on reducing odor related conflict. For the majority of producers who used CAM, the potential impacts to their neighbors factored heavily into their decisions. To that end CAM was believed to be very important to their siting process. A high majority (95%) of the producers clearly understood the model results. Over half of the producers in turn communicated these results to their neighbors of which one third of these were considered positive interactions. Overall, for producers who went on to build at sites that were modeled there was a significant improvement in neighbor relations. As CAM continues to evolve as a tool, by integrating more key odor dispersion parameters and calibrating for different species, it will be critical for support programming and producer interaction protocols to similarly develop. This process will be important in the future as the state of Iowa has passed legislation that would, when funding is made available, integrate the use of CAM into odor management policy.

Rural residents were surveyed about their attitudes about the swine industry and modeling. It was found that people acknowledge the importance of the pork industry but have concerns about the impact on property values and quality of life. In general they believe that rural residents should have tolerance of odors and that large facilities, with proper management, can be environmentally benign. There are some concerns for the rights of rural property owners. The willingness to tolerate odors is a key model input. More than one third of those surveyed (39%) thought that an exposure to strong odors should be less than1/2%, or 30 minutes every 4 days. When asked about moderate odors, 22% felt it should be less than 30 minutes, with 34% feeling that over 2 hours every 4 days would be acceptable.

Introduction: Reducing the social impact of odor emitted from livestock production facilities has long been a primary management goal for livestock and poultry industries (Hogberg et al., 2005; Honeyman, 1996). Of particular concern is the potential for livestock odor to negatively impact rural and state economies, human health, and the quality of rural life (Huang and Miller, 2006, Korsching et al., 2004). Iowa, the nation's leading hog producing state, serves as an excellent case study as the risk for odor related nuisance litigation appears to be on the rise (Heber and Bogan, 2006; Lee, 2004; Korsching et al., 2004). Nevertheless, as noted by Otto and Lawrence (2004) the overall importance of the pork industry in Iowa is not in question as an estimated $2.02 billion of personal income and $3.02 billion of gross state product are supported by the swine industry (based on 2002 levels of production). Additionally, hog farming in Iowa continues to be an important pull into agriculture for young and beginning farmers (Vansickle, 2007); this being a distinct counter-trend to what has been observed in Iowa with regards to crop farming (Duffy, 2004).

For all of these reasons, it has been strongly cautioned that for the consideration of economic sustainability, a state like Iowa cannot afford to depress it's swine industry by way of legal actions (such as odor nuisance lawsuits), in short, "It's important to the state's economy that (swine) production flourish here, but in a manner that respects the outdoors, health concerns and the quality of life" (Des Moines Register Editorial Board, 2002). To this end it's been said that the sustainability of industries within agriculture will be shaped by their collective ability to improve environmental impact technologies (Kliebenstein, 1998). As this is a risk management issue it is advisable for producers to be proactive with regard to odor management planning and communication with neighbors (Sharp, 2005). One of the main ways in which producers can be proactive is in determining appropriate sites for new construction or to determine if an existing site can expand. Current siting requirements for new livestock and poultry production systems are based mainly on animal units and distance to the nearest neighbor independent of direction (eg. Iowa DNR, 2005; Missouri DNR, 2006). Separation distance alone does not account for existing odor sources in a community, nor the influence of localized weather patterns on odor dispersion. A science-based approach requires the use of physics to predict the odor impact on neighboring receptors in order to develop a procedure for making decisions on where a swine facility of a given size could be placed in a community with or without a pre-existing odor load. In this manner, siting decisions could be made using key odor dispersion variables such as historical weather patterns, size of production facility, odor control measures implemented, and existing odor loads in a community.

Most all models associated with gas dispersion use some form of the Gaussian Plume model (Turner, 1994; Guo et al., 2004). The Gaussian Plume model has persisted over time as a reliable model that predicts reasonably well the dispersion of gases from stationary sources. With appropriate field calibration data comparing odor dispersion from animal sources as a function of atmospheric stability, it is believed that an appropriate tool for siting of animal production systems can be developed and more importantly, used in practice. The objective of an odor dispersion model of this type is to describe the historical average conditions that receptors in a community of animal production systems might experience. The goal of the model developed with this approach is not to develop a procedure that describes odor transmission on an hour-by-hour, day-by-day, etc. basis. Instead, historical average conditions, along with parameters that reasonably describe odor sources, are implemented in an attempt to provide a siting tool that predicts historical average expectations. When a facility is built in a community, it is felt that the long-term implications are more important than the day-to-day implications of having a production facility in a community.

Hoff et al. (2008) developed the community assessment model for odor dispersion (CAM) in which parameters were used to predict odor strength levels downwind from multiple sources to multiple receptors. CAM can currently model up to 20 swine-related sources and up to 100 receptors in a land base of any size. The model is intended as a tool to help site new facilities and to evaluate the effectiveness of odor control technologies for both new and existing facilities. CAM considers the overall size of a swine production system, the type of swine production system (production phase), local historical weather conditions, and odor control mitigation strategies which have been implemented. It predicts the number of hours of exposure to various levels of odor, by month, for each receptor in a given community. This final distinction is very important. CAM can be classified as a receptor-based model versus a source-based model. CAM views odor dispersion from a receptors point-of-view, determining the odor impact on each receptor from all sources in the community, a newly proposed source as well as from all existing sources. This is in stark contrast to a source-based model where in general circles of odor influence around the source are predicted, with no direct link to each and every receptor in the community.

To date CAM has been used in the state of Iowa for over 150 specific cases since June, 2005. The implementation of CAM has been a voluntary process, initiated by the producer and implemented through a joint effort between the Coalition to Support Iowa's Farmers (CSIF), the Iowa Pork Industry Center (IPIC), and faculty with Iowa State University's College of Agriculture and Life Sciences. The estimated total expense (currently free to the farmer) to implement CAM is $1,000 per siting case.

Objectives: The objectives of this project were to:

1. Evaluate the effectiveness of the producer's experience through the modeling process including the impact it has had on neighbor relations;

2. Seek producers with successful and less successful model runs in order to analyze their experience and the perceived accuracy of the model through case study development;
3. Conduct a neighbor survey of up to four selected siting cases to compare CAM predictions with each neighbor's perception on accuracy of the predictions;
4. Analyze the needs of CAM users to determine what educational supplements would make the model results more understandable and helpful.
5. Develop educational supplements to meet producers' needs.

Materials and Methods: This project was undertaken in two phases. Phase one surveyed swine producers to gather information on their impression of the effectiveness of CAM. (objectives 1,2,4,5) The second phase surveyed community members to evaluate their impressions. (objective 3)

Producer Survey

In total, 85 producers who utilized CAM since 2005 were targeted for interviews. These producers were identified as having had enough time since the modeling to have reasonable insights into the process and discuss their opinions regarding post-modeling outcomes. The survey was conducted via telephone interviews and followed Dillman's (1999) tailored design telephone survey protocols. Data was collected by the Center for Survey Statistics and Methodology (Iowa State University) in the Fall of 2008. Ten of the producers were re-classified as ineligible (e.g., in six cases the modeling had been done too recently to provide significant insights; three producers did not recall participating). This resulted in an eligible sample of 75. Interviews were completed with contact people for 62 of the facilities, for a response rate of 82.7%.

The survey tool was designed to elicit evaluatory information regarding several key areas of the modeling and extension process and to provide background information on the producers/production systems who sought siting assistance. Specifically, questions covered: 1) overall producer impressions regarding the modeling and extension process, 2) the understandability of the model and model results, 3) producer impressions on the ability of the model to predict odor exposure, 4) overall effect of model process and results on producer decision making, 5) characterization of neighbor and community relations before and after the modeling process and finally 6) details about the producers themselves.

Community Survey

The original plan was to talk to actual neighbors of modeled sites, but after further contemplation, it was decided that this might create problems for the cooperating producers. Therefore, it was decided to take more of a global approach to assessing neighbor attitudes.

It has long been viewed that concern regarding livestock odor is as much a function of social factors as physical and management factors (e.g., ASAE 1999; Mikesell et al., 2004). In order to capture the kinds of information that, apriori, was believed would be able to help explain citizen acceptability of CAM modeling the survey tool was divided into seven different categories of citizen information. These information categories are as follows:

1. Respondent demographic characteristics.
2. General satisfaction with living in respective communities.
3. Degree of farming experiences.
4. General attitudes & concerns about rural environmental quality.
5. Beliefs about the importance of the swine industry in Iowa.
6. Experiences with and attitudes about swine odor.
7. Social acceptability of and trust in CAM modeling.

Three counties were selected to serve as the population base for telephone based citizen surveys based on the general criteria that they are counties where CAM would have distinct application due to the following specific three criteria (see table 1 below for the summary details of the three selected counties):

1) The county has experienced a significant increase in hog population (> 40% increase) between agricultural censuses 2002-2007. This criterion ensures that residents will likely have (to some degree and in various ways) an awareness of industry *expansion* (e.g., via local media, seeing new buildings, encountering increased transportation, increased extension activities, etc.).

2) The county is within the top 50 counties in total hog population. This criterion ensures that the hog industry has a significant presence within the county – (e.g., hog numbers, facility numbers, related transportation infrastructure, local and regional economic impact, etc.).

3) The county is mostly rural – e.g. few if any large towns/cities (> 5,000 people). This criterion minimizes the chance that survey respondents are urban and therefore less likely to be directly (at their home) impacted by livestock odor.

Table 1. Counties surveyed regarding CAM and the selection criterion statistics, 2009.

County	Hog population increase 2002-2007 [1]	Total county hog population (2007)	Total county human population (2007)
Crawford	52%	345,000	16,900 (9,600) [2]
Osceola	45%	452,000	7,000
Franklin	45%	600,000	10,700

[1] USDA, NASS. 2007 Census of Agriculture, Iowa – County Data

[2] Based on the 2000 US Census 7,300 people live in the city of Denison; The zip code for Denison (51442) will be excluded from the survey in order to fulfill the "rural population" criteria ; therefore population size is effectively 9,600.

The Center for Survey Statistics and Methodology at Iowa State University (http://cssm.iastate.edu/) was retained to perform all data collection activities. As it is believed that most rural Iowans (80 - 90%) have telephone land-lines and are reasonably likely to have listed phone numbers (Blumberg 2009), telephone interviews were determined to be the best option for the collection of this data. Therefore a white pages sample of 1,050 telephone numbers with associated names and addresses was purchased from Survey Sampling International (http://www.surveysampling.com/). The sample contained 350 listings for each county, divided into a base sample of 300 with a replicate of 50 for each county. The goal was to obtain a minimum of 300 completed interviews with 100 in each of the three sampled counties. Within each household that was contacted, the adult with the next birthday was selected to represent their household by completing an interview. This is a well established method of selecting one respondent per household in a manner that should approximate the population as a whole.

Response rates for completed interviews are calculated as the percentage of interviews completed out of the eligible sample. Response rates were 31.8% in Franklin County, 36.1% in Osceola County, and 39.6% in Crawford County, with an overall average of 35.7%.

Results:

Producer Survey *(Objectives 1,2,4,5)*

Description of the CAM Process

Currently, there are quite a few outlets that feature information regarding CAM and related extension programming. In terms of learning about the model and modeling process, for 81% of the participants the not-for-profit (501 c 6) organization (and programming partner) the Coalition to Support Iowa's Farmers (CSIF) has been the main source of information. Iowa State University extension via multiple nodes (e.g., personal communication, workshops, and conferences) was the next top source of information regarding CAM with 29%. The Iowa Pork Producers Association and the Iowa Pork Industry Center were mentioned by about a fourth of the respondents. The other responses to this question (e.g. other producers, pig suppliers/integrators, Farm Bureau, attorney) indicate a degree of "word-of-mouth" exposure. Table 2 below summarizes the most used sources of CAM information.

Table 2. Top sources of information where producers learned about the CAM model process (n=62). Note that producers were able to list more than one source.

Source of Information	Percent of Producers
The Coalition to Support Iowa's Farmers (CSIF)	81%
Iowa State University Extension (e.g. personnel, workshops, conferences)	29%
Iowa Pork Producers Association	25%
Iowa Pork Industry Center (IPIC)	22%
Someplace else[a]	16%
Another producer	15%
A pig supplier or integrator	13%

[a] Farm Bureau (8%), attorney (5%), "Our feed guy" and Corn Growers Association (3% combined).

The modeling process begins when a producer contacts personnel associated with the CSIF and formally requests that a model be conducted for a proposed site (or sites; note that existing sites can also be modeled). The use of CAM requires an on-site visit to assess and map community receptors and existing animal-related odor sources. The mapped data is then brought to the Department of Agricultural and Biosystems Engineering (ISU) where one of two faculty members run the CAM. At the conclusion of a CAM modeling run, a staff member from IPIC conducts a follow-up site visit with the farmer to present and explain a one-page report regarding the CAM predictions.

From the producer's perspective timeliness is a critical part of the modeling process as producers are making capital intensive decisions that may be time-sensitive with regard to obtaining financing, making land bids, and pursuing appropriate permits. A high majority of respondents (82%) felt as though the time between their request for modeling and the delivery of the report was acceptable. Overwhelmingly, 98% the producers felt as though they were given significant opportunity to provide input into the modeling process. Key producer input includes the accurate description and identification of the potential site(s), the anticipated scale and type of operation, and the thought process and determining factors the producer used to decide on a potential site; this information being highly critical to modeling a location accurately.

Of significant importance to the future of CAM programming is the cost of the modeling process. While currently free to the producer, CAM is a labor intensive procedure and therefore costly (≈ $1,000 per producer request; includes faculty and staff labor, travel and computer time) and yet involves considerable direct input from the producers. Therefore determining ways in which the producer could further help make the process more efficient and reduce overall costs is critical. Forty-two percent of the respondents felt that there were portions of the modeling development that they could have done on their own. Knowing these activities will help guide future instruction protocols to facilitate greater producer involvement. In terms of activities producers felt they could have done prior to modeling, the mapping of planned site(s) (using downloadable orthophotos, platt maps and/or manure management plan documents) and separation distance assessment between site and neighboring homes, business, and wells were the most often mentioned tasks (by 24% of the producers). Another main task mentioned (by 8% of the producers) was the prior logging of critical numbers (e.g. planned number of animals, building orientation, building/ventilation type, etc.) perhaps via a standardized on-line template.

Seventy-seven percent of the producers stated that a website showing examples of model results would be useful to them. There were also calls for a web based data entry template which is believed to be a useful way for producers to submit information directly and thereby reduce analysis time. This was particularly true for integrators with multiple modeling requests. Additional to the internet providing an opportunity for better upfront data exchange, responses to the open ended question "From your perspective, how could the process of executing the model be improved?", two of the main response themes involved the ability to view the results of their model online and the availability of electronic displays (examples) of well labeled/explained data. However there where a small handful of producers who wanted more site visit opportunities – something that a web-based interface might discourage. Just under half (48%) of the respondents felt that the current process for executing the model from initial contact to receiving final results served their needs well.

Producers's Understanding of the Model

Because of the inherent complexity of the model itself (e.g., the computational rigor, the number of factors being assessed, interpretation of results) conveying these complexities succinctly and accurately is critical to the extension process – informed decisions hinge on the transparency of the process and the understandability of the results. The higher degree that producers understand the model parameters and can interpret the results, the more effectively they can assess the risks of siting their production facilities. This also can lead to greater program efficiency with fewer steps and fewer errors. Just as importantly, the better producers understand the process the better they should be able to explain results to neighbors. Overall, the vast majority (92%) of the producers felt that the CAM results were explained to them "well" to "very well" (42% to 50% respectively). In turn the information accounting process translated similarly into degrees of general model understanding with 95% stating that they understand the model results "well" to "very well" (50% to 45% respectively).

The two main parameters of CAM that are critical for producers to understand are the number of hours of odor exposure and odor dilution levels. As explained in Johnson (2006) the modeling is conducted for odor exposure during a March to October (8 month) time-frame to correspond to the period of time when residents tend to spend a lot of time outdoors. The modeling procedure assesses a given site based on the percent time exposure of a residence to various levels of odor. Currently, site selections are judged based on a limit of a 1 percent time exposure to a 2-to-1 (2:1) odor and a 0.5 percent time exposure to a stronger 7:1 odor. CAM predicts the number of hours of exposure for weak (2:1 dilution factor) and greater or identifiable (7:1) and greater odors. For example, an odor concentration of 2:1 means it would take two volumes of fresh-air mixed with one volume of odorous air to make the odor “barely detectable”. Additionally a few states (e.g., Colorado Wyoming and Missouri) use an odor concentration of 7:1 to assess whether an operation is in compliance relative to odor (Johnson, 2006; Powers, 2003). Eighty-six percent of the interviewed CAM users stated that they understand the concept of hours of exposure well to very well (42% to 44% respectively). A lower, but still majority percentage of producers (56%) understand the concept of odor dilution factors well to very well (32% to 24%); just under a third (32%) stated they understand dilution moderately well. These levels of understanding in turn translate fairly well in terms of the farmers being able to explain the results of CAM to neighbors. Sixty percent believe that they understand the model well enough to explain the results to others; 36% could explain the results moderately well. Communication with neighbors is consistently listed as a key to preventing or mediating conflict (Caldwell and Williams, 2003). Being able to convey technical information using the terms of the model was noted by many of the CAM using producers as being an important component in maintaining their community relationships (see the Neighbor Relations section below). Table 3 below summarizes how well these CAM users understand the model.

Table 3. Degree to which participating producers understand the results of the Community Assessment Model.

Understanding the CAM model	Not well at all	Not Well	Moderately well	Well	Very Well
Overall, how well was the CAM model results explained to you?	--	2%	6%	42%	50%
How well did you understand the CAM model results overall?	--	2%	3%	50%	45%
How well do you understand the concept of hours of exposure	3%	3%	8%	42%	44%
How well do you understand the concept of odor dilution levels?	3%	8%	32%	32%	24%
How well could you explain the model results to others?	--	4%	36%	45%	15%

An open–ended follow up question asked the producers “What would help you to understand the results better” and the top requests were for more time to be spent with the explanation process that would, in addition, include periodic extension follow-up. There were also some requests for “cheat-sheets” in the form of official documents/materials that could be used for explaining the modeling process to neighbors.

Influence of the Model on Producer Behavior

Sixty-eight percent of the respondents opted to build the sites that were modeled with CAM; 32% were not built. Overall, just under half (48%) of the respondents stated that the model results directly affected their decision on whether to build or not. Fifty percent of the producers who opted not to build indicated that the model contributed directly to their decision. For the other half that did not build for reasons other than the model results, 15% opted out strictly for financial reasons (due mostly to a mix of low hog prices and high feed costs); another 10% did not build largely due to pre-existing social pressures regarding odor though the model results did confirm their original concerns. Of the 68% of producers who did build, 26% said they built largely because it was located close enough to their cropping operations that they could utilize the manure (or that they had manure buyers in mind), though the model did confirm their original opinions that the location was a good one.

According to 74% of the producers, the model verified what they already suspected regarding the viability of the site being modeled. Based on the subjective assessment of the producers who did build, 36% feel as though the model predicted what actually happened in terms of odor exposure "very well" and 31% said it predicted "well". Another 14% said that the model has predicted "moderately well" and 14% stated that it is still too early to tell. Only 5% think that the model's predictions ended up being incorrect (underestimating the impact they would have on neighbors).

Just under half of the participating producers (47%) indicated that they were surprised by some of the results. Based on 29 responses to an open ended probe question the top surprises were: 1) that the model predicted less of an impact than expected (this from 13 producers), 2) the prevailing wind direction turned out to be in a different direction than previously believed (9 comments to this effect), and one producer expressed surprise in just how far odor can travel. Only one producer said that he was surprised the model predicted a greater than anticipated impact on neighbors.

Neighbor Relations

A high majority of the producers who had sites modeled by CAM (81%) stated that their overall concerns regarding the potential impacts to their neighbors factored heavily into the decision to build or not. Almost half of the sites assessed with CAM were located less than one-half mile from the nearest non-relative neighbor, another 48% were located within one-half and one mile.

Fifty-eight percent of the producers who used the CAM subsequently communicated the modeling process and results of the model to neighbors (40% did not; 2% of the corporate producers were not sure). A third of the time, neighbors responded to the modeling results positively to very positively (25% and 8% respectively). Almost another third (31%) of the neighbors reportedly reacted in a neutral way and another 30% reacted poorly to very poorly (22% to 8% respectively).

The producers were asked to rate (on a 5 point scale; 1 = very poor, 5 = excellent) their relationship with proximal neighbors at the time of modeling and, if construction took place at that location, afterwards. The overall mean score at the time of modeling was a 3.39 meaning that by and large the relationships were moderate leaning toward being "good". Breaking this down, 56% of the producers said that at the time of modeling their relationships with proximal neighbors were good to excellent (33% to 23% respectively). Twenty-three percent stated that their neighbor relations at that time were poor to very poor (15% to 8% respectively). After the modeling, 40 producers went on to build at the modeled site. After construction, the overall mean score shifted distinctly to the "good" category with a statistically significant mean score change to 3.60 ($F = 13.591$; $p = .0001$). Eight of the producers moved into improved relations with their neighbors after modeling (five moving from poor to moderate or good, two moving from moderate to good and one moving from good to excellent). Three of the producers, however, saw their relations become worse with one of them experiencing an excellent relationship becoming very poor after constructing the facility. Table 4 below summarizes this data. For those producers whose neighbor relations improved, we asked the producers to weigh-in on what they saw as the factors that led to the change. By and large for those producers whose relations improved the leading factor was that "things (e.g. odor, noise, flies) didn't turn out to be as bad as they (the neighbors) originally assumed they would".

Table 4. Producer ratings of neighbor relations during time of modeling and after construction. On a scale from 1 to 5, where 1 means very poor relationship and 5 means an excellent relationship

			Producer Rating of Neighbor Relations				
Timing	Total n	Mean Score [a]	Very Poor	Poor	Moderate	Good	Excellent
During modeling	62	3.39	8%	15%	23%	33%	23%
After construction	40	3.60 [b]	8%	5%	28%	40%	20%

[a] On a scale from 1 to 5, where 1 means very poor relationship and 5 means an excellent relationship
[b] Significantly different, F = 13.591; p = .0001).

Overall, 75% of the producers rate the usefulness of the modeling process and results as useful to very useful (23% to 52% respectively); 15% viewed the CAM process as moderately useful. Ten percent indicated that the CAM process was not particularly useful, however, this conclusion appears to be an artifact of the situation that most of these producers likely would not have built regardless of the model results as they opted not to build for financial reasons.

In response to a final open-ended question asking producers what if any suggestions they might have about how individual pork producers can effectively deal with neighbor or community concerns regarding their production facilities, 46% of the CAM users stated that direct and personal communication ("face to face") with neighbors is absolutely key. To that end it was mentioned repeatedly that scientific information (such as that provided by CAM) from a place like Iowa State University distinctly can help convey objective perspectives on potential odor issues. Some producers suggested that site modeling should be mandatory. Many producers additionally added that "open-houses", "complimentary pork gifts", and gifting manure also can go a long way to strengthening neighbor relations. Finally it was mentioned by 16% of the producers that working with organizations like CSIF is definitely a plus, partly because these organizations can get producers in touch with programming such as CAM but also because they are skilled at mediating difficult situations.

Producer Demographics and Characterization of the Facilities Modeled

The average age of the producers who utilized CAM is 45. In terms of ownership structure half of the producers who used CAM are contract growers, 26% are owner producers, 10% raise both their own hogs as well as others on contract, and 8% are corporations. Forty percent of the CAM users generally have between 1,000 and 5,000 head of pigs in their total operation, 36% have over 10,000 pigs at any one time. Since 2005, just under three-fourths (74%) of the producers utilizing CAM had only one site modeled, 18% had two options modeled and 5% and 3% had 3 to 4 different sites modeled respectively.

A diversity of facility types and planned production scales have been modeled by CAM. The majority (69%) of the planned production sites modeled were for 1,000 to 2,500 head facilities. Forty five percent of the buildings were tunnel ventilated with another 36% being side-wall curtain systems with periodic mechanical ventilation, the rest (19%) were designed to be 100% natural ventilation systems. The vast majority (95%) of the modeled facilities included a deep-pit manure storage system. Table 5 below displays these general production details.

Table 5. Characterization of modeled facilities and general production details.

Characterization of the Facilities Planned	Percent of Producers
Number of potential building sites modeled per producer	
1 site	74%
2 sites	18%
3 sites	5%
4 sites	3%
Production type	
Wean to finish	73%
Grow/feeder to finish	26%
Production scales modeled	
< 1,000 head	7%
1,000 – 2,500 head	69%
2,501 – 5,000 head	14%
5,000 head +	9%
Ventilation Systems	
Tunnel ventilated	45%
Hybrid -curtain walled	36%
100% natural	19%
Manure storage	
Deep pit	95%
Compost	5%
bove ground (concrete or steel)	2%
lagoon	2%
	0%

Community Survey *(Objective 3)*

Respondent Characteristics

The results of the survey will first be broken down across all three counties and then examined more specifically across various groupings. Overall the survey respondents were fairly evenly split by gender (47% male; 53 % female) with an average age of 57 years. Just over 90% of the respondents view their health as at least “good”. Forty percent have at least a high school education with another 45% having attended college (22% hold degrees). A little over a third of the respondents earned between $25K and $50K in 2008 and slightly over 50% earned over $50K.

The respondents have lived an average of 21 years in their current homes (of which 88% are home owners) and they have lived an average of 42 years in the general area. Currently 86% rate their communities as a “good” to “very good” place to live (54% = very good); slightly down from 10 years ago (91% rated area as a “good” to “very good” place to live 10 years ago; 12% reduction in the number of respondents who rated area “very good” 10 years ago). Fifty-six percent of the respondents live in a town; 44 % live in rural areas (30% on a farm). About 28 % live less than 1 mile from the nearest hog operation (31% live between 1 to 2 miles; 41% live > than 2 miles).

In terms of experience with farming, a full quarter of the respondents are currently working on a farm and 70% of those who are not have worked on a farm at some point in their lives. Eighteen percent of those interviewed (or someone in their household) are currently raising livestock for commercial purposes (71 % are raising hogs).

General Beliefs Regarding Environmental issues and the Hog Industry in Iowa
When asked how concerned the respondents are about Iowa's environmental quality, 57% stated that they are "concerned" to "very concerned" (24% to 33% respectively). In response to an open ended question regarding what they consider to be the main environmental issue facing their community today, 31% mentioned "farm chemicals and manure runoff", another 28 % stated "odor and water pollution, hog confinements". With respect to citizen opinions regarding the importance of the hog industry to their county's economy 65% state that the industry is "important" to "very important" (26% to 39% respectively; it should be noted that these percentages are relatively homogeneous across the three counties). Thinking of the overall state economy, however, 82% of the respondents state that the industry is "important" to "very important" (63% to 20% respectively).

When asked to weigh-in on a number of statements regarding the hog industry in Iowa, the respondents generally agreed that people who live in rural areas need to accept a certain degree of odors associated with animal production and that, if managed accordingly, large facilities can be environmentally benign. However, they also tended to agree that in their respective counties not enough is being done to protect property owners from problems associated with hog production and that hog facilities can reduce property values. See table 6 below for a summary of this data.

Table 6. Citizen agreement with statements regarding the swine industry in Iowa.

Rank Agreement	N	Mean Score [1]	Std. Dev.
People who live in rural areas should be prepared to accept occasional odors associated with animal production	303	3.79	1.061
If properly managed, large pork production facilities do not harm the environment	287	3.51	1.103
In this area, the rights of property owners near pork production facilities are not protected well enough	283	3.45	1.173
Large pork production facilities cause nearby property values to decrease.	289	3.70	1.074
Hog odor should be reduced in this area even if it hurts the local economy	288	3.10	1.162

[1] Rank score based on 5 point scale. Scores > 3 indicates agreement and the higher the score up to 5 indicates degree of agreement

Odor Tolerance as Defined By Survey Respondents
In an effort to characterize what citizens consider to be their threshold for odor tolerance, two questions were asked: "In any 4 day period of summer, how many hours of **moderate** (question 1) or **Strong** (question 2) odor are you willing to tolerate, before you feel that your quality of life is being affected? The results of these questions are shown below in table 7. Interestingly, more people are willing to tolerate up to an hour of strong odors versus moderate odors (59% vs. 36%), but at longer durations significantly fewer people are willing to tolerate up to 2 hours or more of strong odors.

Table 7. Social tolerance of "moderate" and "strong" swine odor.

	Moderate Odor Percent (%) [1]	**Strong Odor Percent (%) [1]**
Up to half an hour	22	39
Up to 1 hour of odor	14	20

Up to 2 hours of odor	30	21
More than 2 hours	34	20
Total	100	100

[1] Significant differences with Pearson chi-square test; p = 0.000.

Survey Respondent Personal Experiences with Hog Odor

Overall, in terms of personal experiences with hog odors, almost half of those interviewed rarely to never experience hog odors (36% do on "occasion"; 16% "often" to "everyday"). The odors that are experienced generally happen at certain times of the year with 29% indicating they notice mostly in the mornings and 35% during the day. Manure spreading, hog barns and manure storage are the top three listed sources of odors experienced. Just under two thirds (73%) of the respondents stated that they have encountered what they would consider "problem" odors 30 days or less over the past year (34% < than 10 days); 11% stated that they encountered problem odors over 90 days last year. To gauge the general impact that these odor encounters had, the respondents were asked how "annoyed" they were with these odors and 46% stated that they were not annoyed (26% had no opinion); 29% stated that they were "annoyed" to "very annoyed" with odors they experienced. In response to these odors the majority of the respondents (55% or >) stated that they either never or rarely: have to keep windows closed, change outdoor plans, or not invite people over to the house.

Social Acceptability of CAM Modeling

To assess the social acceptability of CAM modeling in general, two questions were asked, the first started with a brief description of the CAM model to which respondents were asked to what degree they approve of this modeling process to identify good locations for hog production facilities. The second question was based on a "what-if" scenario geared at gauging trust in such a model if it were their home in question. For the first question the following lead in was provided:

"Several years ago Iowa State University engineers developed a computer model to help identify locations for new hog production facilities where odor would affect neighboring homes as little as possible. It predicts the number of hours of exposure to various levels of odor, by month, for each home in a given community or area. The model has been tested for accuracy many times and tests have shown that it works well. Using a scale from 1 to 5, where 1 means you do not approve of this idea at all and 5 means you very much approve, which number would you choose?

For the second question, the following scenario was used as the set-up:

"How much would you trust the results of the computer model if a neighboring farmer came to you with modeling results, calculated by Iowa State University and showing that, after analyzing and rejecting several other locations, it was determined that a new 24 hundred head hog facility could be built within 1 mile **up-wind** of your home with minimal impact from odor. On a scale from 1 to 5, where 1 means you would not trust the model results at all and 5 means you would trust the results very much, which number would you choose?"

Table 8 below displays the results of respondent approval of CAM and their trust in the model if it were being used to analyze a site near their home.

Table 8. Responses regarding approval and trust of the use of CAM near their home.

Approve of CAM	**Frequency**	**Percent (%)**
Do not approve at all	22	7.5
Do not approve	12	4.1
Undecided	57	19.5
Approve	49	16.7
Very much approve	153	52.2
Total	293	100

Trust in Model	**Frequency**	**Percent (%)**
Do not trust at all	59	19.7
Do not trust	36	12.0
Undecided	98	32.8
Trust	60	20.1
Trust very much	46	15.4
Total	299	100

Sixty-nine percent of the respondents “approve” to “very much approve” of the modeling process to site hog production facilities. However when the modeling involved their own home 36% would trust the results. It is interesting to note that 29% of the respondents who “approve” to “very much approve” of CAM modeling stated that they ultimately would not trust the model when it comes to their own home. Still almost a third stated that they would trust the results (another third of the respondents were undecided).

Based on analysis of variance tests (ANOVA) the results reported here are homogeneous across all three counties. Additionally, the social acceptability of CAM also does not differ across: 1) degrees of odor experiences, 2) opinions regarding the importance of the hog industry and concerns thereof, and 3) any demographic or respondent characteristics. Explorations of potential ordinal predictions (dependent variable is categorical as either “approve”, “disapprove” or “undecided”) based on multi-nominal logistic regression failed to find any well-fitted models.

Discussion:

A diversity of pork producers with various production systems have utilized CAM in order to make better decisions regarding the siting of production facilities. Based on the findings of our producer survey, overall the current programming appears to be largely effective in terms of understandability and process (from initial producer request through to the presentation of results). However there were suggestions that can be used to help improve programming on both the front and back ends of the CAM process. There were some areas discovered for improvement or adjustment in regard to the facilitation of higher level producer participation via increased pre-model interface opportunities for producers to provide key model input thus streamlining the modeling process. A web-based information hub with data-entry capacity (specifically for the producer to provide model parameters) would likely improve the model initiation proceedings. The information conveyed to the producers is complex and their understanding of the model results are critical on two fronts: 1) using the CAM results to help make well informed decisions that critically weigh site location risk; and 2) in being able to effectively communicate the results to concerned neighbors. Because around 40% of the CAM users expressed a moderate ability to explain the model and some of its key parameters to neighbors, improvements in data presentation and explanation (perhaps utilizing more user-friendly graphics and more lay-audience language) will be sought by program developers.

In terms of gauging the impact effectiveness of CAM, from the producer perspective the model played a significant role in the siting decision process. In some cases the model confirmed producers' initial beliefs about a site but for many producers CAM also revealed "surprises" in how odor moves and interacts with wind patterns. It is believed by a number of producers that CAM was a very useful tool in terms of communicating the complicated issues of environmental risk to neighbors. Sixty-seven percent of the CAM users believe that all evidence (from their point of view) suggests that CAM "got it right" (14% believe that it was moderately close). Overall, for those producers who went on to build at sites that were modeled there was a significant improvement in neighbor relations. While it is not possible to determine to what degree CAM played in this improvement, it is suggestive after examining across all the previously summarized data that CAM was a major contributor. Ultimately, from the perspective of a high majority of the producers, the CAM model was found to be very useful in their planning process.

As CAM continues to evolve as a tool, it will be important for support programming and producer interaction protocols to similarly develop. Formative and summative feedback from the users of complex decision support tools such as CAM is and will continue to be an integral part of the CAM process.

In response to producer suggestions, a website with examples is being developed. Specific, well labeled examples will accompany model results to further assist producers in explaining the results to neighbors. Other "cheat sheets" will be developed to further aid the communication process.

In evaluating the general public attitudes about the swine industry and modeling, it was found that people acknowledge the importance of the pork industry but have concerns about the environment and impact on property values. In generally they believe that rural residents should have tolerance of odors and that large facilities, with proper management, can be environmentally benign.   There are some concerns for the rights of rural property owners.

The willingness to tolerate odors is a key model input. More than one third of those surveyed (39%) thought that an exposure to strong odors should be less than1/2%, or 30 minutes every 4 days. When asked about moderate odors, 22% felt it should be less than 30 minutes, with 34% feeling that over 2 hours every 4 days would be acceptable.

What's Next for CAM

As Hoff et al. (2008) noted in the technical description of CAM the percentages of exposure in the CAM approach do not include calm meteorological conditions which would have an effect on decision percentages at each odor category. Therefore, part of the current research agenda for CAM is the integration of calm meteorological conditions (e.g., wind speeds $\leq$1.03 m/s) as well as other key odor dispersion factors such as terrain variations and obstruction downwash. Additionally, swine is the only species for which CAM is calibrated. As such, CAM needs to be extended to all other pertinent species which will require the inclusion of source volumetric rate, odor concentration data, and seasonal variation (Hoff et al., 2008).

Finally, in spring 2008, Iowa House File 2688 (Livestock Applied Research and Evaluation) was signed by Iowa Governor Culver. This Bill authorized a three-phase, multi-institute (ISU, Iowa Department of Natural Resources, and the Iowa Department of Agriculture and Land Stewardship) interactive approach for siting swine production facilities for producers who seek advanced evaluatory assistance. Phase one involves an internet-based self assessment, followed by a phase two consultation with a specialist designated by ISU. If recommended by the specialist designate, phase three will involve the modeling of the site using CAM. At the time of this writing this bill remains unfunded; however, HF 2688 is a policy bill, which will provide the framework for future appropriations (IPPA, 2008).

References

American Society of Agricultural Engineers. 1999. Control of manure odors. ASAE EP-379.2. Pp. 655-657. ASAE Standards - 1999, 46th ed. St. Joseph, Michigan.

Anderson, J.R. and G. Feder. 2004. Agricultural Extension: Good Intentions and Hard Realities. World Bank Research Observer, Vol. 19, No. 1, pp. 41-60, Spring 2004

Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, July-December 2008. National Center for Health Statistics. May 2009. Available from: http://www.cdc.gov/nchs/nhis.htm.

Carberry P.S., Z. Hochman, R.L. McCown, N.P. Dalgliesh, M.A. Foale, P.L. Poulton, J.N.G. Hargreaves, D.M.G. Hargreaves, S. Cawthray, N. Hillcoat and M.J. Robertson. 2002. The FARMSCAPE approach to decision support: farmers', advisers', researchers' monitoring, simulation, communication and performance evaluation, Agricultural Systems 74: 141–177

Caldwell, W. J. and M. Williams. 2003. Agricultural & Livestock Intensification: Community Perceptions of Environmental, Economic and Social Impacts as an Impediment to Agricultural Production. School of Environmental Design and Rural Development, University of Guelph, Guelph, Ontario.

Douglah, M. 1998. Developing a Concept of Extension Program Evaluation. University of Wisconsin Cooperative Extension. Program Development and Evaluation G3658-7. Bulletin I-4-98-.5M-200.

Duffy, M. 2004. Trends in Iowa farmland Ownership. AgDM newsletter, October 2004. Available at: http://www.extension.iastate.edu/agdm/articles/duffy/DuffyOct04.htm (Last accessed 1-25-09).

Guo, H., L.D. Jacobson, D.R. Schmidt, R.E. Nicolai, and K. Janni. 2004. Comparison of five models for setback distance determination from livestock sites. Canadian Biosystems Engineering 46: 6.17-6.25.

Heber, A.J. and B.W. Bogan. 2006. The Study and Regulation of Agricultural Air Quality in the US. Pp 32 – 35. In Aneja et al. (Eds.), Proceedings: Workshop on Agricultural Air Quality: State of the Science, Potomac, Maryland, June 5 -8, 2006.

Hoff, S.J., D.S. Bundy, and J.D. Harmon. 2008. Modeling receptor odor exposure from swine production sources using CAM. Applied Engineering in Agriculture. Vol. 24(6): 821-837.

Hogberg, M. G., S. L. Fales, F. L. Kirschenmann, M. S. Honeyman, J. A. Miranowski, and P. Lasley. 2005. Interrelationships of animal agriculture, the environment, and rural communities**.** Journal of Animal Science 2005 83: E13-17E

Honeyman, M. S. 1996. Sustainability issues of U.S. swine production. Journal of Animal Science 1996 74: 1410-1417.

Huang H, and G.Y. Miller. 2006. Citizen complaints, regulatory violations, and their implications for swine operations in Illinois. Review of Agricultural Economics 28(1):89–110

(IPPA) Iowa Pork Producer. 2008. Iowa Pork Producer Association Legislative Summary. Volume 45, Numbers 6-7, July 2008, pp 10-11. (http://www.iowapork.org/Portals/iowapork/July%20Mag%20Web.pdf). (Last accessed 6-9-09)

Johnson, C. 2006. Assessing where to build. Iowa Manure Matters: Odor and Nutrient Management. Iowa State University Extension. Summer 2006, EDC-129-32, Vol. 9, Issue 2. Pp 5-6.

Kliebenstein, J.B. 1998. Economic and associated social and environmental issues with large-scale livestock production systems. Concept Paper for the World Bank Workshop on Sustainable Intensification of Agricultural Systems: Linking Policy, Institutions and Technology. July 5-10, 1998. Iowa State University, Ames, Ia.

Korsching P., P. Lasley, and D. Roelfs. 2004. Rural Iowa Life Survey 2003 Summary Report. Iowa State Univ. Ext. Bull. PM 1960. Iowa State Univ., Ames

Lee, J. D. 2004. “More hog lot disputes are ending up in court.” Des Moines Register. March 23.

Mikesell, RE, Kephart, KB, CW Abdulla. 2004. Overview of social issues related to the swine industry. Illini Swine Odor and Waste Management. University of Illinois Extension. 3/17/2004. Available from: http://www.livestocktrail.uiuc.edu/sowm/paperDisplay.cfm?ContentID=6504.

Mikesell R.E., K.B. Kephart, L.J. Ressler, and F.K. Willits. 2001. Comparison of neighbor and non-neighbor perceptions of large-scale animal agriculture. International Symposium on Animal Production & Environmental Issues. Oct. 3–5, 2001. Research Triangle Park, NC.

Otto, D. and J. Lawrence. 2009. The Iowa pork Industry 2008: Patterns and Economic Importance. Iowa State University Extension. Industry Research. 2009.

Petheram, R.J. 1998. Review of Evaluation in Agricultural Extension. Rural Industries Research and Development Corporation, Human Capital, Communications & Information Systems Research and Development. RIRDC Publication No. 98/136.

Sharp, J.S. 2005. Policy Issues: Rural/Urban Community Effects, In: Encyclopedia of Animal Science. Edited by W.G. Pond and A.W. Bell. Marcell Dekker publishing. 952p.

Turner, D.B. 1994. Workbook of Atmospheric Dispersion Estimates. CRC-Press; 2nd edition. 192p.

Vansickle, J. 2007. Livestock Coalition Lends a Helping Hand. National Hog Farmer. May 15, 2007. Available at: http://nationalhogfarmer.com/mag/livestock_coalition_lends_hand/ (Last accessed 1-25-09)