

## TOXOPLASMA GONDII IN UNITED STATES SWINE OPERATIONS: AN ASSESSMENT OF MANAGEMENT FACTORS

Kliebenstein J.,<sup>1</sup> Patton S., Zimmerman J., Hu X., Hallam A., Roberts T., Bush E.

Des sérums de porcs ont été analysés pour la recherche d'anticorps anti *Toxoplasma gondii* par le test modifié d'agglutination directe (MAT). Des échantillons de sérum ont été prélevés chez des truies faisant partie de l'enquête porcine du National Animal Health Monitoring System (NAHMS). Les sérums étudiés représentaient 3473 truies provenant de 412 élevages porcins tirés au sort aux Etats-Unis. L'enquête NAHMS comportait des informations sur les installations par type de production, le niveau d'accès des chats, chiens et oiseaux aux installations, les méthodes de renouvellement des femelles et sur la productivité des truies. Sur les truies testées, 19% étaient positives pour la toxoplasmose. Cette étude a montré une association positive entre les truies ou élevages positifs à *Toxoplasma gondii* et les trois facteurs suivants : 1) méthode de dératisation, 2) type de production, 3) accès de certains animaux (chats, chiens, oiseaux) aux installations. Ces données indiquent qu'il sera difficile d'éliminer *Toxoplasma gondii* des élevages porcins permettant aux chiens et chats d'accéder aux installations. L'utilisation des chats comme méthode de dératisation pourrait être déconseillée. En revanche, une association forte entre les élevages négatifs et la méthode de dératisation basée sur l'utilisation d'appâts uniquement a été observée. Les truies provenant d'élevages où les femelles de remplacement sont élevées en interne étaient significativement plus souvent positives au test de toxoplasmose. Des truies dans des installations fermées avaient une prévalence significativement plus faible de *Toxoplasma gondii*. En général, aucune différence régionale n'a été observée pour les taux de prévalence.

### OBJECTIVE

The overall objective of this study is to evaluate the relationship between anti-*Toxoplasma gondii* antibodies in hogs and farm management practices used by swine producers.

### INTRODUCTION

*Toxoplasma gondii* (*T. gondii*) is a microscopic parasite that can lead to toxoplasmosis in animals as well as humans. It can cause stillbirths, abortions, early infant mortality, crippling and blindness. Reducing the risk of acquiring *T. gondii* directly benefits society through the potential for reduced transmission of toxoplasmosis to humans and animals. Roberts and Frenkel have projected the human illness costs of congenital toxoplasmosis to be in the \$368 million to \$8.8 billion range annually in the United States (1990, 1985). Moreover, about half of the adult human population in the United States has anti-*T. gondii* antibodies (Dubey et al, 1991). Dubey (1990) found that 23% of market hogs had positive serum samples for anti-*T. gondii* antibodies. Cats have been identified as definitive hosts for *T. gondii*. However, all species of birds and mammals can be carriers of *T. gondii*.

### PROCEDURES

This study was undertaken to obtain information on toxoplasmosis infection in United States swine. Serum samples from individual sows were assayed for evidence of *T. gondii* infection using the modified agglutination test. Serologic results were then combined with herd data to evaluate possible associations between farm management practices and *T. gondii* infection.

Data for this study were obtained from a random survey of swine herds conducted by the National Animal Health Monitoring System (NAHMS) during 1989-1990. This is an organization developed in the U.S. to monitor animal health problems. As part of the survey, a general farm management and production policy questionnaire was completed by 1,663 swine producers. The survey included questions on production facilities, biosecurity measures, management practices, pig inventory, etc. Sow serum samples were collected from 10 randomly selected sows on 412 of the 1,663 farms. Serum samples were available from 3,473 sows. A herd was considered positive if one animal tested positive for antibodies against *T. gondii*; a herd was considered negative if 10 animals were tested and all tested negative. Herds with fewer than 10 sows tested and all testing negative were dropped from the herd level analysis.

Herd data and serologic information were used to study the relationships between *T. gondii* infection in sows and specific farm management practices. Logistical regression and the odds ratio were used for analysis. The categorical information available, such as presence or absence of *T. gondii* antibodies, type of swine facilities, type of rodent control, etc., was well suited for logistic regression. The odds ratio provides information on the strength of the respective associations.

<sup>1</sup> Economics Department, 178 Heady Hall, Iowa State University, Ames, Iowa, 50011, USA

## RESULTS

As shown in Table 1, 19 percent of the sows tested were positive. Herds with 10 sows tested showed an 18 percent prevalence rate, while those with fewer than 10 sows tested had a 23 percent prevalence rate.

Information selected for in-depth management strategy analysis was: sow replacement method, swine production facility (housing) type; and access of dogs, cats, or birds to the production facilities. Multiple regression along with a literature review and researcher knowledge of the disease epidemiology was used to assist in identifying variables associated with *T. gondii* prevalence and titer levels. Comparisons of breeding stock replacement methods were also completed. Among herds that raised all replacement females, 26% of the sows were positive as compared to 15% for farms that purchased all replacements (Table I). The prevalence rate was significantly higher in the herds that raised all replacements.

Facility type also had an impact on the *Toxoplasma* status of sows. For facility analysis, herds were placed in one of three categories by facility type: total confinement, open buildings, or no buildings (Table I). Herds with mixed facilities were classified according to the lowest level of confinement. For example, herds with some confinement and some open building facilities were considered "open building herds." Sows in open building facilities or no building facilities had a significantly higher chance of being positive. Of the sows in confinement facilities, 18 percent were positive. This compared to 27 percent and 26 percent for sows in open building and no building facilities, respectively.

**Table I**  
number of sows tested and percent positive and negative

Comparison method	Number of sows	Number sows negative	Number sows positive	Percent sows negative	Percent sows positive
All herds	3473	2795	678	81	19
Sows tested per herd					
10	2350	1928	422	82	18
Less than 10	1123	860	256	77	23
Sow replacement strategy					
All raised <sup>a</sup>	2034	1513	521	74	26
All purchased <sup>b</sup>	446	381	65	85	15
Swine housing					
Total confinement <sup>c</sup>	1194	979	215	82	18
Open building <sup>d</sup>	1079	791	288	73	27
No building <sup>e</sup>	528	390	138	74	26

<sup>a</sup> All replacement females selected from within the herd.

<sup>b</sup> All replacement females are purchased and brought into the herd.

<sup>c</sup> All swine facilities are total confinement - enclosed.

<sup>d</sup> Some swine facilities are open building - not totally enclosed.

<sup>e</sup> Some swine facilities are pasture or hut facilities.

Information on herd prevalence levels showed that 49 percent of the herds were positive (at least one sow positive) for *T. gondii* antibodies. This did not differ by number of sows tested per herd. A significantly higher percentage of the herds which raised all replacements tested positive (65%) as compared to those which purchased all replacements (46%). Similarly, a significantly higher percentage of the herds which were in "no building" and "open building" categories tested positive (70%) than did the herds in total confinement operations (52%).

Cat, dog, or bird access to swine production facilities and use of bait for rodent control were also evaluated, based on producer response to the NAHMS survey questionnaire. For the analysis, no access reflected that cats, dogs, or birds did not have access to facilities in any of the production phases. Odds ratios were used to determine the strength of the association between facility types and herd *T. gondii* antibody status, and between cat, dog and bird access to facilities along with method of rodent control and herd status. Logistic regression was used to test for the sign and level of significance. For both the odds ratio and the logistic regression the items compared are described in Table II.

Information from comparisons evaluating the effect of cat, dog or bird access on infection status provides evidence that those operations which did not allow cat, dog or bird access had a significantly lower probability of being positive for *T. gondii*. For example, in the first comparison (dog access vs. not access) the odds ratio (OR) was 0.412. The interpretation is that the probability that a facility without dog access was positive was 41% of the probability of a herd without dog access being positive for *T. gondii*. Or, stated another way, herds with dog access were 2.38 (1/.41) times more likely to test positive for *T. gondii* than herds without dog access. Similarly, herds without cat access were significantly less likely to test positive for *T. gondii* than operations with cat access (OR = 0.434). A comparison of bird access vs. no bird access found that those facilities with bird access were 4.35 times more likely to test positive than those without bird access. This, too, was significant. Those that used bait only as the method of rodent control were significantly more likely to test negative for *T. gondii*. Those that used cats only were more likely to test positive.

This study has shown a positive relationship between sows or herds testing positive for *T. gondii* and method of rodent control, type of production facility and sow replacement strategy, and cat dog or bird access to production facilities. It will be difficult to eliminate *T. gondii* from swine herds which allow for cat, dog or bird access. While

cat or dog access to most facilities can be controlled somewhat by not having cats or dogs around the operation, it is difficult to control access of stray cats or dogs from facilities which provide open access. Similarly, control of bird access is even more difficult for facilities with open access, as birds freely move from facility to facility.

The exclusion of cats as a method of rodent control should be considered. While there were only a few operations where cats only or bait only was used for rodent control, there was a strong association between use of bait only and the herd testing negative as compared to the use of cats only for rodent control. Greater industry awareness is needed on methods for the effective use of bait to control rodents.

Operations which purchased female replacements were more likely to test negative for *T. gondii*. This suggests that a survey of production practices, etc., used by those who produce replacement females for sale may be useful in identifying practices which reduce prevalence of *T. gondii*.

**Table II**  
analysis of herd level farm management strategies and *T. gondii* tests for herds with total confinement housing

Comparison item	Number of farms			Odds ratio	95%		Sign and significance
	Total	Positive	Negative		Lower bound	Upper bound	
<b>Dogs access vs. not access</b>							
Total farms	109	60	49	0.412	0.186	0.910	(+)**
Dogs not access farm	41	17	24				
Dogs access farm	68	43	25				
<b>Cats access vs. not access</b>							
Total farms	114	66	48	0.434	0.173	1.084	(+)**
Cats not access farm	24	10	14				
Cats access farm	90	56	34				
<b>Birds access vs. no access</b>							
Total farms	128	68	60	0.23	0.089	0.593	(+)*
Birds not access farm	27	7	20				
Birds access farm	90	56	34				
<b>Bait and cats vs. all others<sup>a</sup></b>							
Total farms	128	68	60	0.376	0.176	0.802	(+)*
All others <sup>a</sup>	43	16	27				
Bait and cats	85	52	33				
<b>Bait only vs. all others<sup>b</sup></b>							
Total farms	128	68	60	4.683	1.964	11.167	(-)*
All others <sup>b</sup>	94	59	35				
Bait only	34	9	25				
<b>Bait only vs. cats only</b>							
Total farms	42	15	27	8.333	1.416	49.042	(-)**
Cats only	8	7	2				
Bait only	34	9	25				
<b>Cats only vs. all others<sup>c</sup></b>							
Total farms	128	68	60	0.3	0.06	1.5	(+)
All others <sup>c</sup>	119	61	58				
Cats only	9	7	2				

<sup>a</sup> All others includes bait only or cats only for rodent control.

<sup>b</sup> All others includes bait and cats or cats only for rodent control.

<sup>c</sup> All others includes bait only or bait and cats for rodent control.

\* Significant at 1% level.

\*\* Significant at 5% level.

\*\*\*Significant at 10% level.

## REFERENCES

- Dubey, J., Beattie, C., 1988. Toxoplasmosis in man (*Homo sapiens*). In Toxoplasmosis of Animal and Man, CRC Press, Inc., Boca Raton, Florida, USA, 41-53.
- Dubey, J., 1990. Status of toxoplasmosis in pigs in the United States. Journal of the American Veterinary Medical Association 196, 270-274.
- Roberts, T., 1985. Microbial pathogens in raw pork, chicken, and beef: Benefit estimates for control using irradiation. American Journal of Agricultural Economics 67, 957-965.
- Roberts, T., Frenkel, J., 1990. Estimating income losses and other preventable costs caused by congenital toxoplasmosis in people in the United States. Journal of the American Veterinary Medical Association 196, 266-270.