

# *Toxoplasma gondii* in U.S. swine operations: An assessment of herd factors

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ASL-1422

## Summary and Implications

This study showed a positive relationship between sows or herds testing positive for *Toxoplasma gondii* and three factors: 1) method of rodent control, 2) type of production facility, and 3) access of certain animals (cats, dogs, birds) to production facilities.

These data indicate that it will be difficult eliminate *T. gondii* from swine herds which allow cats, dogs or birds access to facilities. While cat or dog access to most facilities can be controlled to a degree by not permitting cats or dogs around the operation, it is impossible to exclude stray cats or dogs from open facilities, lots, or pastures. Similarly, control of bird access is even more difficult, as birds freely move between accessible facilities.

Use of cats as a method of rodent control should be discouraged. We found a strong association between use of "bait only" for rodent control and the herd testing negative as compared to the use of "cats only" for rodent control. Greater industry awareness is needed for methods of rodent control through the use of baits.

## Introduction

*T. gondii* is a microscopic parasite. Infection with *T. gondii* is termed "toxoplasmosis." *T. gondii* is infectious for both animals and humans. In pregnant women, toxoplasmosis may cause stillbirths, abortions, early infant mortality, blindness, and mental retardation in children (Roberts and Frenkel). Similarly for animals, infection may cause abortions, stillbirths, and non-viable offspring among domestic, farm, fur-bearing, and game animals. Reducing the risk of acquiring *T. gondii* directly benefits society through the potential for reduced transmission of toxoplasmosis to humans and animals.

Differences in "within herd" prevalence between these two groups were shown, as well. Twenty-six percent of sows from herds raising replacements were positive as

## Materials and Methods

This study was undertaken to obtain further information on toxoplasmosis infection in U.S. swine. Serum samples from individual animals were first 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. Availability of data on individual sows and their litters allowed for evaluation of the potential impact of toxoplasmosis on sow production, as well.

Data for this study were obtained from a survey of swine herds conducted by the National Animal Health Monitoring System (NAHMS) during 1989-1990 in 18 states. As part of the survey, a general farm management and 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 412 of the 1,663 producers. Blood samples from 10 randomly selected sows were collected from each herd. Serum was frozen at -20 C until assayed by the modified agglutination test (MAT) for antibodies against *T. gondii*. Serum samples were available from 3,473 sows for *T. gondii* antibody tests. Of these, 2,795 were negative (81%) and 678 were positive (19%). A herd was considered positive if one animal tested positive for antibodies against *T. gondii*; a herd was considered negative if 10 animals tested negative.

The herd data and serologic information were used to study the relationships between *T. gondii* infection in sows and specific farm management practices. Two methods were used for analysis: logistical regression and calculation of the odds ratio. Much of the data available for analysis was categorical, i.e., presence or absence of *T. gondii* antibodies, type of swine facilities, type of rodent control, etc. The logistic procedure fits this type of data. Given the presence of a significant relationship, the odds ratio is a measure of the strength of the association between infection and a specific variable.

## Results and Discussion

As seen in Table 1, 62% of all herds were positive. Among herds that purchased all replacement females, 46% were positive as compared to 65% of herds that raised all replacements. The percent of positive herds raising all replacements was significantly higher than herds purchasing replacements (chi-square test), compared to 15% of sows from herds where all replacements were purchased.

Herd size was also significantly different between positive and negative herds (t-test). Positive herds were significantly smaller than negative herds. Positive herds were smaller for all three replacement strategies: 151 sows vs. 240 sows for raised replacements; 174 vs. 437 sows for purchased replacements; and 93 vs. 363 sows for mixed replacement strategies. The positive herds averaged 147 sows, while the negative herds were double that size or 295 sows.

Herds were placed in one of three categories by facility type: total confinement, open buildings, or no buildings (Table 2). 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."

Facility type had an impact on the *Toxoplasma* status of herds. Herds in "no buildings" and "open buildings" categories had a significantly higher percent of herds test positive than did the total confinement operations. Approximately half of the total confinement herds were positive as compared to 70% of the "open building" or "no building" herds. A higher percent of the sows from open building (27%) and no building (26%) herds were positive as compared to the total confinement systems (18%).

As with the sow replacement comparison, herd size was a strong factor. Negative herds with total confinement averaged 402 sows, compared to 219 for the "open building" and 110 for the "no building" herds. The positive herds for both total confinement and open building systems were significantly smaller than were the negative herds for the respective systems.

Odds ratios were used to determine the strength of the association between facility types and herd toxoplasmosis status, and between method of rodent control and herd status. Logistic regression was used to test for the sign and level of significance. Information on significant farm management strategies and production systems, as they relate to the level of *T. gondii* in swine herds, are presented in Tables 3 and 4. For both the odds ratio and the logistic regression the comparison is described in the table. For example, in the first comparison of Table 3, open housing is compared to total confinement.

Information from comparisons evaluating the effect of different types of facilities on infection status provide further evidence that total confinement operations had a lower probability of being positive for *T. gondii*. For example, in the first comparison (open housing vs total confinement) the odds ratio (OR) was 0.57. The interpretation is that the probability that a total confinement herd was positive was 57% of the probability of a herd with open housing being positive for *T. gondii*. Or, stated another way, herds with open housing were 1.75 (1/0.57) times more likely to test positive for *T. gondii* than total confinement facilities. Similarly, total confinement operations were less likely to test positive for *T. gondii* than facilities with no buildings (OR = 0.452). A comparison of

no building vs. open building herds found no significant difference in terms of the probability of being positive for *T. gondii*.

The lower part of Table 3 presents an assessment of the impact of specific measures on herd infection status. The access of dogs or birds to production facilities had a positive relationship to a herd testing positive for *T. gondii*. Operations with dog access were 1.81 times (OR = 0.552) more likely to test positive while those with bird access were 3.84 times (OR = 0.263) more likely to test positive. The lack of significance between cat access and *T. gondii* (p = 0.554) was surprising since cats are recognized as the "definitive host" of *T. gondii*. On the other hand, an analysis of type of rodent control relative to herd status suggested a link to cats. Specifically, herds using bait as the only method of rodent control were 2.6 times more likely to test negative for *T. gondii* than herds using other methods or combinations of methods. Herds using only bait compared to those using only cats for rodent control were 6.1 times more likely to be negative. Alternatively, herds using only cats were 3 times (1/0.33) more likely to be positive when compared to all other methods or combinations of rodent control.

Analysis of herd management strategies for operations with total confinement facilities shows similar results (Table 4). Here again, operations with cat, dog or bird access were more likely to test positive for *T. gondii*.

Information presented in Table 4 provides a similar comparison to that of Table 3, except Table 4 consists only of herds with total confinement housing. This includes herds that purchase replacement females, as well as herds that raise all replacement females or have a mixture of raised as well as purchased females. These results are similar to those provided in Table 3. Again, the access of dogs or birds to production facilities is associated with *T. gondii* infection. Overall, the access of cats was just marginally positively related in this particular comparison. The use of bait only as a means of rodent control significantly reduced the likelihood of the herd having a positive *T. gondii* test, while the use of cats only significantly increases the chances of having a positive test.

## References

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**Table 1. Number of herds, herd size, and percent positive and negative by type of sow replacement strategies.**

Type of Sow Replacement	Number of Herds			Percent of Herds		Average Number Sows per Herd			Number of Sows Tested			Percent of Sows	
	Total	Pos.	Neg.	Pos.	Neg.	Total	Pos.	Neg.	Total	Pos.	Neg.	Pos.	Neg.
All Raised <sup>a</sup>	226	147	79	65%	35%	182	151	240	2,034	521	1,513	26%	74%
All Purchased <sup>b</sup>	48	22	26	46%	54%	316	174	437	446	65	381	15%	85%
Mixed <sup>c</sup>	34	23	11	68%	32%	180	93	363	321	55	266	17%	83%
Total	308	192	116	62%	38%	203	147	295	2,801	641	2,160	23%	77%

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

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

<sup>c</sup>Some replacement females are selected from the herds and some are purchased.

**Table 2. Number of herds, herd size, and percent positive and negative by type of housing.**

Type of Swine Housing	Number of Herds			Percent of Herds		Average Number Sows per Herd			Number of Sows Tested			Percent of Sows	
	Total	Pos.	Neg.	Pos.	Neg.	Total	Pos.	Neg.	Total	Pos.	Neg.	Pos.	Neg.
Total													
Confinement <sup>a</sup>	126	66	60	52%	48%	278	164	402	1,194	215	979	18%	82%
Open Building <sup>b</sup>	122	85	37	70%	30%	151	121	219	1,079	288	791	27%	73%
No Building <sup>c</sup>	60	41	19	68%	32%	152	171	110	528	138	390	26%	74%
Total	308	192	116	62%	38%	203	147	296	2,801	641	2,160	23%	78%

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

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

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

**Table 3. Analysis of herd level farm management strategies and *T. gondii* tests for herds with raised female replacements.**

Comparison Item	Number of Farms			Odds Ratio	95%		Chi-Sq. test	Logistic Regress.
	Total	Pos.	Neg.		Lower bound	Upper bound		
<b>Open Housing vs. Total Confinement</b>								
Total farm	180	113	67	0.57	0.309	1.049	0.07	(+) <sup>***</sup>
Total confinement farm	89	50	39					
Open housing farm	91	63	28					
<b>No Building vs. Total Confinement</b>								
Total farm	135	84	51	0.452	0.209	0.982	0.044	(+) <sup>***</sup>
Total confinement farm	89	50	39					
No building farm	46	34	12					
<b>No Building vs. Open Housing</b>								
Total farm	137	97	40	0.797	0.358	1.758	0.569	
Open housing farm	91	63	28					
No building farm	46	34	12					
<b>Dogs Access vs. Not Access</b>								
Total farm	198	134	64	0.552	0.293	1.039	0.064	(+) <sup>***</sup>
Dogs not access farm	60	35	25					
Dogs access farm	138	99	39					
<b>Cats Access vs. Not Access</b>								
Total farm	213	142	71	0.755	0.332	1.807	0.554	
Cats not access farm	26	16	10					
Cats access farm	187	126	61					
<b>Birds Access vs. Not Access</b>								
Total farm	226	147	79	0.263	0.093	0.741	0.007	(+) <sup>*</sup>
Birds not access farm	17	6	11					
Birds access farm	209	141	68					
<b>Bait and Cats vs. All Others<sup>(a)</sup></b>								
Total farm	226	147	79	0.936	0.506	1.73	0.836	
All others <sup>(a)</sup>	209	133	62					
Bait and cats	17	14	17					
<b>Bait Only vs All Others<sup>(b)</sup></b>								
Total farm	226	147	79	2.605	1.227	5.528	0.012	(-) <sup>**</sup>
All others <sup>(b)</sup>	195	133	62					
Bait only	31	14	17					
<b>Bait Only vs. Cats Only</b>								
Total farm	61	39	22	6.071	1.842	20.009	0.002	(-) <sup>*</sup>
Cats only	30	25	5					
Bait only	31	14	17					
<b>Cats Only vs. All Others<sup>(c)</sup></b>								
Total farm	226	147	79	0.33	0.121	0.899	0.024	(+) <sup>**</sup>
All others <sup>(c)</sup>	196	122	74					
Cats only	30	25	5					

(a) All others includes bait only or cats only for rodent control.

(b) All others includes bait and cats or cats only for rodent control.

(c) All others includes bait only or bait and cats for rodent control.

\* Significant at 1% level.

\*\* Significant at 5% level.

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

**Table 4. 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%		Chi-Sq. test	Logistic Regress.
	Total	Pos.	Neg.		Lower bound	Upper bound		
<b>Dogs Access vs. Not Access</b>								
Total farm	109	60	49	0.412	0.186	0.910	0.027	(+)**
Dogs not access farm	41	17	24					
Dogs access farm	68	43	25					
<b>Cats Access vs. Not Access</b>								
Total farm	114	66	48	0.434	0.173	1.084	0.07	(+)**
Cats not access farm	24	10	14					*
Cats access farm	90	56	34					
<b>Birds Access vs. No Access</b>								
Total farm	128	68	60	0.23	0.089	0.593	0.001	(+)*
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 farm	128	68	60	0.376	0.176	0.802	0.01	(+)*
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 farm	128	68	60	4.683	1.964	11.167	0.000	(-)*
All others <sup>(b)</sup>	94	59	35					
Bait only	34	9	25					
<b>Bait Only vs. Cats Only</b>								
Total farm	42	15	27	8.333	1.416	49.042	0.016 <sup>(d)</sup>	(-)**
Cats only	8	6	2					
Bait only	34	9	25					
<b>Cats Only vs. All Others<sup>(c)</sup></b>								
Total farm	128	68	60	0.3	0.06	1.5	0.0004 <sup>(d)</sup>	(+)
All others <sup>(c)</sup>	119	61	58					
Cats only	9	7	2					

(a) All others includes bait only or cats only for rodent control.

(b) All others includes bait and cats or cats only for rodent control.

(c) All others includes bait only or bait and cats for rodent control.

(d) Fisher test rather than  $\chi^2$  was used for these tests because of small number of observations.

\* Significant at 1% level.

\*\* Significant at 5% level.

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