Session 3

Epidemiological and Climatic Correlates of Mare Reproductive Loss Syndrome

Chairperson: Dr. Atwood C. Asbury, The Grayson-Jockey Club Research Foundation, Lexington, Kentucky

Epidemiological Correlates of the 2001 and 2002 Episodes of Mare Reproductive Loss Syndrome

R. M. Dwyer

FOLLOWING AN EXPLOSIVE OUTBREAK OF EARLY FETAL LOSS (EFL) and late fetal loss (LFL) in late April through May 2001, extensive investigation of mare and fetal samples and tissues revealed no definitive cause. Field investigations into mycotoxins, fungal endophytes, ergot alkaloids, and other forage factors were also negative. An intensive field epidemiological survey was undertaken to determine factors associated with Mare Reproductive Loss Syndrome (MRLS).

Significant factors associated with EFL were presence of moderate to high concentrations of eastern tent caterpillars (ETC) in areas where mares grazed, farm population of greater than 50 mares, presence of barren or maiden mares in affected fields, mares bred in February of 2001, presence of wild cherry trees in or around mare pastures, and the frequent presence of waterfowl on the farm (1). The only protective factor found was feeding hay to mares outside.

Observations made on farms by private and University of Kentucky agronomists detected a correlation between cherry trees infested with ETC and fields with MRLS-affected mares. Based on these preliminary diagnostic, epidemiological, and observational findings, a contingency plan was formulated for 2002. The plan emphasized minimizing exposure of pregnant mares to ETC and cherry trees. The following study was performed to determine the extent of ETC control measures and EFL losses on farms compared to 2001.

Materials and Methods

A questionnaire was designed to determine the numbers of 2002 EFL on farms as of June 1, 2002. These data could not be determined from Jockey Club records until 2003, and an estimate was needed by the equine industry. From 2001 MRLS survey experience, the fastest and most accurate way to disseminate a questionnaire was through the Kentucky Thoroughbred Farm Managers fax system. In 2001, an initial questionnaire by this method had a 59% return rate with a 72-hour turnaround time (2).

The questionnaire involved questions about methods of ETC control measures; whether MRLS losses were on pastures at the periphery or central part of the farm; and, if pastures were on the periphery of the farm, whether they abutted urban areas, railroads, or non-equine premises. The one-page questionnaire was faxed to 263 farm managers on June 3, 2002, requesting a return date of June 7, 2002. Data were entered on database software for analysis (Microsoft Excel 97, Microsoft Corporation, Redmond, WA).

Results

Early Fetal Loss

Of 263 questionnaires, 92 (35.0%) were returned by farm managers in 10 counties. Of 2,277 mares bred between February 1 and April 1, 2002, replies indicated that 2,102 (92.3%) mares were still in foal as of June 1.

Farm mare populations ranged in size from two to 300 mares bred as of June 1, 2002, with an average of 53 broodmares. Responding farms indicated that in 2001, 75 had EFL, 14 had no EFL, and three did not answer. For 2002, 33 farms had EFL consistent with MRLS, 55 had no EFL, and four did not answer. Of the 33 farms with EFL in 2002, 22 (67%) had lower losses than 2001, seven had an equal number of losses, three had higher losses, and one did not answer.

ETC Control Measures

The types of caterpillar control measures used on the farm during 2002 are described in Table 1.

The majority of farms implemented between two and five control measures, as shown in Table 2.

A comparison was made between the number of measures used by farms having EFL in 2001 and 2002 versus farms having EFL in 2001 but not 2002. Farms having EFL in both years used an average of 3.1 control measures; farms not having EFL in 2002 used an average of 3.4 control measures. No individual technique was identified that

Table 1. Measures taken by farm managers to decrease exposure of mares to ETC in 2002.

	Respondents	
Spraying trees with pesticides	66	(71.7%)
Keeping mares stalled during frost warnings	59	(64.1%)
Keeping mares stalled at night	49	(53.3%)
Eliminating cherry or crab apple trees	38	(41.3%)
Limiting mare's pasture exposure (daytime)	37	(40.2%)
Manual removal of ETC eggs or tents	25	(27.2%)
Tree injection to make leaves toxic to ETC	5	(5.4%)

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made a significant difference between whether farms had EFL in 2002 or not.

Location of EFL Mares on Farms

For the 33 farms that had EFL in 2002, 25 (78.1%) had losses in mares housed primarily on the periphery of the farm, whereas only two had losses in centrally located paddocks, and five farms had losses in both areas (one survey had no response).

Of the 25 farm managers reporting losses primarily from mares on the periphery of the farm, 15 (60%) reported these fields were adjacent to non-equine premises, subdivisions, or railroads.

Discussion

The study was undertaken at the request of the Central Kentucky equine industry to determine 2002 EFL losses and the types of measures used to keep mares out of proximity of ETC. Inherent bias in mailed or faxed surveys always exists, and the above data must be interpreted with participant self-selection bias in mind.

The 92.3% pregnancy rate from these farms correlates well with the study performed by local equine clinics that reported a 90% pregnancy rate of 3,089 mares examined by ultrasound (3). The computerization of Thoroughbred breeding records on Kentucky farms greatly assisted in the compilation of these figures.

Extensive efforts were made by farms to control exposure of mares to ETC, and each measure involved extensive labor and added expense. Some farms that eliminated all wild cherry trees had no MRLS at all in 2002, after suffering extensive losses in 2001.

With only 33 farms having EFL in 2002 and 25 having losses in mares pastured on the periphery of the farm, further field investigations are needed to document the locale of the pastures versus size of farm, presence of cherry trees, and the types of adjoining property in order to make any significant conclusions.

When comparing similarities between the 2001 and 2002 foaling seasons, several points are obvious in respect to MRLS. EFL, LFL, pericarditis, and endophthalmitis cases all began in late April/early May of each year; no primary infectious etiologies were detected in animal samples; no toxins, endophytes, ergot alkaloids, mycotoxins, nitrates, nitrites, etc., were detected in pasture samples. Pastures with concentrations of ETC were correlated with EFL and/or LFL.

In contrast, the differences between the two years showed a dramatic decrease in the numbers of EFL, LFL, pericarditis, and endophthalmitis. The weather was milder in 2002. The use of pesticides varied from 0 of 133 survey farms in 2001 to 89 of 92 farms using one or more ETC control measures in 2002, with 71.7% utilizing pesticides.

Table 2. Numbers of ETC control measures used by farms in 2002.

Number of Measures	Number of Farms
1	12
2	18
3	21
4	18
5	18
6	1
7	0
no answer	3
other	1*

* Kept mares out of pastures with ETC.

Extensive efforts have been undertaken to determine the cause of MRLS, but identifying the etiology(ies) of a new disease is complex. With infectious agents, fulfilling Koch's postulates is critical. With diseases of environmental, toxic, noninfectious, or multifactorial nature, Sir Bradford Hill's Causation Criteria have to be fulfilled (4). They include the strength, consistency, and specificity of the association, temporal relationship (exposure must precede the disease), biological gradient (more exposure = more disease), biologic plausibility, coherence (proposed etiology should not conflict with factual information about the disease), evidence from experimentation, and analogy. While meeting all the criteria is not necessary to "prove" causation, the first three factors are considered the most important and need to be kept in mind as an investigation progresses.

Conclusion

Based on information from 92 Central Kentucky Thoroughbred farms, the overall EFL rate was lower in 2002, with fewer farms having EFL losses in 2002 than in 2001. Multiple control measures were undertaken to limit exposure of broodmares to ETC on the majority of farms. Observed similarities and differences in diagnostic results, weather data, temporal relationships, and the continuing ETC factor indicate that the study of ETC in the role of MRLS is critical.

Acknowledgments

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Mare Reproductive Loss Syndrome in Southeastern Ohio, Spring 2001

G. S. Frazer

The first report from a veterinarian about an unusual number of late fetal losses (LFL) in southeastern Ohio was received during the first week of May of 2001. A telephone survey of 37 veterinarians who perform a significant amount of broodmare work in Ohio localized the problem to the Appalachian foothills in southeastern Ohio (15 veterinarians). The LFL cases occurred south of a diagonal line from Cincinnati to Wheeling, West Virginia. Much of this region is comprised of heavily wooded terrain designated as the Wayne National Forest. The region contains a high number of black cherry trees, and a heavy infestation of eastern tent caterpillars (ETC) occurred during late April and May of 2001. One veterinarian from southeastern Ohio reported on numerous cases from several counties in West Virginia that are contiguous with the Ohio River.

There were no reports of similar fetal losses or ETC infestations from veterinarians in southwestern (five), central (eight), northeastern (seven), or northwestern (two) Ohio. A large farm that foaled 285 mares and bred more than 500 mares in 2001 did not report an increased incidence of either LFL or early fetal loss (EFL). This operation is located east of I-70, between Cincinnati and Columbus, in a region that is characterized by flat cropping country and minimal wooded areas. There were no reports of ETC from that location. County Extension agents did not report any unusual reproductive problems in either beef or dairy cattle herds in southeastern Ohio.

The epidemiologic investigation was impeded by the nature of the horse industry in this part of the state. Most owners raise horses as a hobby and do not rely on them as a significant source of income. Unlike the situation in Kentucky, the state veterinary diagnostic laboratory (VDL) charged more than $100 for a necropsy on an aborted foal. These economic factors meant that few fetuses were submitted for examination. Veterinarians were asked to note numbers reported in their practice, and 165 LFL cases were documented by the end of May of 2001. The majority of the abortions occurred in mares that were within four weeks of their expected foaling date. Mares aborting close to term were not agalactic and usually experienced premature placental separation or "red bag" syndrome. Some fetal membranes were described as being edematous. Most fetuses were stillborn. Some weak foals survived for a short time but succumbed to respiratory distress. Three veterinarians reported a total of 14 cases of EFL. A total of five cases of severe unilateral uveitis (endophthalmitis syndrome) was reported in foals. These neonates had corneal edema and hyphema (hemorrhage into the anterior chamber).

Based on reports from Kentucky, the Ohio VDL determined that six aborted foals exhibited lesions that were consistent with MRLS. At least three cases had prominent fibrinopurulent omphalitis (funisitis) and amnionitis. The umbilical cord lesions were limited to the amniotic segment. Bacterial isolates from aborted foals included heavy growths of *Enterobacter amigens*, *Bacillus* spp., *Serratia proteamaculans*, *Streptococcus bovis*, and moderate *E. coli.* Three horses with effusive, fibrinous pericarditis were presented for necropsy at the state VDL, and two further cases were admitted for treatment in the veterinary hospital at the Ohio State University. The pericardial sac was distended with fluid. Thick mats of fibrin diffusely coated the visceral layer of the pericardial sac and also diffusely covered the epicardial surfaces of the heart. A heavy growth of *Actinobacillus equuli* was isolated from one case.

Permission was obtained from Dr. Roberta Dwyer to use the format that was developed for the large epidemiologic survey in Kentucky. Veterinarians from southeastern Ohio

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provided contact information for those clients who were most likely to participate. Many of these subsequently declined, but 18 owners with the most reported LFL cases (117) did complete the survey. One farm reported 45 abortions within a one-week period and had experienced an especially heavy ETC infestation. Breeds represented in the LFL numbers included Thoroughbred, Standardbred, Quarterhorse, Tennessee Walking Horse, Arabian, paint, Pony, Miniature, Appaloosa, Belgian, and Percheron. The most consistent finding from the survey was the answer to the question about the severity of ETC infestation. The southeastern Ohio respondents were unanimous in that blankets of ETC covered trees, pastures, fences, stalls, hay, and water supplies. Most of the owners fed their mares on the ground, and the horses were predominately at pasture both day and night.

A follow-up survey was conducted in the spring of 2002. The majority of respondents noted that ETC were not an issue this season or that they were seen in limited numbers. Reports of an occasional abortion in southeastern Ohio were consistent with historical data. However, two cases of funisitis in aborted fetuses and one case of fibrinous pericarditis were reported from southeastern Ohio in the spring of 2002.

The conclusion from this study is that there is a circumstantial link between the heavy ETC infestation in southeastern Ohio during the spring of 2001 and the high number of LFL cases—plus unilateral uveitis and pericarditis cases—that occurred concurrently. The limited number of LFL reported in the spring of 2002 is consistent with the minimal number of ETC noted in southeastern Ohio.

Climatic Correlations of the 2001 and 2002 Episodes of Mare Reproductive Loss Syndrome

T. Priddy, C. Pieper, and W. Wang

SINCE MAY OF 2001, THE AGRICULTURAL WEATHER CENTER (AWC) has completed numerous weather analyses to determine if there were weather and climate correlations with Mare Reproductive Loss Syndrome (MRLS). According to the MRLS Web site (<www.ca.uky.edu> or <www.uky.edu.Agriculture/VetScience/gluck1.htm>), 2002 had many more equine abortions than did 2001, with 823 equine abortions during 2002 and 1,024 during the same time period in 2001. During this same time period from 1996 to 2001, an annual mean of nearly 640 equine abortions had been submitted for examination. The lack of the number of years with the occurrence of MRLS presented significant problems, but at the minimum, weather comparisons could be made between years where MRLS had occurred. In retrospect, there is evidence that cases of MRLS occurred in 1981 (1). The ultimate objective was to determine weather and climate predictors that could be monitored so that future advisories can be issued by the College of Agriculture if weather patterns begin to mirror past weather conditions when MRLS had occurred. Weather-related risk management factors were determined to be the rate of change of temperatures in the form of degree days (base 50°F) during the spring, the occurrence and frequency of frost, and the accumulation of heat as determined by analyzing threshold temperature data.

Materials and Methods

Weather and climate data were utilized from AWC databases, National Climate Data Center (NCDC), and the Midwest Climate Center, which is a regional office of NCDC. Weather and climate data from Kentucky weather stations included first-order National Weather Service weather stations and Kentucky Climate Cooperative weather/climate stations. Comparisons and analyses were conducted for maximum and minimum temperature and departure from normal, degree days (base 50°F), temperature variation, precipitation and departure from normal, soil temperature, dewpoint, and cloud cover. The complete analysis is available at: <wwwagwx.ca.uky.edu/MRLS.html>.

The focus of the study was Lexington, Kentucky, with data available from Bluegrass Airport, which is five miles west of the city, and Spindletop Research weather station, which is seven miles northwest of the city. In addition, regional climate data were utilized back to 1895 and are available on AWC's Web site at: <wwwagwx.ca.uky.edu/climdata.html>.

Results

Precipitation Analysis

Departure from normal monthly rainfall can be seen in Figure 1. An effort was made to find any similarities between rainfall patterns, especially during the spring months (shaded area). For example, in 2001, two of the three months during March through June experienced below-normal rainfall and the third above-normal rainfall. For the same time

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period in 2002, one of the three months was below normal, while two of the three were above normal. These patterns for 2001 and 2002 are actually *diametrically opposed.* Total departure from normal for 2001 and 2002 was -3.45 and 3.25 inches of rainfall, respectively.

Further, regional rainfall totals for March through May were ranked for the past 108 years of data available for the Bluegrass area in Kentucky. It was found that 2001 was the *tenth driest* with 9.93 inches, and 2002 was the *ninth wettest* with 18.93 inches. Overall, although pattern differences and similarities can be drawn from these sets of monthly data, higher resolution data and/or another moisture variable, such as dewpoint temperature, may be needed to further analyze moisture patterns.

Temperature Analysis

Several methods were utilized to express temperature comparisons between the MRLS years; frequency and distribution of days with maximum and minimum above or below a certain value, departure from normal, heat units or degree days, and frost.

Frequency of Days

The number of days on which the maximum temperatures were greater than or equal to 75°F was above normal for both 2001 and 2002, as shown in Table 1. While none occurred during March of either year, nearly twice the normal number of days occurred during April of 2001 and 50% more than normal for April 2002.

Monthly Temperature Analysis

Monthly temperature departures were analyzed in order to determine what, if any, correlation there was between this scale weather pattern and the occurrence of MRLS in a given year.

Departure from normal for average monthly temperature can be seen in Figure 2. Temporal similarities in average temperature departure are limited. The last two months of the MRLS season were above normal in 2001, and the first two months were above normal in 2002. In both cases, two of the three months of the MRLS season were above normal, and one month was below normal. Total deviation from normal for the two years totaled 5°F. For those years when MRLS occurred, monthly temperatures for April were record warm periods, with 1981 ranked as the third warmest, 2001 as the fourth warmest, and 2001 as the sixteenth warmest in the past 108 years. Overall, although pattern differences and similarities can be drawn from these sets of monthly data, higher resolution data may be desired to further analyze temperature patterns.

Table 1. Frequency of days with maximum temperature greater than or equal to 75°F in Lexington, Kentucky, March - June.

Year	March	April	May	June	Total
2001	0	13	19	26	58
2002	0	10	13	28	51
Normal*	2	7	16	27	51

* Normal is based on the years 1971-2000.

Heat Accumulation or Degree Day Analysis

An additional method was needed to quantify the explosive nature of spring temperatures to analyze the amount of heat accumulation or "degree days" that occurred. A degree day is calculated using the daily average temperature (sum the daily high and low temperatures, then divide by two) minus a threshold temperature.

Degree days are used in a number of applications such as insect growth and development (i.e., European corn borer degree days), crop growth and development (corn and rice growing degree days), and residential heating and cooling (heating and cooling degree days). The difference between each of these applications is the "threshold temperature" used to calculate the degree days. For example, one insect called alfalfa weevil develops at temperatures equal to or

Figure 1. Monthly rainfall departure from normal for January 2001 through July 2002. (Shading represents spring months.)

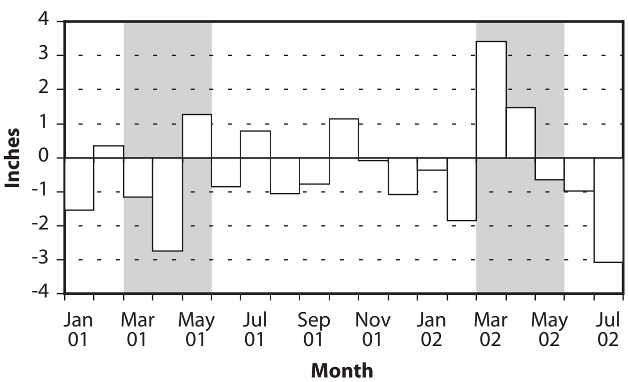
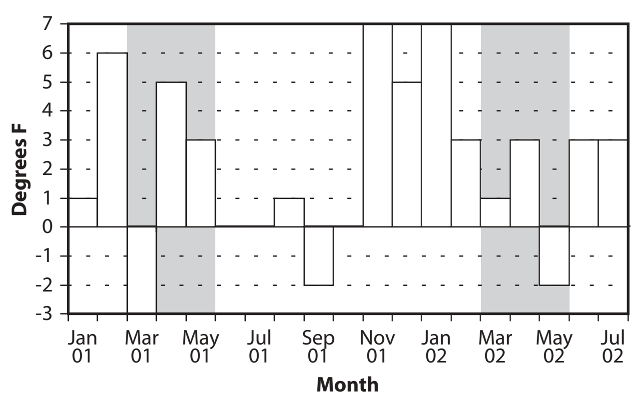


Figure 2. Departure from normal monthly temperatures for 2001 through July 2002. (Shading represents spring months.)



greater than 48°F, so the threshold temperature is 48. Corn growing degree days are calculated using a threshold temperature of 50°F, and heating and cooling degree days use a threshold temperature of 65°F.

For MRLS degree days, a threshold temperature of 50°F was selected. For a given day, if the daily high temperature was 80°F and the daily low temperature was 60°F, the following calculation provided the MRLS degree days (MRLS DDs) for the day:

$$\left[\frac{\text{(High temp + low temp)}}{2}\right] \text{ - threshold temperature = daily MRLS DDs}$$

Example: [(80˚ + 60˚)/2] - 50˚ = 20 MRLS DDs

To make these calculations, a computer program was developed that calculated the daily MRLS degree days from the daily high and low temperature for Lexington for current and past years. Additional variables calculated were the degree day accumulation, daily normal, daily departure from normal, accumulated normal, daily accumulated departure from normal, and the rate of change from normal over the previous 7 days.

MRLS degree days were plotted for 30 years. Those years in which MRLS occurred showed a significant rate of change of heat accumulation over a relatively short time period of 7 to 10 days during March and April, as shown in Figure 3. Further, low temperatures near or below 32°F during April occurred in all MRLS years, yet were not always an occurrence during non-MRLS years.

The total accumulation of MRLS degree days during March and April for 2002 was 348; for 2001, it was 334; and for 1981, it was 360. Normally during March and April, 154 degree days are accumulated. For 2002, the number was 194; for 2001, it was 180; and for 1981, it was 206.

The integration of weather events for 2002 is plotted in Figure 4. The occurrence of the 7-day rate of change of

Figure 3. Accumulation of MRLS degree days for March - April of 1980, 1981, and 2001.

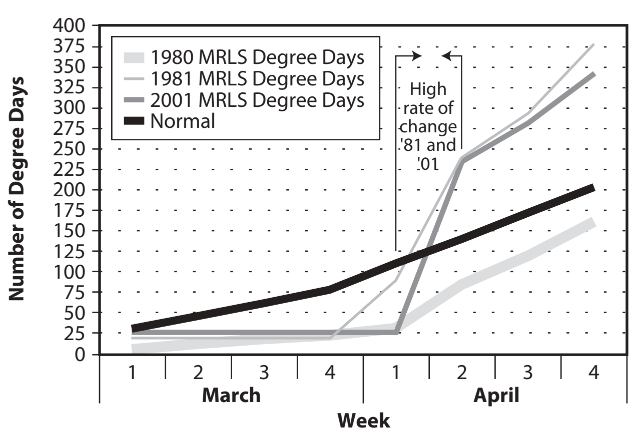
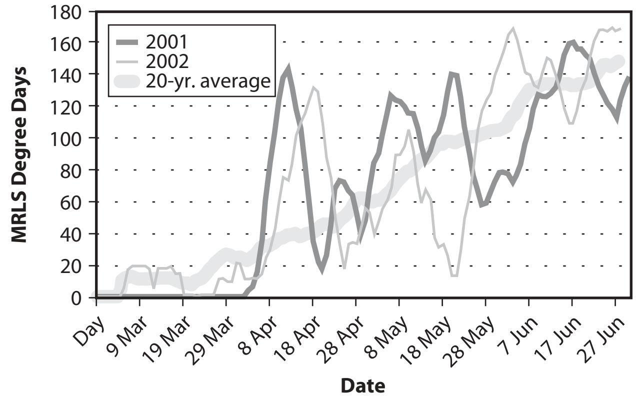


Figure 4. 7-day rate of change of MRLS degree days (2001, 2002, 20-yr. average), Lexington, Kentucky.



MRLS degree days and the total accumulations of MRLS degree days were very similar.

For March and April 2001, the maximum rate of change of MRLS degree days over a 7-day period was 143; for the same period during 2002, it was 132; during 1981, it was 96. The normal rate of change is 40 to 60 MRLS degree days during this time period.

Frost

The frequency and magnitude of minimum temperatures below 32°F are listed in Table 2 and indicate that frost was a common occurrence during the early spring season for both years. In ranking the top 20 warmest spring seasons, only one year (1985) had all of the weather-related risk management factors, including frequent frost, yet did not have MRLS reported. Prior to the year 1980, no MRLS data are available. Therefore, frost will be considered a weather-related risk management factor until more data become available.

Temperature Variation

The fact that both a quick accumulation of heat in a given season and a frost are possible risk management factors for MRLS suggests that variation in temperature may be a factor in MRLS risk management. In Table 3, it can be seen that through the 2001 and 2002 seasons, there was an above-normal number of days above 80°F and also an above-normal number of days below 32°F. Not only are these MRLS seasons abnormally warm, but they were also, in most cases, the victims of frosts and considerable day-to-day temperature variation.

Conclusions

At the beginning of the study, one very important agricultural weather variable, rainfall, was considered to be a possible predictor. Since MRLS occurred during the drought of the spring of 2001 and during the record wet spring of 2002, monthly rainfall totals and departure from normal

Table 2. Frost dates for March and April 2001 and 2002.

Year	Month	Day	Maximum Temperature (°F)	Minimum Temperature (°F)
2001	Mar	1	45	22
2001	Mar	5	36	28
2001	Mar	6	36	24
2001	Mar	7	45	28
2001	Mar	8	51	28
2001	Mar	9	42	23
2001	Mar	10	49	21
2001	Mar	18	49	29
2001	Mar	19	58	29
2001	Mar	23	63	31
2001	Mar	25	42	23
2001	Mar	26	35	19
2001	Mar	27	44	20
2001	Mar	28	55	25
2001	Apr	17	42	29
2001	Apr	18	54	28
2002	Mar	1	49	23
2002	Mar	3	27	21
2002	Mar	4	24	4
2002	Mar	5	51	26
2002	Mar	10	42	24
2002	Mar	11	52	22
2002	Mar	21	52	31
2002	Mar	22	35	16
2002	Mar	23	49	20
2002	Mar	24	67	32
2002	Mar	27	43	30
2002	Mar	28	61	29
2002	Apr	4	47	30
2002	Apr	5	50	28
2002	Apr	6	45	32
2002	Apr	7	67	32
2002	May	19	58	32

Table 3. Temperature variations for 1981, 2001, and 2002.

Days > 80	**2001**	**2002**	**1981**	**Normal**
March	0	0	1	0
April	10	7	4	3
May	11	7	6	9
June	21	24	24	21
SUM (March-June):	42	38	35	33
SUM (March-May):	21	14	11	12
Days < 32	**2001**	**2002**	**1981**	**Normal**
March	14	12	18	13
April	2	4	1	4
May	0	1	0	0
June	0	0	0	0
SUM (March-June):	16	17	19	17
SUM (March-May):	16	17	19	17
(Days > 80) + (Days < 32)	**2001**	**2002**	**1981**	**Normal**
March	14	12	19	13
April	12	11	5	7
May	11	8	6	9
June	21	24	24	21
SUM (March-June):	58	55	54	50
SUM (March-May):	37	31	30	29

rainfall was deleted as a possible weather-related risk management factor.

Several other weather-related risk management factors were determined as possible predictors of years favorable for MRLS. Heat accumulation in the form of degree days (base 50°F) was determined as a possible predictor. The rate of change of heat accumulation over a 7-day period was also determined as a possible predictor. The magnitude and frequency of frost was considered the third predictor for the occurrence of years with MRLS.

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Summary

D. Powell

I will consider the three presentations and highlight some aspects and conclude with one slide (Figure 1) that relates to the possible influence of population dynamics on Mare Reproductive Loss Syndrome (MRLS).

It is important to emphasize the continuing nature of the epidemiological studies. Initially, in the summer of 2001 several risk factors were identified: caterpillars and the role of cherry trees. That's exactly the purpose of an epidemiological study: not necessarily identify cause but risk factors, which enable researchers to pursue a particular path of investigation. In addition, epidemiological studies assisted in developing not only research proposals but also recommendations for what farms should do to prevent the problem in 2002. We have seen the benefits of both those initiatives.

With the experience of working in Kentucky and other parts of the world, I would like to emphasize the significance of obtaining accurate data. The equine population in Central Kentucky is an excellent resource for such information. The observations Dr. Frazer made about his

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investigations in Ohio support that statement. The Central Kentucky equine population, primarily Thoroughbred, is very well managed, with excellent records that provide good accurate data.

Another factor I'd like to emphasize in the recognition of access to data is the importance of having one diagnostic laboratory to which material is submitted from the Bluegrass area. This situation created a tremendous influx of material for detailed pathological examination. During that first week of May of 2001, material coming through the University of Kentucky Livestock Disease Diagnosis Center (UKLDDC) was overwhelming but reflective of what was occurring in the field.

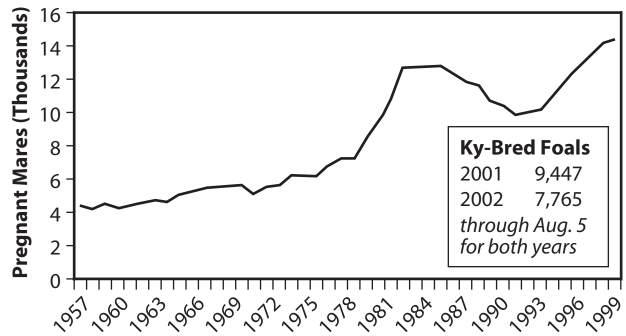
Dr. Dwyer emphasized, as a consequence of the epidemiological studies and with considerable help from the industry, farm managers, and veterinarians, we now are in a position to develop excellent baseline disease incidence data regarding fetal and foal losses allowing meaningful interpretations from year to year.

Considering Dr. Frazer's presentation, in Kentucky we learned initially through phone calls or conversations the possible distribution of MRLS outside the state. Dr. Frazer's contribution has better defined the geographical distribution. It is intriguing how it was restricted to southeastern Ohio, and the question one might ask is, "What are the factors that appear to have restricted it to that area which didn't prevail in other areas of Ohio?"

Moving to Tom Priddy's presentation, we've been working with him over the years examining weather factors that might relate to the sporadic appearance from year to year of fescue endophyte toxicosis. This culminated with the weather observations during 2001 and 2002. From the data he's presented, there's a wealth of information, and perhaps we should take a closer look at weather patterns and their influence on disease incidence.

I will conclude with a slide that examines the host-parasite relationship. A great deal of this meeting will be looking at what is the potential parasite(s) causing MRLS. This morning we examined the effect of MRLS on the mare. Figure 1 examines the host/parasite relationship at the population level looking at the annual incidence of EHV-1 abortion and how it has changed from year to year. The

Figure 1. Population of pregnant Thoroughbred mares in Kentucky 1957 - 2000.



annual Thoroughbred pregnant mare population in Kentucky is derived from the Jockey Club foal registrations each year estimated to represent 70% of the pregnant mare population of the previous year. The population changes from year to year are primarily influenced by economic forces, principally the annual sale price of yearlings. As the yearling prices increased in the early 1980s, so did the pregnant mare population, and as prices fell in the early 1990s, so did the mare population. In recent years, the population rose to the highest it's ever been. During 1981, the pregnant mare population was about 8,000. Since that time, the population has virtually doubled. A significant increase in the book size, or number of mares covered annually by each Thoroughbred stallion, has taken place. It was 40 mares per year but has gradually increased to the extent that many stallions in Central Kentucky cover more than 100 mares. In order to manage the stallion to accommodate a large number of mares over a relatively short breeding season, barren and maiden mares are mated during February and early March. It was those mares in 2001 between 40 and 100 days gestation by the end of April and early May that were exposed to the causal agent of MRLS. This provides an explanation for the large number of losses that occurred. Figures recently provided by the Jockey Club indicate the number of foals registered in Kentucky in 2001 was 9,400 and in 2002, as of August 5, it was 7,765, a 17.8% reduction.