A BETTER knowledge of the normal reproductive performance of the horse is needed as a background for studies directed toward improving reproductive efficiency. Detailed information on the reproductive efficiency of breeding farms under various systems of management is of value in locating problem areas and factors affecting this efficiency. The present study was undertaken for the purpose of making such observations on selected farms where detailed records were available. No attempt was made to obtain data representative of the horse industry as a whole, nor were the data considered sufficiently standardized for statistical interpretation.

Materials and Methods

Breeding records from 14 farms for the 1960–64 breeding seasons were assembled. Data for each year were not available from each farm, however, the source and nature of data obtained are shown in table I. Records and information concerning management systems and reproductive problems were collected by visitation. Three measures of annual reproductive efficiency were used, defined as follows:

\[
\text{Conception} \% = \frac{\text{No. foals born alive or dead} + \text{No. abortions noted}}{\text{No. mares mated}} \times 100
\]

\[
\text{Foaling} \% = \frac{\text{No. foals born alive}}{\text{No. mares mated}} \times 100
\]

\[
\text{Weaning} \% = \frac{\text{No. foals reported dead before 6 mo.}}{\text{No. mares mated}} \times 100
\]

Where data were pooled over years, the "mare-years" expression became the denominator in the above estimates. Individual service records were used to construct breeding frequency ratios including periods/mare-year, services/mare-year and services/period. A breeding period was defined as an estrus where at least one service took place. Two services separated by 10 days or more were considered to indicate different periods. A service was defined as an individual insemination either natural or artificial. Effects of the breeding status of the mare, month of breeding and age of mare were considered. Observations were also made on management practices and reproductive problems on each farm. The primary breed represented on each farm has been abbreviated as follows: T=Thoroughbred, Q=Quarter Horse, S=Standardbred, Ap=Appaloosa, A=Arabian, P=Pony (including Shetlands, Welsh, Hackney and Grade.)

Results and Discussion

A summary of conception efficiency by farms and years is shown in table 2. Considerable variation between years within farms suggest year differences as shown by Speelman et al. (1944). The possibility of breed differences agrees with the findings of Jordao et al. (1952a, b). Although conclusions cannot be drawn regarding the high efficiency observed on the farm, either breed differences favoring the ponies or an exceptionally favorable management situation is suggested. The variability between farms may reflect important differences in management practices affecting the environment for reproductive performance. Although very diverse management methods were noted, the systems on the five Thoroughbred farms can be classified as "intensive" hand breeding, while the other farms primarily used less intensive hand breeding techniques. The intensive system is characterized by giving maximum individual attention and veterinary assistance to each mare. Burger (1963) observed similar types of breeding management systems and "less than gratifying" results in the "more precise" system. Pasture breeding was also used with one stallion on Farm Q1 involving 50 mare-years in three seasons, and on Farm Q4 with three stallions involving 30 mare-years in one season. Conception efficiency means resulting from these pasture matings were 94.0 and 100.0%, respectively.

1 Published with approval of the Director, Agricultural and Life Sciences.
A reflection of the management differences observed among farms was shown in the breeding frequency ratios summarized in Table 3. The periods/mare-year ratio, primarily an expression of non-return rate, varied over a range of 1.12 to 2.30 with a mean of 1.68. The services/period ratio, which is affected primarily by management practices and estrus length, varied from 1.11 to 2.33 with a mean of 1.64. Both ratios contribute to the magnitude of the services/mare-year ratio, which varied from 1.24 to 3.55 with a mean of 2.74. Although these data do not lend themselves to conclusions involving optimum service frequency, the variability of ratios and efficiency observed suggest a need for studies in this area. Few such observations on breeding frequency have been reported. Trum (1950) reported services/mare-year ratios of 1.8 and 1.6 for two stallions, which were bred to 222 mares with 80.2% conception. Caslick (1937) stated that about three periods are required to produce each pregnancy in the average Thoroughbred stud, while Lieux (1963) estimated that the average Thoroughbred stallion supplies slightly more than two services per mare in settling 70 to 75% of 40 to 45 mares in a season. These estimates seem comparable to the results of the present study. It was expected that mares that were not settled would be served in considerably more periods and would receive more services/mare-year than mares who did conceive during the season. Most stud managers further expressed intentions of serving "problem" mares more frequently within each period. Periods/mare-year, services/period and services/mare-year ratios of 1.58, 1.64 and 2.59, respectively,
TABLE 3. CUMULATIVE BREEDING FREQUENCY RATIOS AND REPRODUCTIVE EFFICIENCY MEANS

<table>
<thead>
<tr>
<th>Farm</th>
<th>Observations</th>
<th>Efficiency means</th>
<th>Frequency ratios&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Percent conceiving</td>
<td>Percent foaling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>76.9</td>
<td>66.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80.4</td>
<td>71.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>69.4</td>
<td>62.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63.3</td>
<td>60.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>72.3</td>
<td>65.9</td>
</tr>
<tr>
<td></td>
<td>1042</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q&lt;sub&gt;1&lt;/sub&gt;</td>
<td>3</td>
<td>228</td>
</tr>
<tr>
<td></td>
<td>Q&lt;sub&gt;2&lt;/sub&gt;</td>
<td>5</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Q&lt;sub&gt;3&lt;/sub&gt;</td>
<td>3</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Q&lt;sub&gt;4&lt;/sub&gt;</td>
<td>2</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Q&lt;sub&gt;5&lt;/sub&gt;</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>400</td>
<td>88.3</td>
</tr>
<tr>
<td></td>
<td>S&lt;sub&gt;1&lt;/sub&gt;</td>
<td>5</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;1&lt;/sub&gt;</td>
<td>5</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;</td>
<td>4</td>
<td>112</td>
</tr>
<tr>
<td></td>
<td>P&lt;sub&gt;1&lt;/sub&gt;</td>
<td>4</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>Total all farms</td>
<td>1876</td>
<td>80.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Mare-years are the total number of matings each year summed over the number of years studied.

<sup>b</sup> All frequency ratios based on 1027 mare-years.

<sup>c</sup> Based on 487 mare-years.

<sup>d</sup> Based on 172 mare-years.

<sup>e</sup> Based on 1093 mare-years.

... were observed for mares which conceived compared to ratios of 2.14, 1.53 and 3.28, respectively, for mares not conceiving. The differences in magnitude of the services/mare-year and periods/mare-year ratios were surprisingly small while the smaller services/period ratio for non-conceiving mares suggests that true "problem" mares may not have been identified.

The cumulative efficiency means of 80.1% conception, 73.8% live foaling and 70.8% weaning in this study are somewhat higher than those reported or estimated by other workers. Cummings (1942), Kays (1953) and Ensminger (1961) have estimated the national live foal crop at 50 to 65%. Unpublished data assembled by the American Quarter Horse Association (Jim Goodhue, personal communication, 1966) for stallions serving 50 or more mares annually in 1960 and 1961 indicated that 64.9% of 5265 such mares produced registered foals. Honnen (1963) surveyed Quarter Horse breeders by questionnaires and reported a 65.5% foal crop for 21,226 mares. However, Ensminger (1961) found an 80% foal crop in records of 122 farms responding to his questionnaire and concluded that "better producers" had responded.

**Effects of the Month of Breeding.** Comparisons of conception rates by months are shown in table 4. Considered collectively or on a within-farm basis, the months January and February appear poorest, while the optimum breeding season appears to be from April onward. For those farms where breeding continued through the summer months, no decline in fertility was noted; however, the numbers of observations in August and September were small. This general pattern of seasonal fertility agrees with the findings of Day (1940), Berliner (1942) and McGee (1958) who have noted more pronounced occurrences of cyclic irregularities and lower fertility early in the breeding season. Trum (1950) found that...

TABLE 4. CONCEPTION RATES<sup>a</sup> BY MONTH OF SERVICE

<table>
<thead>
<tr>
<th></th>
<th>Five TB&lt;sup&gt;b&lt;/sup&gt; farms</th>
<th>Four non-TB farms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo.</td>
<td>No. served</td>
<td>% Conc.</td>
<td>No. served</td>
</tr>
<tr>
<td>Jan.</td>
<td>. . .</td>
<td>7</td>
<td>28.6</td>
</tr>
<tr>
<td>Feb.</td>
<td>53</td>
<td>20.8</td>
<td>37</td>
</tr>
<tr>
<td>March</td>
<td>232</td>
<td>47.4</td>
<td>63</td>
</tr>
<tr>
<td>April</td>
<td>283</td>
<td>47.7</td>
<td>161</td>
</tr>
<tr>
<td>May</td>
<td>250</td>
<td>34.4</td>
<td>168</td>
</tr>
<tr>
<td>June</td>
<td>99</td>
<td>46.5</td>
<td>117</td>
</tr>
<tr>
<td>July</td>
<td>. . .</td>
<td>81</td>
<td>50.3</td>
</tr>
<tr>
<td>Aug.</td>
<td>20</td>
<td>45.0</td>
<td>20</td>
</tr>
<tr>
<td>Sept.</td>
<td>. . .</td>
<td>7</td>
<td>57.1</td>
</tr>
</tbody>
</table>

<sup>a</sup> Percent conception = \( \frac{\text{No. mares conceiving to terminal service in a particular month}}{\text{No. mares served during this month}} \times 100 \)

<sup>b</sup> Thoroughbred.
more long estrous periods (over 10 days) occurred in March than in succeeding months, and that lower fertility was associated with long estrus periods.

Effects of Mare Age on Conception Efficiency. Birth years for brood-mares on six farms were obtained, comprising 659 mare-years. Over-all conception efficiency for this group was 76.2%. The relationship observed between mare age and conception efficiency is shown in table 5. Average fertility fluctuated until age 7, maintained a plateau of about 80% until age 12, and then gradually declined. An unexplained but sharp decline in conception efficiency of 6-yr.-old mares was noted on all four Thoroughbred farms, but not on the Arabian or the Standardbred farm. This general pattern of the mare age effect is similar to those reported by Lambert et al. (1939) and Speelman et al. (1944), with the exception of this sixth year phenomenon. Although no reason for this effect is proposed, the peculiar racing and breeding management of Thoroughbreds may be involved. Most of these 6-yr.-old mares were in their second lactation and/or breeding season.

Reproductive Status of the Mare. Caslick (1937) studied records of 683 foaling, 233 barren, and 73 maiden Thoroughbreds and reported conception percentages of 77.9, 82.4 and 83.7, respectively. However, Andrews and McKenzie (1941) reported an opposite trend for 160 matings of Thoroughbred and grade draft mares. Conception percentages for lactating, dry and maiden mares in their study were 71.1, 68.9 and 42.1, respectively. Results of the present study (table 6) show less variability for these groups, as conception efficiencies for lactating, barren and maiden mares were 79.5, 72.4 and 78.6%, respectively. Limited observations for mares that had previously aborted and those that had lost foals in the current season indicated conception efficiencies of 83.3 and 68.7%, respectively. For these 775 mare-years, where status information was obtained, cumulative conception and foaling percentages were 77.8 and 72.8, respectively. Observed abortion rates (conception %—foaling %) were 4.8, 7.2, 0.0, 4.2 and 6.2%, respectively, for lactating mares, barren mares, maiden mares, mares that had previously aborted and mares that had lost foals, respectively. No abortions were noted for the maiden mares in this study.

Other Observations. In 1,161 mare-years of records where individual service data were supplied, only seven anestrous mare-years were reported for an incidence of 0.60%. This contrasts sharply with the reports of Andrews and McKenzie (1941) who reported that 15% of 89 mares were anestrous in at least one season in a 3-yr. study. Lieux (1963) expressed concern regarding a twinning rate

<table>
<thead>
<tr>
<th>Age</th>
<th>Four TB farms</th>
<th>All farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>% Conc.</td>
<td>No.</td>
</tr>
<tr>
<td>2-4</td>
<td>34</td>
<td>82.1</td>
</tr>
<tr>
<td>5</td>
<td>40</td>
<td>75.0</td>
</tr>
<tr>
<td>6</td>
<td>39</td>
<td>56.5</td>
</tr>
<tr>
<td>7</td>
<td>52</td>
<td>76.9</td>
</tr>
<tr>
<td>8</td>
<td>56</td>
<td>80.4</td>
</tr>
<tr>
<td>9</td>
<td>48</td>
<td>89.6</td>
</tr>
<tr>
<td>10</td>
<td>46</td>
<td>84.8</td>
</tr>
<tr>
<td>11</td>
<td>38</td>
<td>81.6</td>
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<tr>
<td>12</td>
<td>33</td>
<td>84.8</td>
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<tr>
<td>13</td>
<td>23</td>
<td>78.3</td>
</tr>
<tr>
<td>14</td>
<td>22</td>
<td>81.8</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>66.7</td>
</tr>
<tr>
<td>16-19</td>
<td>31</td>
<td>67.7</td>
</tr>
<tr>
<td>20-24</td>
<td>13</td>
<td>53.8</td>
</tr>
</tbody>
</table>
TABLE 7. MONTH OF TERMINAL SERVICE FOR MARES WHICH DID NOT CONCEIVE

<table>
<thead>
<tr>
<th>Month last bred</th>
<th>No. mares</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>Total barren</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five TB farms</td>
<td></td>
<td>.</td>
<td>0</td>
<td>7</td>
<td>19</td>
<td>47</td>
<td>53</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>126</td>
</tr>
<tr>
<td>Total nine farms</td>
<td></td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>23</td>
<td>59</td>
<td>70</td>
<td>23</td>
<td>9</td>
<td>3</td>
<td>323</td>
</tr>
</tbody>
</table>

of approximately 5% on his Thoroughbred practice. Only 11 (2.4%) of the 462 Thoroughbred conceptions in the present study were twins, and only one twin conception (0.16%) was noted among 624 non-Thoroughbred conceptions. Only two of the 12 mares reported conceiving twins carried them to term. It is noted that apparent conception efficiency as discussed previously is not the same as true conception or fertilization. Early abortions and embryonic deaths would not be detected from these records. The number of terminal services to non-conceiving mares, which occurred before the last months of the breeding season (table 7) suggests early embryonic mortality as a factor in low apparent conception efficiency. Since the breeding season on Thoroughbred farms is a rigid February to June period and frequent estrus detection is practiced, it seems important that 73 of 126 barren Thoroughbred mares (57.9%) were served terminally before the last month of the season.

Summary

Reproductive efficiency was estimated from breeding records involving 1,876 mare-years on 14 farms and six breeds for the period 1960–64. Conception, foaling and weaning efficiency means were 80.1%, 73.8% and 70.8%, respectively. Individual service data on 1,027 mare-years indicated mean breeding frequency ratios of 1.71 period/mare-year, 2.75 services/mare-year and 1.61 services/period. Considerable variation in efficiency between years and farms was noted. Lactating, barren and maiden mares averaged 79.5%, 72.5% and 78.6% conception, respectively. The conception rate varied seasonally, being very low in January and February, rising to a peak in May and declining gradually thereafter. The conception efficiency of young mares fluctuated until age 7, reached a peak of 89.6% at age 9, remained on a plateau above 70% until age 15, and declined thereafter. On each of four Thoroughbred farms, an unexplained sharp decline was noted for the sixth year. The incidences of complete anestrus and twinning were low, 0.60% and 1.1%, respectively.

Literature Cited


