Influence of available uterine space per fetus on fetal development and prenatal survival in rabbits selected for uterine capacity

M.J. Argente a,*, M.A. Santacreu b, A. Climent b, A. Blasco b

a Universidad Miguel Hernández de Elche, Departamento de Tecnología Agroalimentaria, División de Producción Animal, Carretera de Beniel Km 3,2, 03312 Orihuela, Spain
b Universidad Politécnica de Valencia, Departamento de Ciencia Animal, P.O. Box 22012, 46071 Valencia, Spain

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Abstract

The relation between the number of implanted embryos and available uterine space per fetus in intact does, and also the effect of available uterine space on the development of the fetus and the survival rate at 18 days of gestation were examined. Rabbits came from the sixth generation of a divergent selection experiment on uterine capacity. The high and low lines showed the same ovulation rates, but the high line had a higher rate of implantation and number of live fetuses (P<0.05). As a consequence of the higher degree of uterine overcrowding in the high line, the length of full uterine horn was 10% higher (P<0.10) and the available uterine space per live fetus was 20% lower (P<0.05) than in the low line. The available uterine space per implantation site showed a negative quadratic regression coefficient with the number of implanted embryos (P<0.001) and a negative linear regression coefficient with the number of dead fetuses (−0.19 ± 0.10). The available uterine space had a quadratic relation with the length of maternal placenta (P<0.001), and it was linearly associated to development of fetal placenta and fetus (P<0.05). The fetal position within the uterus did not affect the proportion of dead embryos. However, the fetuses with placentae receiving fewer than three blood vessels showed a higher probability of death (P<0.01) and a smaller uterine space (P<0.05) than those receiving more than three blood vessels. A poor vascular supply and reduced uterine space could affect the subsequent fetal development.

Keywords: Blood vessels; Fetal development; Fetus; Placenta; Rabbits; Uterine horn

1. Introduction

Prenatal survival is an important trait in relation to litter size, since only 60% to 80% of shed ova arrive at birth (see review in rabbits, pigs and mice by Blasco et al., 1993). Increasing the number of implanted embryos does not increase litter size in the same proportion, because many embryos are reabsorbed between implantation and birth (Adams, 1960; Hafez, 1966 in rabbits; Dzuik, 1968; Webel and Dzuik, 1974 in pigs). It has been suggested that losses resulting from intrauterine crowding can be reduced by select-
ing for uterine capacity (Blasco et al., 1994 in rabbits; Christenson et al., 1987 in pigs; Clutter et al., 1990 in mice). Uterine capacity is defined as the maximum number of fetuses that the dam is able to support at birth when ovulation rate is not a limiting factor (Christenson et al., 1987). Therefore, uterine capacity depends on the number of implanted embryos and subsequent fetal survival. Vallet and Christenson (1993) reported in pigs that fetal development seems to be associated with available uterine space per fetus. Thus, fetal survival can be related to availability of uterine space. The aim of this study is to examine the relation between the number of implanted embryos and the available uterine space per fetus from an experiment of divergent selection on uterine capacity (Blasco et al., 2005).

2. Materials and methods

2.1. Animals and management

Rabbits came from the sixth generation of a divergent selection experiment on uterine capacity. Details on this experiment can be found in Argente et al. (1997). Uterine capacity was estimated as litter size in unilaterally ovariectomized does. Records were available from 12 intact does of the high uterine capacity line and 14 intact does of the low uterine capacity line. Females were individually housed in cages from 18 weeks of age and they were fed with a diet containing 17.5% crude protein, 14.5% crude fiber and 3.4% fat. The does were first mated at 18 weeks of age and thereafter 10 days after parturition. Does were slaughtered on day 18 of their last gestation (fifth or sixth) at \(4.01 \pm 0.37\) kg live weight (mean \(\pm\) S.D.). The ovaries and the uterine tract were recovered immediately following slaughter and transported within 10 min to the laboratory for further processing. At the laboratory, the number of corpora lutea was recorded. An external examination of the uterine horn was made to locate the implantation site of each fetus. The number of blood vessels arriving at the implantation sites was counted, as shown in Argente et al. (2003). Afterwards, the mesometrium was trimmed from the right and left uterine horns. Each ovary and uterine horn with its fetuses was weighed. The length of each uterine horn was determined by measuring along the antimesometrial border from the tip to the base of the horn, then it was opened lengthwise and the position and status of each fetus were recorded starting at the ovarian end. There were three uterine positions: oviduct (the first fetus nearest the ovarian end), middle (fetuses in middle of the uterine horn) and cervix (the last fetus in the uterine horn from the ovarian end). Fetuses were classified according to their status as live or dead; the presence in the implantation site of an atrophic fetal placenta with maternal placenta or only atrophic maternal placenta was also considered as a dead fetus. Each fetus with its fetal placenta was removed from the uterine horn. The fetus and its fetal placenta were separated and weighed, and fetal crown-rump length (CRL) was measured. Length of each maternal placenta and the distance between adjacent maternal placentae or to end of uterine horn were measured. Space of uterine horn occupied by a fetus was calculated. Space for the fetus on the oviductal or cervical end of the uterus was calculated as the distance from the tip of the uterine horn to the maternal placenta plus the length of its maternal placenta and one-half the distance to the adjacent maternal placenta. Space for other fetuses was considered to be the length of their maternal placentae plus one-half the total distance to their two adjacent maternal placentae. This measurement was considered to be the available space per fetus (see Fig. 1). In total, there were 129 and 110 live fetuses in the high and low lines, and 15 and 23 dead fetuses in the high and low lines, respectively. Finally, each dissected empty uterine horn was weighed and the length of each empty uterine horn was measured.

2.2. Traits

2.2.1. Traits measured on each uterine horn of the doe

Variables measured were ovulation rate estimated as the number of corpora lutea, number of implanted embryos estimated as the number of implantation sites (implantation sites are identifiable during early gestation and they remain identifiable on day 18 of gestation or later if the embryo dies shortly after implantation site formation), number of live fetuses at 18 days of gestation, number of dead fetuses from implantation until day 18 of gestation (implanted embryos—live fetuses at 18 days of gestation), embryonic survival (implanted embryos/ovulation
rate), fetal survival at 18 days of gestation (live fetuses at 18 days of gestation/implanted embryos), prenatal survival from ovulation rate until 18 days of gestation (live fetuses at 18 days of gestation/ovulation rate), ovarian weight, length and weight of each full and empty uterine horn, distance between the oviduct and the first maternal placenta, and distance between the last maternal placenta and the cervix.

2.2.2. Traits measured on the fetus
Variables measured were individual weight of the fetus and its fetal placenta, crown-rump length, length of the maternal placenta and available uterine space per fetus.

2.3. Statistical analyses

2.3.1. Differences between lines for doe traits
The traits were analyzed using the following model: $y_{ijklm} = \mu + L_i + OP_j + SU_k + m_{ijkl} + e_{ijklm}$. Where $\mu$ is the general mean, $L_i$ is the line effect (high and low), $OP_j$ is the order of parity effect (fifth or sixth), $SU_k$ is the side of uterine horn (right or left), $m_{ijkl}$ is the random effect of female and $e_{ijklm}$ is the random residual term. The model for ovarian weight included ovulation rate as a covariate. For uterine length and weight and distance between oviduct and first maternal placenta, number of implanted embryos by uterine horn was added to the model as a covariate. MIXED procedure of SAS (SAS Inst. Inc., Gary, NC) was used for these analyses.

2.3.2. Differences between lines for individual traits of the fetuses
The individual traits of the fetuses were analyzed with a mixed model that included a random effect of mother of the fetus. The model was: $y_{ijklm} = \mu + L_i + \text{OP}_j + \text{SU}_k + \text{Pl} + m_{ijkl} + e_{ijklm}$, where $\text{Pl}$ is the fixed effect of the position of fetus in the uterine horn, $m_{ijkl}$ is the random effect of mother of the fetus and $e_{ijklm}$ is the random residual term. Number of implanted embryos by uterine horn was added to the model as a covariate in order to analyze available uterine space per fetus and length of the maternal placenta. For length of the maternal placenta, either total number of implanted embryos in both uterine horn or available uterine space per fetus was included in the model as a covariate. MIXED procedure of SAS was used for these analyses.

2.3.3. Relationships between traits of the doe and average traits of the live fetuses
In order to assess the relationships of average available uterine space by implanted embryo on number of implanted embryos, the followed model was used: $y_{ijklm} = \mu + L_i + \text{OP}_j + \text{SU}_k + m_{ijkl} + bx_{ijklm} + (b^*L_i)x_{ijklm} + e_{ijklm}$, where $x_{ijklm}$ is the covariate, $b$ is the overall regression coefficient and $(b^*L_i)$ is the interaction between the regression coefficient and the line. $b + (b^*L_i)$ is the regression coefficient within the line. If the interaction $(b^*L_i)$ was significantly different from zero, the regression coefficients of the high and low uterine capacity lines were different. A quadratic term was included in the former model to study the quadratic relationships between traits. MIXED procedure of SAS was used for this analysis.

Average available uterine space per implanted embryo depended on the number of implanted embryos (IE). In order to analyze the relationships between available uterine space per implanted embryo and number of dead fetuses, free of the effect of number of implanted embryos, a regression of the residual values
of available uterine space was performed. The residual values were estimated using the following model:

\[ y_{ijklm} = \mu + L_i + OP_j + SU_k + b_1 * IE_{ijkl} + b_2 * IE_{ijkl} + e_{ijklm}. \]

### 2.3.4. Relationships between traits of the doe and individual traits of the live fetuses

In order to study the relationships among individual weight of the live fetus, individual weight of the fetal placenta, and individual length of the maternal placenta on number of implanted embryos and on available uterine space per fetus, the following model was used:

\[ y_{ijklmnp} = \mu + L_i + OP_j + SU_k + P_l + m_{ijklm} + bx_{ijklm} + (b_1 * L)x_{ijklm} + e_{ijklm}. \]

MIXED procedure of SAS was used for these analyses.

### 2.3.5. Uterine position, blood supply and fetal development

The distributions of percentage of live and dead fetuses per uterine position and number of blood vessels were analyzed using a contingency chi-square test. Moreover, weight of the live fetus and its fetal placenta, length of the maternal placenta, fetal crown-rump length and available uterine space by fetus were analyzed using a mixed model that included a random effect of the position of fetus in the uterine horn and individual length of the maternal placenta on number of implanted embryos and on available uterine space per fetus, the following model was used:

\[ y_{ijklmnp} = \mu + L_i + OP_j + SU_k + P_l + m_{ijklm} + bx_{ijklm} + (b_1 * L)x_{ijklm} + e_{ijklm}. \]

MIXED procedure of SAS was used for these analyses.

### 3. Results

#### 3.1. Differences between lines for doe and fetal traits

Differences per uterine horn between intact does of the high and low uterine capacity lines for doe traits are shown in Table 1. Although both lines showed the same ovulation rate, the high line had a higher implantation rate per uterine horn (1.43 ± 0.61 embryos, \( P < 0.05 \)) as a result of a greater embryonic survival, or early embryonic survival from ovulation until implantation site formation--day 7 of gestation--(0.13 ± 0.06, \( P < 0.05 \)) in this line. In spite of the higher number of implanted embryos in the high line, this line showed similar fetal survival at 18 days of gestation to the low line. In this case, fetal survival is related to early fetal survival from day 7 until day 18 of gestation. The high line had a greater number of live fetuses at 18 days of gestation than the low line (1.30 ± 0.53 a 32% more fetuses, \( P < 0.05 \), due to the fact that its implantation rate was higher. As consequence of a higher degree of uterine overcrowding in the high line, length of the full uterine horn and weight of the full and empty uterine horn were higher (approximately 10% and 20%, respectively, see Table 2). Distance between oviduct and first implantation site was shorter in the high line than in the low line (42% shorter). These differences disappeared, or diminished for distance between oviduct and first implantation site, when the number of implanted embryos per uterine horn was added to the model as a covariate. Nevertheless, there was no difference between the high and low lines for distance between last implantation site and cervical end.

Table 3 shows the differences between the high and low uterine capacity lines for individual available uterine space per fetus, individual length of the maternal placenta, individual weight of the fetal placenta, and individual weight of the live fetus and fetal crown-rump length. Live fetuses of the high line had lower available uterine space than fetuses of the low line (−0.98 ± 0.42 cm, a 20% less, \( P < 0.05 \)). This lower available space in the high line was related to a
greater number of implanted embryos per uterine horn, because the difference disappeared when the model included quadratic regression on number of implanted embryos per uterine horn as covariate. The maternal placenta was shorter in the high line than in the low line (−0.23 ± 0.09 cm, a 12% less, \( P<0.05 \), see Table 3). The lower uterine space per fetus and higher number of implantation sites per uterine horn in the high line seem to have a negative effect on the development of maternal placenta at 18 days of gestation. The difference between the lines was reduced to almost half when the number of implanted embryos or available uterine space per fetus was included in the model as a covariate. No differences between lines were found in the development of fetal placenta and fetus. The live fetuses of the high line were longer than those in the low line (−0.42 ± 0.21 cm, a 23% less, \( P<0.05 \), see Table 3).

3.2. Relationships between traits of the doe and traits of the live fetuses

The average available uterine space per implantation site showed a negative quadratic regression coefficient with number of implanted embryos (Fig. 2). The number of dead fetuses was negatively related to available uterine space. A reduction in available space per implanted embryo, after being adjusted for number of implanted embryos per uterine horn, was linearly associated with an increase in number of dead fetuses (\( b_1 = -0.19 \pm 0.10, P<0.10 \)). Each additional dead fetus decreased the available uterine space by 0.19 cm; this represents 4% of available uterine space. Each additional implanted embryo was linearly related

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**Table 2**

<table>
<thead>
<tr>
<th>Trait</th>
<th>High</th>
<th>Low</th>
<th>Significancea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of ovaryb (g)</td>
<td>0.56 ± 0.03</td>
<td>0.50 ± 0.03</td>
<td>ns</td>
</tr>
<tr>
<td>Length of full uterine horn (cm)</td>
<td>18.48 ± 0.73</td>
<td>16.63 ± 0.68</td>
<td>†</td>
</tr>
<tr>
<td>Length of full uterine hornb (cm)</td>
<td>17.79 ± 0.72</td>
<td>17.33 ± 0.67</td>
<td>ns</td>
</tr>
<tr>
<td>Length of empty uterine horn (cm)</td>
<td>22.80 ± 1.04</td>
<td>21.46 ± 1.01</td>
<td>ns</td>
</tr>
<tr>
<td>Length of empty uterine hornb (cm)</td>
<td>21.84 ± 1.08</td>
<td>22.46 ± 1.05</td>
<td>ns</td>
</tr>
<tr>
<td>Weight of full uterine horn (g)</td>
<td>63.47 ± 4.38</td>
<td>52.10 ± 4.03</td>
<td>†</td>
</tr>
<tr>
<td>Weight of full uterine hornb (g)</td>
<td>58.49 ± 2.32</td>
<td>56.74 ± 2.13</td>
<td>ns</td>
</tr>
<tr>
<td>Weight of empty uterine horn (g)</td>
<td>27.78 ± 1.53</td>
<td>22.86 ± 1.49</td>
<td>*</td>
</tr>
<tr>
<td>Weight of empty uterine hornb (g)</td>
<td>26.04 ± 1.03</td>
<td>24.69 ± 1.00</td>
<td>ns</td>
</tr>
<tr>
<td>Distance between oviduct and first maternal placenta (cm)</td>
<td>1.31 ± 0.22</td>
<td>2.24 ± 0.22</td>
<td>**</td>
</tr>
<tr>
<td>Distance between oviduct and first maternal placenta (cm)</td>
<td>1.42 ± 0.21</td>
<td>2.13 ± 0.21</td>
<td>*</td>
</tr>
<tr>
<td>Distance between cervix and last maternal placenta (cm)</td>
<td>2.71 ± 0.26</td>
<td>3.19 ± 0.25</td>
<td>ns</td>
</tr>
</tbody>
</table>

**Table 3**

<table>
<thead>
<tr>
<th>Trait</th>
<th>( N^a )</th>
<th>( N^a )</th>
<th>( N^a )</th>
<th>Significanceb</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISF (cm)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
<tr>
<td>ISFb (cm)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>ns</td>
</tr>
<tr>
<td>IPL (cm)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
<tr>
<td>IPLb (cm)</td>
<td>129</td>
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</tr>
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<td>129</td>
<td>110</td>
<td>110</td>
<td>ns</td>
</tr>
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<td>IPL (cm)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
<tr>
<td>IPL (cm)b</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
<tr>
<td>IWFP (g)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>ns</td>
</tr>
<tr>
<td>IWF (g)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
<tr>
<td>CRL (cm)</td>
<td>129</td>
<td>110</td>
<td>110</td>
<td>*</td>
</tr>
</tbody>
</table>

**Significance**

- \( P<0.05 \), \( P<0.05 \), \( P<0.10 \), ns=non-significant.
- Significance level for the high vs. low uterine capacity lines.
- Analysis adjusted by ovulation rate.
- Analysis adjusted by number of implanted embryos in this uterine horn.
to a decrease in length of the maternal placenta and weight of the fetal placenta by 0.06 cm and 0.03 g, respectively. This represents 2% of length of the maternal placenta and weight of the fetal placenta. Development of the maternal placenta was positively associated with available uterine space. This relationship was quadratic (Fig. 3). Available uterine space was linearly related to development of the fetal placenta and fetus, but the coefficients were low ($b_1 = 0.03 \pm 0.01$ and $b_1 = 0.02 \pm 0.01$, respectively). Development of the fetal placenta was correlated to development of its maternal placenta (Fig. 4) and fetal development was related to development of its fetal placenta (Fig. 5). Each additional cm of maternal placenta increased the weight of fetal placenta by 0.28 g; this represents 20% of the weight of the fetal placenta. An increase of 1 g in weight of the fetal placenta was associated with an increase in weight of the fetus of 0.18 g; this represents 9% of weight of the fetus. There were no differences between lines for any studied relationships.

\[
SIE = (16.67 \pm 0.72) + (-3.68 \pm 0.26)IE + (0.25 \pm 0.02)IE^2.
\]

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\]

\[
IPL = (0.76 \pm 0.13) + (0.32 \pm 0.03)ISF + (-0.02 \pm 0.01)ISF^2.
\]

\[
IPL = (0.76 \pm 0.13) + (0.32 \pm 0.03)ISF + (-0.02 \pm 0.01)ISF^2.
\]

\[
IWFP = (0.62 \pm 0.06) + (0.28 \pm 0.07)IPL.
\]

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\]

\[
IWF = (1.74 \pm 0.19) + (0.18 \pm 0.04)IWFP.
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\]
3.3. Uterine position, blood supply and fetal development

Table 4 shows that there were no differences in the percentages of dead fetuses among the different positions within uterine horn (oviduct, middle or cervix). The lightest live fetuses were located in oviduct uterine position, weighing 4% less than those of middle of uterine horn and cervix position (Table 5). Also, fetuses and maternal placentae had shorter lengths in the oviduct uterine position (6% and 12%, respectively, see Table 5). The fetuses in oviduct and middle uterine position showed a lower availability of uterine space than in the cervical end (30% less, see Table 5).

Table 4 shows that fetuses with a better blood supply have a lower probability of death. Table 5 shows that greater available uterine space seems to allow a higher number of blood vessels to arrive at each implantation site. Therefore, a poor blood supply is associated with a smaller available uterine space. The implantation sites receiving a single or two blood vessels showed a slight lower fetal weight (3%) than implantation sites receiving four or more blood vessels, but this tendency was not significant. The smaller maternal placentae and lighter fetuses were located near the oviduct, probably due to both a smaller uterine space per fetus and a lower blood flow in this region (Table 5).

4. Discussion

Animals in this study came from a divergent selection experiment on uterine capacity (Blasco et al., 2005). Results show differences in the number of implanted embryos and live fetuses at 18 days of gestation. Also, the high line had a higher litter size up to the first four parities than the low line (10.3 vs. 8.9 young rabbits, respectively; Argente, personal communication). The greater number of implanted embryos in intact does of the high uterine capacity line was associated with a lower available uterine space per embryo in this line. The negative quadratic relationship between the available uterine space per implantation site and the number of implanted embryos suggests that each embryo requires a certain minimum space of uterus to attach, survive and

Table 5
Least square means for individual available uterine space per fetus (ISF), individual length of maternal placenta (IPL), individual weight of the fetal placenta (IWFP), individual weight of the live fetus (IWF) and crown-rump length (CRL) per position of the fetus in the uterine horn and number of blood vessels reaching each implantation site

<table>
<thead>
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<th>Status</th>
<th>Position</th>
<th>Number of blood vessels</th>
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<tr>
<td></td>
<td>Oviduct</td>
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\[ \chi^2 = 0.07 \quad P = 0.97 \]

\[ \chi^2 = 11.85 \quad P = 0.003 \]

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4. Discussion

Animals in this study came from a divergent selection experiment on uterine capacity (Blasco et al., 2005). Results show differences in the number of implanted embryos and live fetuses at 18 days of gestation. Also, the high line had a higher litter size up to the first four parities than the low line (10.3 vs. 8.9 young rabbits, respectively; Argente, personal communication). The greater number of implanted embryos in intact does of the high uterine capacity line was associated with a lower available uterine space per embryo in this line. The negative quadratic relationship between the available uterine space per implantation site and the number of implanted embryos suggests that each embryo requires a certain minimum space of uterus to attach, survive and
develop. A reduction in the available uterine space, even after adjusting for the number of implanted embryos with a quadratic regression, was associated with an increase in the number of dead fetuses. The available uterine space per fetus seems to be especially affected by the development of the maternal placenta at 18 days of gestation, and to a lesser degree by the development of the fetal placenta and the fetus. Argente et al. (2003) found a stronger relationship between the uterine space and the number of dead fetuses at the end of the gestation in ULO does of the second generation of this experiment. In pigs, development of placenta is also limited by the availability of uterine space (Knight et al., 1977; Vallet and Christenson, 1993). A reduction in prenatal survival and litter size is associated with a restriction in uterine space per fetus from day 25 of gestation, although the relationships are stronger as the gestation progresses (Webel and Dziuk, 1974; Wu et al., 1987, 1989; Chen and Dziuk, 1993). Ford et al. (2002) have suggested that uterine length (maternal effect) may be an important component of uterine capacity in pigs, limiting litter size after day 30 of gestation; simultaneously, a reduction in placental size of conceptus (individual conceptus effect) could improve uterine capacity. In rabbits, Mocé et al. (2004) found in the high and low uterine capacity lines of this experiment that fetal survival depends mainly on the maternal genotype. There is a key moment for fetal survival in rabbits after implantation, between days 8 and 17 of gestation; 66% of the total post-implantation mortality occurs in this period (Adams, 1960). The haemochorial placenta of the rabbit has finished its development and the nutrition of the fetus begins to be controlled by the placenta. The placenta would require an adequate surface area for its development and for nutrient exchange from the maternal to fetal streams. Hence, the available uterine space is determining the development of the maternal placenta from the 18th day of gestation. In addition to an adequate development of the placenta, it is necessary that the placenta be efficient (Wilson et al., 1998; Biensen et al., 1999; Vonnahme et al., 2002).

In rabbits, the fetal weight is positively related to development of the fetal placenta (Bruce and Abdul-Karim, 1973; Argente et al., 2003) and negatively related to litter size (Breuer and Claussen, 1977; Argente et al., 2003) in the later stages of pregnancy. The results of this study show that fetal weight is associated with development of the fetal placenta at 18 days of gestation to a lesser extent than at the end of gestation and that the number of implanted embryos does not seem to have any effect on development of the fetus at 18 days of gestation in contradiction to the results found in intact (Breuer and Claussen, 1977) and ULO does (Argente et al., 2003) at the end of the gestation. Duncan (1969) has reported that there was a lower blood supply for each implanted embryo in rabbits when the number of implanted embryos was increased, due to the limited maternal blood supply at each uterine horn. The competition for nutrients may also play an important role on development of the fetus, particularly in the later stages of gestation. However, it does not seem that there is strong competition among the fetuses for the maternal vascular supply at the uterine horn in the middle of the gestation.

The position of the fetus in the uterine horn affects the weight of live fetuses. The live fetuses in the oviduct uterine position have a lower weight and less available uterine space than those at the cervical end. This smaller available uterine space could prejudice development of the maternal placenta and, in turn, the fetal development. This is difficult to explain because this pattern changes in the later stages of gestation, and the heaviest fetuses were localized in the position nearest the oviduct and the lightest fetuses developed in the intermediate positions (Duncan, 1969; Bruce and Abdul-Karim, 1973; Poigner et al., 2000). Also, Argente et al. (2003) observed in ULO does of the second generation of selection of this experiment that the fetuses at either end of the uterus had a greater weight than fetuses in the middle. The same results have been reported in pigs (Waldorf et al., 1957; Perry and Rowell, 1969; Wise et al., 1997). The fetuses located near the oviduct probably have less competition for available uterine space than fetuses in the middle of the uterus and there is a better vascular supply in this region at the end of gestation, as reported by Duncan (1969) and Bruce and Abdul-Karim (1973) in rabbits.

5. Conclusion

In the rabbit, it is observed that an increase in the number of implanted embryos per uterine horn
decreases the available uterine space per fetus. The relationship between both traits is quadratic at 18 days of gestation. A reduction in the available uterine space seems to be penalizing the development of the fetus and in fetal survival, possibly because of a limitation in blood supply at each implantation site.

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References


