Your Partner in Reproductive Science

The ROYAL CANIN® philosophy, *Knowledge is to be Shared*, has been made possible in part through our partnership with you – the professional dog breeder. In an effort to return the favor, we'd like to share science-based reproduction and best kennel practices education.

Variables Influencing Litter Size

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Many variables work collectively to determine litter size. We expect the dam to exert an influence, but there are other contributing factors. Breeding management plays several roles in the number of offspring we can expect. It's not too hard to accept that genetics, environment and nutrition all play a part as well.

Starting with the dam, we can identify specific factors that will bear on litter size. Every litter starts with the estrous cycle. Within each cycle are four distinct stages which must evolve along a given time line for optimal breeding results. Proestrus is the first stage showing outward signs the cycle has started. This transitions into estrus the stage at which she is ovulating and will accept the male.

The third stage is diestrus, hallmarked by the bitch's refusal of the male. It is during this phase that the uterus, mammary tissue, and the female's metabolism are preparing for pregnancy, whether she is pregnant or not. This persists for about 60 days.

The last stage is anestrus in which the uterus returns to a normal, non-pregnant state. This requires at least 90 days. If the bitch is cycling too frequently, her uterus is not fully returning to a normal stage, making it a hostile environment for embryos, leading to early embryonic death.

AGE MATTERS

The age of the bitch can also affect litter size. Very young females, as well as older ones, can produce smaller litters. The age of the bitch when she has her first litter has a significant impact. If the bitch is four years or older with her first litter, her litters will be smaller than those seen in a younger dog. We see an overall decrease in litter size after 5 years of age in the majority of breeds, except for small breeds. In general, the first litter for any bitch will be smaller than average for the breed. Litter size will increase with each litter generally through the third, sometimes the fourth litter, at which time the number of pups decreases steadily.

BIG BREED, SMALL BREED

Another factor in the bitch is her breed. Smaller breeds tend to have smaller litters and larger breeds tend to have larger litters. Sometimes expectations of litter size are based on such a small population as to skew real averages. This can happen within a kennel or from information pooled from three or four breeders.

A three-year study involving 15 breeds was performed in order to gather real data on litter sizes, ages of dams, number of litters, and so on. A total of 728,271 litters make up the database for this study.

Labrador Retrievers had a typical range of 5-10 puppies per litter, with an average of 7.6 based on over 85,000 litters. German Shepherd Dogs had just over 44,500 litters with a range of 4-9 puppies per litter and averaging 6.6 per litter. From the 39,000 American Cocker spaniel litters tracked, an average litter size was five, with a normal range of 3-7 puppies. Shetland Sheepdogs produced over 28,400 litters during the course of this study, revealing a typical range from 2-6 puppies, averaging 4.3 per litter. Yorkshire Terriers were represented in just over 53,000 litters, showing a range of 2-5 puppies and averaging 3.3 per litter. Chihuahuas had identical results based on 55,000 litters.

The point being that if one expects a German Shepherd Dog to consistently produce 8 puppies per litter, thinking this is an average litter size, it might be concluded that the bitch is not performing up to her potential when she births 4-6 pups, which is actually well within the normal range for her breed. Likewise, while Chihuahuas and Yorkies have a typical range of 2-5 puppies, 80 percent of these litters produce less than four puppies.

Breeding management is a key contributor to litter size and luckily one in which we can exert a great degree of control. The canine species is unique in that the ovulated eggs are not immediately capable of fertilization. An additional 48 hours is required for the ova to be mature enough for fertilization. If the bitch is bred too early, by the time the ova are ready to fertilize the sperm have died or are deteriorating. Likewise, if a bitch is bred too late, the sperm will be very viable but the ova are not. The best approach to achieving larger litters is to know as accurately as possible when ovulation occurs. Tools that can aid in this include monitoring the bitch's behavior, vaginal cytology, and hormone assays for progesterone and luteinizing hormone (LH). Both these hormone assays can also be used to determine if a bitch ovulated at all, as it is perfectly possible for a female to have a "normal" estrous cycle by all appearances, yet not ovulate.

LARGE BREED LITTER
The amount of pups possible in a litter, from a large breed dog.

ARTIFICIAL INSEMINATION

The next layer of the embryonic mass is the mesoderm, or middle layer. From this primordial layer the muscles, connective tissue, bone, circulatory system, urinary system and genital system will emerge. The outermost layer of cells, the ectoderm, will develop into the outermost layers of skin with the hair follicle and sebaceous glands. It will also differentiate into the nervous system tissues including the eyes, brain, spinal cord, and peripheral nerves. Finally, it further specializes into the sensory organs for sight, sound, balance, tactile sensation, and pain receptors.

POTENTIAL BIRTH DEFECTS

Artificial insemination (AI) is becoming more common in the dog breeding industry. However, when AI is used, there is a negative effect on litter size. When fresh or chilled semen is used, a decreased litter size of 15 percent is not unusual. With frozen semen, that impact rises to 25 percent reduction. Fresh semen remains viable for five to seven days, but that range decreases to three days when the semen is chilled.

Frozen semen has, at best, one day. Because of this, the manner in which the semen is deposited, and the location of the deposition, is critical to maximize viability and ensure optimal results. Transcervical deposition occurs when a bitch is naturally bred and the mating achieved a "tie," or when pipette manipulation during artificial insemination successfully maneuvers through the cervix.

Vaginal deposition can result from faulty AI technique, or from a natural breeding that does not achieve a mating tie. When the person performing insemination is not technically trained, vaginal deposition is the most common result. The problem is that the vaginal environment becomes more acidic towards the vulva, and can kill sperm. The last option is to surgically exteriorize a uterine horn and inject the semen directly into the uterine lumen. This is the only option when using frozen semen due to the very short period of viability.

Mating frequency leverages litter size. Smaller litters result if the bitch is bred only once, regardless of the type of breeding employed. With multiple breedings, it does not matter how many days separate the first and last breeding as long as both occur within the window of fertility. Peak fertility is from the luteinizing hormone (LH) surge (which triggers ovulation) through the six days following. Litters from mating on day seven from the LH surge, are the smallest due to degeneration of the ova and the closing cervix. Due to the nature of surgical AI, one breeding is all there is. Understandably, it is critical to have the LH surge identified as accurately as possible.

No matter how well a bitch is maintained, pregnancy and lactation deplete her body stores of energy, protein, vitamins, and minerals. With each successive litter, that depletion becomes more pronounced. The degree of depletion will vary with litter size and frequency. After a large litter, the next litter is generally smaller than average. Luckily the converse is true, with a larger-than-average litter typically following a small litter. There is a limit to the ability of the bitch to rebound after each sequential litter, and for this reason it is recommended to allow a skipped cycle periodically.

Beyond the size and breed of the parents, another factor is the degree of inbreeding. This can be reflected by an inbreeding coefficient, a numerical value ranging from zero (not inbred at all) to one (completely inbred). In many breeds it has been demonstrated that the more inbred the dam, the smaller litter she will have. Add that to the observation that some family lines within breeds are not prolific ovulators and the impact of inbreeding is even more profound.

Responsibility rests with breeders when choosing animals to pair. Breeding stock is selected for many reasons: performance, conformation, and health but rarely, if ever, for reproductive traits such as litter size, milk production, or mothering ability. All these are important factors which have high degrees of heritability. Other issues, including libido, should also be evaluated.

If the bitch is at her ideal body condition at the time of breeding, the odds of her fulfilling her potential to produce an optimally sized litter are increased. Whether too heavy or too thin, the associated stress decreases reproductive performance. When we consider the role nutrition plays, we start with the basics of protein and energy, and then consider individual nutrients. The goal is to find that optimal level that provides the necessary nutrients in the appropriate quantity to maximize performance without any negative effects on the dam.

Even though energy and protein needs of a breeding female don't change significantly until week six of pregnancy, other nutrients are vital to ensure that her body responds optimally during her estrous cycle, breeding, pregnancy and lactation. The embryologic needs for development are specific and critical, including the uterine environment into which the embryos are secluded.

During pregnancy it is necessary for the energy needs of the female to be satisfied by both fats and carbohydrates in the diet. Diets low in carbohydrates result in increased embryonic death, a greater number of still births, and higher neonatal mortality.

Years of research have documented several nutrients that directly and indirectly impact reproductive success. Each nutrient identified may impact several independent events. Some of these nutrients are vitamins (A, C, E, biotin, and folic acid), amino acids (tyrosine, arginine, and taurine), minerals (copper, zinc, and manganese), as well as omega-3 fatty acids (EPA, DHA) and antioxidants (β-carotene, lutein). Even dietary fiber plays a role.

As the pregnant bitch approaches the last three weeks of gestation, there is a huge demand for all nutrients. The fetal puppies will gain 75 percent of their birth weight in this short time. Depending on the number of pups and the breed of the bitch, she will likely need one and a half to two times her normal maintenance needs during this time frame.

There is also considerable potential impact from environmental conditions. Indoor dogs have a fairly consistent level of lighting and temperature and we won't see seasonal fluctuations. Outdoor dogs are influenced by daylight hours and natural climate changes. Regions that experience distinct seasons show that variables including temperature and humidity affect litter size. Generally, the larger litters are born in the spring and smallest in the summer. ◤

ARTIFICIAL INSEMINATION
Intra-uterine may be carried out using a catheter inserted into the vagina. Palpation of the abdomen is necessary but may be made difficult in very large or overweight bitches.

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