INTRODUCTION TO ARTIFICIAL INSEMINATION
or
ESTABLISHING AN AI PROGRAM FOR GOATS REQUIRES MORE THAN AI

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Introduction

Routinely artificial insemination (AI) is described as a tool-mediated transfer of semen to a female’s reproductive tract -instead of using natural service (NS)- for the production of young. After you get more involved with AI you will come to accept that in reality AI is a first generation assisted reproduction technology (ART) which is used in combination and coordination of various procedures for the sole purpose of ensuring that one or more oocytes (eggs) are fertilized by sperm that were once –usually- frozen in suspended animation.

This presentation/document not only deals with the very small window of opportunity of a few hours when fertilization must take place but situates in proper perspective the need for mastering the AI technique as well as the requirements necessary for establishing a successful AI program, which definitively, entails more than becoming proficient at AI.

For reproduction to be successful (whether by natural or artificial means) several actions must take place at the correct time and in the correct order. Understanding these natural events is the key to successfully substitute the natural course of events with procedures aimed at getting similar outcomes by technological means. As the number of days in gestation advance, more and more, embryo survival, fetal development and birth of a healthy kid will be linked to management actions you may have or may have not taken prior to breeding as well as during pregnancy and parturition.

Importance and Types of AI

Perhaps the chief reason why AI is a commonplace routine used by most productive livestock industries stems from the fact that much of the fast paced genetic progress accomplished by the dairy cattle industry can be traced back to the incorporation of AI in their breeding management. AI provides an important and extremely flexible approach to attain many productive objectives; to date still underutilized by the national goat industry.

Goat AI procedures and equipment vary depending upon the location where sperm is placed in the female’s reproductive tract, and this in turn depends on the technique and technology selected to accomplish it. AI can be used with fresh semen or thawed-frozen semen that was collected on previous years. AI can be used on naturally occurring or hormonally induced estruses. AI can incorporate several levels of management decision-making or one can use timed insemination. Most notably, AI allows goat producers to become independent from the reliance on a “breeding season” characteristic of seasonally polyestrous animals.
In summary, the purpose of this presentation/document is to combine the focused view on a technical aspect with the broader picture of AI management: Help you recognize what is needed to establish an AI program for your herd, -both in terms of technical demands as well as current associated costs-, to highlight what are the conditions most likely to improve your chances of success and to pinpoint realistic expectations of an AI program.

**Reasons to Consider AI**

Experienced producers as well as scientists working in the area of assisted reproduction technology, have come to accept that any time a technical procedure is used in lieu of nature, the outcome is likely to be a less efficient one. That is, it is difficult to have the same number of does pregnant when using AI than when relying on Mr. Buck to naturally service a breeding group. Confronted with this paradoxical statement a newcomer’s logical first-in-line question is, “If AI has sub par performance when compared to natural breeding, why is the technique advocated? This is because AI has a number of important contributions to make. These contributions may not be realistically achieved in a cost-effective manner when using natural breeding.

For example, consider the situation where, for whatever valid reason (e.g., costs of feeding, housing, health, fencing and labor come to mind) raising and caring for your own bucks is not desirable. Or perhaps you only have one valuable buck and you wish to use him on several dozen does in a short span of time. Or think of a herd manager faced with the undesirable option of having to breed genetically related animals (i.e., inbreeding). Or what about the situation where a producer wants to accelerate the pace at which his herd productive performance is being attained? In all these circumstances AI is an attractive option.

Having the paternal contribution to your herd inside a tank can be more economical, convenient and less of an overall headache than having to tend after more than one buck when males are actually only needed during a few weeks out of a calendar year. In addition, to this, if you select the correct male, AI can contribute to accelerate the genetic progress towards economically important traits. Furthermore, your herd most likely can benefit from target breeding. This means selecting to inseminate high proven sires to your seasoned does and using genetically promising bucks to inseminate the young upcoming herd replacements.

AI has additional benefits, it can be used to synchronize kidding operations by manipulating the length of the breeding season. Not only this, but AI, along with estrus and ovulation synchronization by hormonal means can be used to produce kids and/or milk “out-of-season”, at times of additional economic incentive, when, commonly, goats are reproductively quiescent.

From a health-related and animal welfare perspective, the ever present danger of transmitting an assortment of diseases or introducing antihelminthic (deworming chemical agents) resistant parasites can not be overly emphasized and is a valid concern when using natural breeding schemes, particularly if they include scenarios where bucks from other farms are introduced to the herd, even if this introduction is temporary.

Under certain conditions the tactic of pasture breeding will not allow for controlled parturition (much less for goats in range conditions) because actual mating dates often go unrecorded. Finally, I find myself in the community that advocates AI because, if anything, it promotes good record
keeping and a healthy review of historical herd facts. Along with dates of reproductive activity, breeding, pedigrees, etc., more often than not, there is valuable fresh documentation of body weights, conditioning score, type traits, medical treatments, and productive statistics. Certainly this additional appraisal, of information already available, can be used to make strides toward improvement of the flock as it will generate valid and robust arguments for deciding who goes and who stays in the herd. (a.k.a. selection).

**AI technique or AI management?**

It will be beneficial for our discussion if you quickly separate in your mind two aspects associated with AI. Technique from management. The technique of AI is a manipulative skill that relies heavily on perceptual and tactile sensory capabilities. This you learn by doing, following a step-by-step recipe and adjusting as the need arises in response to what type of animal and situation you will be confronted with. Establishing an AI program that fits YOUR operations management can only be taught by YOU.

AI management is more complex and highly individualized because it comprises more than learning one skill and implies experience for a particular dynamic set of circumstances that can not be recreated and transmitted in a classroom setting. My aim, in this respect, is to make you aware of the most important elements required to successfully incorporate an AI program in to your breeding management and to help you get started towards that objective.

**FAQ About AI**

The one basic question very difficult to answer is, “How do I decide if AI fits in my operation?” It’s difficult to respond because, on the one hand, you have producers looking at the profit margin as the deciding factor and, on the other hand, you have goat enthusiasts who feel that not everything a person does needs to be governed by monetary profit. This presentation is geared to help those of you who are in the first group, and would like to come to a better understanding of the hows and whys of establishing an AI program (but I will let you do the math). Folks in the second group need little enticement; they will find the technology fun and gratifying to try.

Here are “the” 10 most frequently asked questions that a newcomer usually has concerning AI:

- Q1 What kind of success rate can I expect to have?
- Q2 Should I hire an AI technician or become proficient myself?
- Q3 How long will it take to learn to AI and where do I get this training?
- Q4 What is the basic equipment needed for AI and what are the associated costs?
- Q5 Where can I get the material and equipment needed for AI?
- Q6 How labor intensive is actually AI’ing?
- Q7 What other conditions do I need to provide to increase my chances of success?
- Q8 What is the “correct” AI procedure to use?
- Q9 If I adopt AI, can I say adios to Mr. Buckaroo?
• Q10 Are there any drawbacks when adopting AI?

Each one of above questions can not be answered without careful qualification. In other words, the answer depends on what, how much and how in depth the person responding to the questions knows about YOUR particular herd situation. The answer provided is only going to be relevant and useful as the context in which your question is made.

Q1. Evaluating results (success rate) of AI

When making comparisons three simple rules apply: 1) Don’t compare apple with oranges; the results of such contrasts are likely to be meaningless, 2) Use the same scale of measurement to avoid distorting (biasing) the results and, 3) The more variables differ between what is being compared, the greater the inaccuracies that will creep into the assessment. That is, the more breeding systems or AI protocols and techniques diverge from each other, the more difficult it will be to attribute the reason for the differences to a single cause.

Evaluating AI results can be tricky since there are different ways to appraise results. One of the reproductive efficiency evaluation measures frequently used is pregnancy rate1 (PR). However, recognize that even when we agree upon a statistic there are still... many forms of measuring PR2!

If comparisons are going to be made using this guide then, it is only fitting to use the same scale of measurement. PR is defined as the number of females found to be pregnant (by some means of pregnancy detection at a standardized number of days post breeding) after a given number of breeding attempts (either by AI or NS) at an specific time in the breeding season.

If the gold standard for comparison is Mr. Buck’s performance at his best3, under ideal conditions, then we can expect him to provide a pregnancy rate to 1st breeding of 85 to 90%. This means that if the buck is with a reasonable number of healthy and fertile females of breeding age, showing estrus and in good body condition he should be able to get 8 to 9 females pregnant out of a breeding group of 10 females over a period of about a week (assuming of course that the females will in fact come into heat during this time and not all on the same days).

Starting with this, perhaps to unrealistically perfect scenario, any time we intervene with some management practice, breeding performance is likely to drop. Keep in mind that even though pen breeding and hand mating also use natural service as the means for getting does pregnant, this type

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1 There are various other ways to measure reproductive performance. For example, conception rate, fertility (kidding rate), prolificacy and fecundity.

2 Pregnancy rate needs to be defined in terms of the method that is used to detect pregnancy. It is not valid to compare PR’s generated using the popular non-return rate to estrus (21d-NRR? or 24dNRR?) and hormonal levels of blood or milk progesterone and/or the less common 45-d ultrasound scan.

3 Implied in the use of "at its best" is the notion that the buck has undergone and passed a breeding soundness exam (BSE), has the necessary sexual power/desire (libido tests are rarely done) and there is proof (kids on the ground) of his reproductive prowess.
of breeding arrangement will in fact deliver decreased pregnancy rates because some of the responsibility is now, by design or necessity, being assumed or shifted to management.

There are 5 basic methods of artificially inseminating. These procedures are defined by the anatomical place where semen is deposited in the female’s reproductive tract. Be aware nevertheless, that the 1st two “procedures” are really default actions rather than “types of insemination”. It is what you do if you can not accomplish trans-cervical AI (TAI). In different words, if TAI fails you settle for leaving the semen within the cervix (i.e., intracervically) counting the rings you were able to pass (3 rings, 2 rings, 1 ring in succession), if this is also unsuccessful you accept the worst case situation by leaving the semen as close to the cervix as possible. Each of these alternatives has an associated degree of success which presuppose a high proficiency has already been attained using each of the last 3 techniques in question:

<table>
<thead>
<tr>
<th>Method</th>
<th>PR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaginal</td>
<td>&lt;15-25</td>
</tr>
<tr>
<td>Cervical (CAI)</td>
<td>&lt;40-45</td>
</tr>
<tr>
<td>Transcervical (TAI)</td>
<td>55-65</td>
</tr>
<tr>
<td>Deep cornual (DCAI)</td>
<td>70</td>
</tr>
<tr>
<td>Intrauterine (LAI)</td>
<td>80-90</td>
</tr>
</tbody>
</table>

Evaluating also has to be understood as that moment of truth when we analyze how good are our results. Compare your own progress in time and then compare your achievements to those obtained by other people attempting the same thing. Keep in mind differences in animals, time, technique and environment, but absolutely, set the bar high by judging your accomplishments under the light of what the experts attain. This translated means, “published material that has received peer review in one of the many scientific journals” not your next door neighbor, or some entertaining magazine plagued with anecdotic accounts and other tales you will be unable to repeat, or some commercial party that has vested interest in inflating their results. “If it sounds too good to be true, it probably ain’t true”. It’s your time and money. Ask to see the data.

After evaluation time, along the way (if your PR’s are not speaking loud enough) at some point in time, you need to understand how and why you are getting the PR results your getting. Comparisons without adjustments will not fix the problem(s). With greater emphasis if your PR’s are under the values given in table 1. You will accomplish this evaluation and fine tuning more effectively if you bring into the picture somebody who is not “emotionally attached” to your AI program who can serve as a fair evaluator and advisor. Maybe your local extension agent or somebody he or she may suggest that has the necessary expertise.
Q2. Hiring or learning

The first emotional response is always “yes I want to learn a new procedure”, that’s fine, we all want to take part in the adventure of learning. Do remember, nonetheless, the fun can quickly wear off and good managers avoid reaching decisions on emotions but rather rely on reason.

To determine need you must first agree upon a clearly defined objective. So let’s put the actual desires in perspective to what the objectives really are. A perfectly valid objective is to become a artificial inseminator technician and a totally different one to design, incorporate and manage a successful AI program. Can you do both? Yes. Do you need different skills for both? Yes again.

Be realistic about the time you can devote to the technical portion of an AI program. If you are a busy farm manager and/or goats are only part of your livelihood effort, then consider delegating the actual AI’ing to a member of your working crew and, instead concentrate on the various other aspects necessary to ensure a successful AI program. Does this comment imply that you actually need less time to develop an AI program? No, not at all, to the contrary. But consider that AI has a very narrow span of time when you have to be present or else you will not get those nannies pregnant.

Let’s take the easy question first. You want to develop the skills necessary for producing pregnancies by AI. AI results will reflect mercilessly on the amount of practice you devote to the task but overall it will require proper technique and attention to detail. This means, unequivocally, actual number of does inseminated. I personally would recommend that you give the option of learning a fair opportunity. After all, the cost of a 2 day session (including a wet lab) will be approximately $600 – $800 for a group rate (or ±$60 to $80 per person), whether you end up actually doing the inseminations or supervising technicians it will always be to your benefit having theoretical and practical grounds to influence decisions.

In terms of specific time and numbers involved. Probably the first insemination, from the time you bring in the doe, to the time you place her back on the pasture or pen, the AI procedure will take about an hour to an hour and a half. Don’t take this remark to mean that its OK to be poking around inside a does’ reproductive tract for an hour, certainly not! If the actual “passing of the cervix” is taking more than 10 to15 minutes you need to change the goat.

As you progress in dexterity you can probably plan to AI a typical goat in about 10 to 15 minutes. How many goats will it take for you to get there? Well, that is a very subjective appraisal, but for the sake of discussion, I would not be to convinced if you have not at least produced 20 pregnancies with the methodology of your choice (which actually means that you probably attempted close to 50 goats).

Now let’s tackle the more difficult aspect of the question. Your plan is in fact to design, develop

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4 Langston University/American Institute for Goat Research, through its agricultural extension service, will offer demonstration clinics for AI in goats at Langston (Sept-9), Tahlequah (Oct-7) and a site to be determined in Eastern Oklahoma (Oct-28). Please confirm tentative dates with Dr. Terry Gipson.
and incorporate an AI program to your existing enterprise. How to go about getting this accomplished?

Well, for this type of project you need a broader set of capabilities. Some which you probably already have, some that you will need to developed and keep polishing and some that are yet to come through the unforeseeable road of actual experience. Let me point to the most significant areas that an AI program developer must feel in command:

1. Understand the doe's reproductive organs (anatomy) and their functions (physiology).
2. Know how semen is stored and handled.
3. Learn the appropriate manner of using the equipment required for inseminating goats considering animal welfare, sanitation, manual ability, and yes, actual accomplishments.
4. Develop the ability to accurately detect heat at an early stage.
5. Cultivate the ability to gather accurate records and use information of goat statistics.
6. Learn what are the environmental conditions that will influence your breeding results.

Each of the above areas of knowledge, deserves careful attention and can not be adequately evaluated in the limited scope of this presentation. Attempting to provide a “crash course” on each of these topics may accomplish just that… “crash management”.

**Q3. Learning curve**

How long it will take to learn depends strictly on how much you want to know and whether we are talking about AI technique or AI management. The shape of a learning curve, in either case, is totally dependant on the abilities of teacher and student as well as the resources at hand to accomplish the teaching and learning.

*AI technique*

Learning to AI will require: a) somebody with the expertise willing to teach you (more than likely being paid to teach you), b) your willingness to be taught, c) your ability to develop new skills and, d) your discipline to gain competency by repetition, which is the fancy way of saying “practice, practice, practice”. However, the “practice, practice, practice” part of the equation has no meaning, if all it accomplishes is but providing the opportunity to make the same mistake over and over.

Learning the theoretical basics of AI can probably take a minimum of 1 to 3 hr and the actual practical portion about 3-5 h. Don’t expect too much of a course in which you have invested this bare-minimum time. A lot of the effort comes once you have left the classroom.

It will be to your advantage to actually participate in more than one AI course, this will provide you with the opportunity to learn from different sources, reinforcing the good procedures and perhaps questioning some other previous lessons. Approach your new teachers with an open mindedness, nobody has all the answers, and there is always something to be learned from the experience of other people. Be willing to try new approaches.
AI is a dynamic field and new procedures are always being tested, there are great strides yet to be made in small ruminant AI. The only way to keep up with new developments is to read current material, participate in workshops and conferences, talk to other producers, get your local extension agent involved and update your information by taking refresher courses as often as time and money can permit.

[AI Management]

There is no school, that I know of, set up to provide the teaching of how to establish a successful AI program and its management. The only classroom I have been exposed to is the working arena of real life in the work I do. Any class and lesson set up to teach management is artificial and will not re-create the actual challenges you will be faced with. The best a classroom setting can provide you with is looking and discussing particularly “handpicked” case scenarios, the learning of which, may take a few hours, improving what you learned: a lifetime. I don’t want to sound discouraging on the subject, I do believe, that if a person is motivated to learn something, a bad teacher or a deficient teaching methodology can, at best, only slow you down.

Your best approach to gain the necessary expertise in AI management is to participate for a day or two (longer if you can afford the time) of an on-the-job training arrangement where you can see and try what other people are doing and actually using. Follow this by adopting what fits into your operation and by adapting what you feel is needed but different because of your particular situation.

Q4. Equipment and material cost

Here is a list with up to date costs. You will have to do the math.

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Use</th>
<th>Must have</th>
<th>Co$t (2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid nitrogen tank</td>
<td>Semen storage</td>
<td>✓</td>
<td>400-1200</td>
</tr>
<tr>
<td>Yearly refills</td>
<td>N₂ tank level maintenance</td>
<td>✓</td>
<td>150-200</td>
</tr>
<tr>
<td>Semen/doe</td>
<td>Fertilizing power</td>
<td>✓</td>
<td>25-35-55</td>
</tr>
<tr>
<td>Speculum assortment (25 × 175 mm for doelings and 25 × 200 for does).</td>
<td>Aids in entrance to vaginal vestibule</td>
<td>✓</td>
<td>5-6-8</td>
</tr>
<tr>
<td>Light source</td>
<td>Illuminates cervix entrance</td>
<td>✓</td>
<td>15-30-37</td>
</tr>
<tr>
<td>Non-spermicidal lubricant</td>
<td>Facilitates speculum entry</td>
<td>✓</td>
<td>3.5-4</td>
</tr>
<tr>
<td>Thaw container</td>
<td>Semen thawing</td>
<td></td>
<td>15-30-35</td>
</tr>
<tr>
<td>Inseminating gun</td>
<td>Semen delivery</td>
<td>✓</td>
<td>14-25-50-70</td>
</tr>
<tr>
<td>Paper towels</td>
<td>General clean-up</td>
<td>✓</td>
<td>1-1.5</td>
</tr>
<tr>
<td>Breeding stand</td>
<td>Restrains goat</td>
<td></td>
<td>150-350</td>
</tr>
<tr>
<td>Item Description</td>
<td>Use</td>
<td>Must have</td>
<td>Co$tr (2006)</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------------------</td>
<td>-----------</td>
<td>--------------</td>
</tr>
<tr>
<td>Microscope (900 × Magnific.)</td>
<td>Check semen</td>
<td></td>
<td>250-600</td>
</tr>
<tr>
<td>Record keeping system</td>
<td>Organizes data management</td>
<td>✓</td>
<td>3-2500</td>
</tr>
<tr>
<td>Straw cutter</td>
<td>Opens end of straw</td>
<td></td>
<td>2.5-6</td>
</tr>
<tr>
<td>Plastic straw tweezers</td>
<td>To pull straw from goblet</td>
<td>✓</td>
<td>2.5-5</td>
</tr>
<tr>
<td>Bucket</td>
<td>For disinfection solution</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Thermometer</td>
<td>Monitor water temperature</td>
<td>✓</td>
<td>5-20</td>
</tr>
<tr>
<td>French plastic tips</td>
<td>Facilitates cervical entry</td>
<td></td>
<td>12-18</td>
</tr>
<tr>
<td>Sanitizing solution</td>
<td>For used speculums</td>
<td>✓</td>
<td>3-5</td>
</tr>
<tr>
<td>Speculum brush</td>
<td>Speculum clean-up</td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>Inseminating gun sheaths</td>
<td>Holds semen in place</td>
<td>✓</td>
<td>4.25-6</td>
</tr>
<tr>
<td>Sheath carrier</td>
<td>Maintains sheath integrity</td>
<td></td>
<td>10-15</td>
</tr>
<tr>
<td>Microscope slides &amp; cover slips</td>
<td>Semen placement for microscope observation</td>
<td></td>
<td>24/100 units</td>
</tr>
<tr>
<td>Carrying case</td>
<td>To keep all your AI utensils</td>
<td></td>
<td>15-35</td>
</tr>
<tr>
<td>Sanitary sheath protectors</td>
<td>Maintains straw clean &amp; prevents transmitting infection on the AI gun between goats</td>
<td></td>
<td>10-15</td>
</tr>
<tr>
<td>AI kits (wide selection)</td>
<td>Avoids separate purchasing</td>
<td></td>
<td>100-150-200</td>
</tr>
</tbody>
</table>

**Q5. Source of equipment and materials**

Your best bet on this matter is to consult with your local extension agent, herd veterinarian or fellow goat producers. It is risky to provide company names as they tend to imply an unwanted endorsement of a particular company or product. It also generates an opportunity for the crowd that is left out to argue and complain of unwarranted favoritism and unfair handling of the issue. For this reason I will not put in print their names in this document but I will happily provide you with names of companies I have personally dealt with off-the-record.

If you have access to computers with internet connection you already know that a search using key words on any of the freely available search engines can provide you with literally thousands of “hits” (sites that match your queried item). Printed commercial catalogs are another venue.
If you don’t have the benefit of computers yet, you can visit your local library / college or make an appointment with your extension agent who can help you, in a matter of 30 minutes or so, to place a computerized search that will generate tons of sources from all over the world of where to get equipment or materials for goat AI, procedures, workshops, etc. There are also plenty of testimonials from fellow producers that can help you steer in the right direction.

The source of semen can be from fresh sources (your buck or the neighbor’s) or from semen that has been frozen and thawed prior to its use. There are many companies that will ship frozen semen in dry ice containers. Semen sales and swaps also take place at many of the goat meetings.

**Q6. How labor intensive is actually AI’ing**

The number of people required depends on what kind of set up you have and what type of AI procedure you use. The values provided below apply to all inseminating techniques except laparoscopic procedures which will require more trained personnel as well as, the participation of a state, board certified licensed veterinarian. Laparoscopy is classified as a minor surgical procedure (but “surgical” nevertheless) requiring the use of prescription drugs to sedate the animal.

Breaking down labor requirements involved in AI to more elemental components will make it easier to associate man-power needs with each part of the job at hand:

- ✔ Body condition score (BCS) in preparation to have good breeding groups (2 evaluators).
- ✔ Visual estrus detection (1 person). If you are using a teaser to mark does in standing heat (highly recommended) then you probably need to add another person to help change marking crayons and adjust the breeding/marking harness as need arises.
- ✔ Actual AI’ing (2 people; one of them the AI tech.).
- ✔ Record keeping (1 person).

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5 The attempt to laparoscopically inseminate (LAI) not in adherence to appropriate procedures (which includes animal sedation) is not supported by this author, the American Institute of Goat Research (AIGR) or Langston University. In addition, keep in mind that animal welfare and necessary humane treatment of animals is compromised when unsuitable methods are used or condoned. To avoid liability under state or federal regulations check with your local licensed veterinarian.
Q7. What are other conditions I need to provide to increase my chances of success?

[AI Technique]

1. Practice.
2. Practice.
3. Be consistent and disciplined to follow the routine for the AI procedure you have selected. Whimsical changing of AI protocols will not be traceable. Consistent predetermined alterations can be evaluated over time.6.
4. Make an effort not only to learn the step-by-step procedure but to understand why is it you are doing the things your doing.
5. Know when to inseminate in the estrus cycle.
6. Learn what is the criteria for goats that should not be inseminated.
7. Be open to criticism an incorporate amends to bad technique habits.
8. Even if you can not detect outward changes, recognize you are working with an animal that will respond to your actions.
9. Look and evaluate objectively your historical PR results.
10. Finally see 1 and 2.

[Establishing an AI program]

1. Be knowledgeable about goat reproductive biology.
2. The breeding herd needs your attention long before they are inseminated.7.
3. Have a selection program for younger goats (age, development and genetics) and an appraisal/culling program for adult does which, jointly, will allow you to include premium doelings and exclude poor candidates from your AI program.
4. Make an effort to personally know your semen provider and his freezing procedures.
5. Know how to select appropriate semen.
6. Know how to handle semen shipments, transfer and handling of semen.

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6 Don't draw conclusions on what you see happening in three goats, improvements are usually not as dramatic as one would hope for. More than likely changes will be small and difficult to detect without the aid of some statistical analysis procedure. These mathematical evaluation methods are insensitive to the actions of men and women. They will crunch numbers period. And, will take for granted that changes have been applied consistently over time. Therefore, if you don't have at least 30 goats per steady procedure modification or adaptation, it is rather unlikely that small changes (on a set up that is loaded with actions and events that can not be controlled) will impact results in such magnitude as to be clearly different.

7 This includes: nutrition, genetics, health (deworming and checking for infectious diseases, proper ID, body condition and linear appraisal for type traits.
7. Learn the basics of semen quality evaluation.  
8. Have a working estrus detection program.  
9. Use appropriate AI equipment and materials.  
11. Gain the appropriate skills for the actual AI procedure.  
12. Provide an environment conducive to low animal (and people) stress.  
13. Know how to use the information already collected on your goats.  
14. Recognize differences in animal behavior and animal categories.  
15. Be able to detect pregnancy as early as possible.  
16. Be consistent with procedures that work.  
17. Write it down. Keep logs, journals and records for different areas of work.  
18. Keep records that can be used.  
   a. Simple.  
   b. Accessible.  
   c. Format that allows calculation of basic statistics.  
   d. Format that encourages use-ability and user-friendliness.  
   e. Flexible. What works today may not work tomorrow.  
19. Learn the technical jargon used in connection with different new AI-related areas of knowledge (e.g., reproduction, genetics, statistics, equipment, etc). It will help you communicate with others more effectively.

**Q8. What is the “correct” AI procedure to use?**

Forget about the “ideal” procedure, it hasn’t been published yet for the basic reason that no two goats are alike. Nonetheless, it is true that many procedures have been time-tested and placed under scrutiny in an effort to improve results. In my opinion most inseminating protocols (within one of the types of AI) vary in the detail but essentially accomplish the same objective.

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8 You never know when you have to challenge or question the quality of the product you paid for. Even the most reputable commercial outfits can make a mistake. What if there is question as to whether or not there has been damage to semen by inappropriate semen tank N2 level maintenance?

9 Data are only numbers, statistics allows you to organize and summarize these data. Organized data becomes information. Information collected may or may not be relevant. Information that is not used has no chance of becoming knowledge. Selective use of knowledge will open the door to wisdom.
Procedures need to contain and discuss the following topics:

- Time of insemination:
  - In the breeding season.
  - In the estrous cycle.
  - In the estrus period.

- Animal handling and restraining during AI.

- AI helper’s contribution.

- Semen thawing, handling, loading and delivery.

- Actual entry and exit from reproductive tract.

- Number of inseminations per estrus period.

- Number of inseminations per breeding season.

The material that follows considers and responds to each of the above issues in the context of transcervical insemination (TAI) as used in the AIGR farm AI program.

**Time of insemination in the breeding season.** Most of the year goats that are geographically located away from the equator show different degrees of anestrous depending on breed. That is, there is no sexual activity in either gender. Hence, no sexual receptivity. The breeding season has three phases that are clearly defined but can not be clearly differentiated in terms of outward behavior or physiology.

Breeders talk about a transitional phase at the beginning and end of the breeding season. The actual breeding phase or non-transitional phase is also referred as the cyclic phase in reference to the presence of the recurrent ±21 day estrous cycles. There is some indication that the early transitional phase is characterized by asynchrony between ovulation and “in heat” behavior as well as the presence of “short cycles”. Some people claim that breeding at this time results in reduced pregnancy rates. A three year study, conducted by this author and colleagues, comparing NS and AI of young and adult goats (unpublished results) shows that the allegation of reduced fertility could not be substantiated under the particular conditions the research was conducted.

The transitional phase at the end of the breeding season is more associated with irregular cycles (of matching heat behavior and ovulation) with the presence or absence of heats and/or variable length of estrous cycles. The effects on heat length (at this stage of the breeding season) has not been documented.

**Time of insemination in the estrous cycle.** The estrous cycle is divided in four characteristic phases: Estrus (high estrogen), metestrus (luteal phase begins), diestrus (high progesterone) and proestrus (follicular phase and CL regression). In nature goats are only sexually receptive when in estrus when levels of FSH are high and an eventual LH surge will trigger ovulation close to the end of estrus. AI is performed during estrus. Although a goat may be in estrus it will not necessarily
accept to be mounted by the male. The female will accept copulation only when in “standing estrus”. How long a goat stays in estrus is variable but on the average is between 18 and 36 h. Averages are just that, an insensitive numerical representation of the “typical” value, so don’t be surprised if some goats come in heat for a few hours or stay in heat for several days.

**Time of insemination in the estrus (heat) period.** Not much controversy should exist regarding the time of insemination. It should take place approximately 18 to 24 hrs before the end of estrus because it is believed that does ovulate very near (6 h before), or soon after (12 h), the end of standing heat. Since the eggs viability is at its best at approximately 12 to 24 h after ovulation the sperm must be already on its way to the fertilizing region (upper 1/3 of the oviduct) when the doe is no longer sexually receptive.

Recognize that the time of insemination is given in reference to the end of estrus. This time can not be known but it can be anticipated if you have kept previous records of the female’s behavior, including the length of estrus. Female goats vary in the time they remain in heat, but this time for each animal tends to be somewhat repeatable, therefore, predictable. In my opinion it is always better to err on breeding “too early” than “too late” side because spermatozoa have viable fertilizing power for about 24 to 48 hours, whereas oocytes go down hill after 24 hours.

When you take the above facts in to consideration some useful rules of thumb can be developed if you know the expected length of estrus:

- Breed 18 to 12 h less than the projected length of estrus, (e.g., if a goat is anticipated to have a heat period length of 24 h or less, breed her as soon as she comes in heat. If a doe usually stays in heat for 36 h, breed her 18 to 24 h after she shows the first signs of being in heat. If a doe usually stays in heat for 48 h, breed her 30 to 36 h after she shows heat signs, and so on…).

- Don’t breed after a doe has gone out of heat. It’s too late.

- If you don’t keep track of details such as the length of estrus then breeding either 12 or 24 h after the first signs of standing estrus should not give great differences between times, although, true, the overall PR will be lower than if you knew the actual length of the heat period and breeding were taking place using that information.

**Animal handling and restraining.** A great effort should be placed in providing a low stress environment. Comfort will put the goat at ease and make the job simpler to accomplish. The animal handler should avoid getting goats excited by rough-handling.

The use of a breeding stand (milk stand) can facilitate animal restraining in an upstanding manner. There are a variety of stands with various improvements to facilitate raising up the platform where the goat stands.

**Helper’s contribution.** Ensure you have appropriate help (brains and muscles). If your helper is not knowledgeable in what you are about to accomplish he/she may actually hinder your progress.
With some communication you can settle on some AI procedure choreography that is safe and efficient to follow. For example, a helper can be in charge of bringing the animal to the inseminating area, cleaning the vulva, inserting the lubricated speculum\(^\text{11}\), keeping the goat at ease and, when the time comes, raising the goat over one of his/her bent knees which is also positioned over the breeding stand. This arrangement of “goat over flexed leg” can help situate the goat in the best possible way to improve the actual “passing through the cervix”. The goat should bear her weight on the front legs while the rear legs are slightly off the ground. The body needs to be slightly stretched so that the internal organs of the reproductive tract are stretched in a length-wise manner.

_Semen thawing, handling, loading and delivery._

1. Use the semen inventory sheet to determine what semen will be used and the location of semen straw inside the liquid N\(_2\) tank. Using plastic tweezers\(^\text{12}\) withdraw the appropriate semen straw from the liquid N\(_2\) tank in the minimum time possible. The semen canister manipulation should not take more than 5-8 seconds. If the time is longer than 8 seconds re-introduce the semen straw to the goblet, place the goblet in the canister and reintroduce the storage device into the liquid N\(_2\). Re-attempt the procedure ±2 m later.

2. As soon as the semen straw has been pulled out from the liquid N\(_2\) tank place the styrofoam cap back on the semen tank neck opening and place the semen straw selected immersed in the water bath (34.5°C - 94 °F) for 1 minute.

3. Retrieve straw from water bath (water level should cover straw) and dry thoroughly with paper towel as water is spermicidal.

4. If ambient temperature is cold, warm the inseminating gun by friction accomplished by rubbing the metal rod with both hands prior to inserting the semen straw in the barrel of the inseminating gun. Alternatively you may want to use a commercial warming pad.

5. Cut the waxed end of the semen straw (usually colored) and place the cotton plug end (white) first into the barrel of the inseminating gun. Place (slide) the plastic French tip on the cut end of the French straw using hand pressure. Fit a French jacket sleeve over the metal rod and anchor in place by twisting clockwise or counter-clockwise while using hand pressure pushing down against the base of the metal rod\(^\text{13}\). Wrap the inseminating gun with a paper towel and place under armpit until ready to insert in reproductive tract.

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\(^{11}\) Prepare speculum with the beveled front end lubricated with anti-spermicidal and anti-bacterial lubricating jelly (tip ring to about 2 inches from the tip). Use a dry paper towel to clean surrounding external debris from the vulva. Introduce the speculum in vaginal vestibule by angling the device upwards approximately 30° and then straighten flat and slide through vagina until you reach the cervix wall. Use appropriate speculum bore and length size that matches body development of the goat to be artificially inseminated. For Alpines this is 25 × 175 mm for doelings and 25 × 200 for does.

\(^{12}\) Using your fingers (at 37 °C – 98.6 °F body temperature) will accomplish unwanted thawing of straws. If a portion of the straw thaws and is placed back in the tank the sperm involved will be destroyed.

\(^{13}\) The use of a flexible sheath protector is debatable, may be warranted to protect the plastic French tip that has the semen if the gun is laid down on a table or other place where there can be contamination.
Actual entry into the reproductive tract and exit. This portion of the procedure is divided into seven parts:

1. A lubricated speculum of the correct diameter and length should be already in place inside the goat’s vagina (see footnote on previous page). I’m all in favor of using the humanely designed (what a misnomer) speculums.

2. Introduce the lighting device and visually locate the cervix. Look at the slides from the presentation to understand what you actually should be seeing. If you encounter lots of secretion (which is normal in some goats) you may have to lower the goats rear legs so the fluids come out by gravity flow. Alternatively use a new, clean vaginal swab to extract excessive fluid but do not dry out.

3. Thread the French tip in to the os cervix.

4. With gentle circular motion, using slight forward pressure, complete getting through the cervix. Passing the French tip through the cervix will frequently require extensive manipulation of the inseminating gun. On the way to the uterine body expect to encounter approximately 3 to 4 cervical annular tissue folds. This normal anatomical obstruction (nature designed to interlock and only open at estrus and at parturition), are commonly called “rings” which is misleading and helps to create false expectations in the mind of the inseminator of what he/she will encounter in the way the to the uterine body lumen. The presence of this overlapping tissue is what makes the actual AI procedure challenging as they will interfere with the otherwise smooth nature of the cervical canal. I have found that with difficult cervices delivering a tiny bit of semen helps lubricate the tissue and aids in sliding the French tip. However, don’t be surprised if on some goats the inseminating barrel just “slides right in” and no rings are felt. Unfortunately it does not happen too often.

5. You should stop as soon as there is no pressure felt against the inseminating gun tip. You have arrived home. Slightly touch the wall of the uterus and back off a little bit so you are not right against the uterine wall when semen is delivered.

6. Deposit semen slowly by depressing the inseminating gun plunger. Press with the thumb and not with the fingers (index and middle) so that the inseminating gun stays in place rather than coming out from the required semen-delivery spot.

7. Withdraw the inseminating gun slowly to avoid a siphoning action that can pull your semen back. Withdraw the speculum slowly. Place all inseminating equipment where it belongs and clean and sanitize thoroughly all reusable equipment used.

Number of inseminations per estrus period. This is a question often pondered by inseminators as well as people who give recommendations. There are two(?!) schools of thought on this issue, one
group advocates two inseminations (12 h apart\textsuperscript{14}) because it better guarantees that the small window of fertilizing opportunity is well covered at both ends. The other group supports a one time insemination under the claim that vaginal distention during estrus leads to oxytocin release which may cause cervical and vaginal contractions that affect adversely semen transport. Because I did not find satisfactory conclusive evidence on the matter I put the number of inseminations issue to the test. As you can see from the slides in the graphics of the presentation (data not published) no significant difference could be found that breeding once or twice per estrus period made any difference as far as pregnancy rates were concerned.

\textit{Number of inseminations per breeding season.} The decision is largely determined by economics than by biology. It depends on how valuable is the breeding stock to you, semen costs need to be considered, overhead, variable and fixed costs (as technology investments tend to be) an their impact on keeping open goats in the herd (if a “cleanup” buck is not used) should enter the accounting, Consider also potential pregnancy rates at second or third breeding.

\textbf{Q9. If I adopt AI, can I say adios to Mr. Buckaroo?}

If your operation is such (as most productive operations are) dependent upon the number of replacements generated “in-house” then the answer is, “not really”, a clean-up buck is still a necessity, for those goats that are hard to settle. Even, further, don’t forget that a buck has no match when it comes to heat detection, with him on your team (either on a leash or fitted with a breeding prevention apron) I venture to say that no heat will go undetected. If you have many does in the breeding group one buck will be insufficient unless you use some kind of “buck rotation” approach. A practical alternative strategy is to have some males vasectomized or epididymectomized by your herd veterinarian to be heat detectors and not goat impregnators.

If you are capable of getting by with the pregnancy rates that AI can deliver at your hands or at the hands of whomever you hire to do the inseminating for you, and you are able to afford selling or keeping non-pregnant does, then by all means the answer to the question is yes, and literally, “Can that Buckaroo!” Send him to the LN\textsubscript{2} tank.

\textbf{Q10. Are there any drawbacks when adopting AI?}

Like anything else in life “nothing is completely perfect”. The main shortcoming is that the actual AI technical procedure only delivers acceptable pregnancy rates on skilled hands. I think of all other needs (such as time to learn, capital to purchase required equipment, etc.) as investments that will allow you to compete in today’s technologically oriented competitive livestock production environment.

On the larger objective, that of incorporating a cost-effective AI program, the project will benefit from the experience you already have accumulated on your particular operation, but will

\textsuperscript{14} Some other sources go as far as recommending to keep breeding -12 h apart- until the female is out of heat. Beware that if you use more than one insemination, -apart of the detrimental influence on your economy-, you must use the same source of semen (buck) or be prepared to have to run DNA testing to determine who in fact was the sire of your litter.
demand additional skills and the flexibility to incorporate new management approaches. An AI program will financially require you to decide if the proposal makes sense from an economic stance.

In summary, there is a significant effort that has to be placed on acquiring many specific techniques, much greater effort will be required on AI management areas discussed at some length in this document, but remember one management axiom: Nothing works… unless you do.
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