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Dairy Update

CAN YOUR AI TECHNIQUE AND HERD FERTILITY BE IMPROVED?

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Introduction

Herd fertility directly or indirectly will have great impact on herd productivity. Infertility will reduce the number of calves born and increase the number of involuntary culls. This will limit the opportunity to exert effective genetic cull pressure on the herd. Excessively long lactations and long dry periods often lead to unnecessary metabolic disorders which frequently perpetuate more infertility problems. Lastly, long calving intervals result in significantly lowered milk production which directly affect cash flow.

In a productive, well managed dairy herd you should expect to see the following reproductive indicies:

CI	12-13 months
Services/conception	1.6
Conception rate	65%
Heat detection efficiency	60-70%
Average days open	110 days or less

If your herd is significantly below this level of performance, you can benefit from careful study and application of sound reproductive management practices. This article is intended to focus its attention on AI technique.

It is estimated approximately 50% of dairy farmers today do their own AI. In some areas in Minnesota the number doing their own AI is even higher. Where the owner inseminator develops and maintains the technical skills to do AI and pays close attention to detail, owner AI may improve herd reproductive performance. However, maintenance of that level of technical expertise will require constant practice, vigilant monitoring and self-evaluation, and frequent updating on the latest in AI technology.

Understanding the Problems

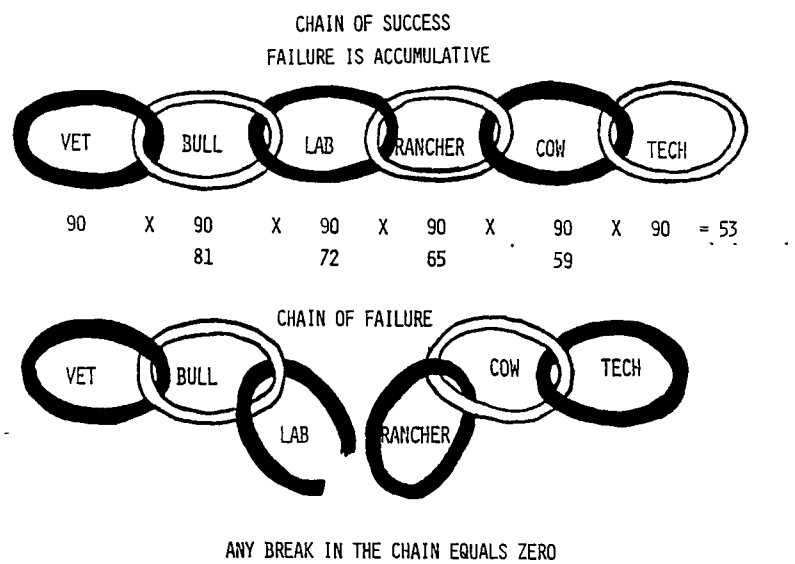
Many factors are involved in the attainment of high breeding efficiency. According to the literature a summary of factors affecting efficiency is given in Table 1. As indicated no figure is given for infertility caused by poor reproductive management. The reason for this is that reproductive management

is highly variable and the overall reproductive success will depend on the degree to which good practices are followed. As shown in Figure 1, there are many factors which combine to determine whether the reproductive management will succeed or fail. It is important to understand that each link in the chain must be completed 100% if total success is to be realized. Failure is accumulative. No matter how good a job you are doing in one area of reproductive performance if you only operate at 50% efficiency in another area, total performance will be less than is desirable. Likewise, if there is a complete break in the chain, complete failure is eminent.

Table 1. Factors affecting infertility in dairy cattle.

1.	Genital abnormalities	3%
2.	Defective ova (eggs)	9%
3.	Fertilization failure	12%
4.	Embryonic mortality	13%
5.	Cystic ovaries	9%
6.	Abortions	3%
7.	Repeat breeders	10%
8.	Genital diseases	3%
9.	Management	?

Figure 1.



Management Factors

Heat Detection: Although it is not the intention of this article to discuss the specifics of heat detection, it must be recognized that poor heat detection is the single greatest obstacle to successful AI programs on nearly all dairy farms. Minnesota DHI records indicate that +20,000 herds are more successful at heat detection than state average performance. Yet 76% of +20,000 herd owners indicated heat detection as the major reason for reproductive failure.

Minnesota studies involving large numbers of cows show that detection of heat is more of a management problem than a cow problem. Ninety percent of all cows thought to be anestrus (not showing heat) were cycling normally. Only 10% of supposedly anestrus cows were actually not cycling as a result of some pathological problem.

Well fed and healthy cows will normally begin to cycle by approximately 20 days postpartum (after calving). Not all of these early ovulations are accompanied by strong heat signs. However, by 60 days postpartum, nearly 100% of normal cows are cycling and expressing normal heat signs. Whether or not these cows are observed in heat depends on the intensity of heat detection efforts. This fact is clearly verified in a summary of three studies found in Table 2.

Table 2. Percentage of normal cows detected in heat at first, second, and third ovulation when maintained under different systems of observation.

Observation system	Ovulation		
	First (20 days)	Second (44 days)	Third (64 days)
(1) Continuous 24 hr observation			
(a) King, et al.	50%	84%	100%
(b) Williamson, et al.			100%
(2) Casual (herdsman)			
(a) King, et al.	20%	44%	64%
(b) Williamson, et al.			56%
(c) Morrow, et al.	23%	46%	64%

How can we improve our heat detection skill? One obvious answer is to simply spend more time looking for cows in heat (Table 2). However, for dairy farmers already pressed for time, perhaps a better answer would be to spend more productive time looking for cows in heat. A periodic review of the scientific knowledge about the behavioral and physical signs of heat is useful for dairy managers. Since reproduction is a complex physiological process, it is easy to become confused about the significance of various heat signs and how they relate to the optimal time for breeding. Study of the University of Minnesota Agricultural Extension Folder AG-FO-2018 Detection of Heat in Dairy Cows is recommended.

Source and Quality of Frozen Semen: Semen quality is basic to successful artificial insemination. High quality semen is dependent on a healthy bull and careful processing of the semen by AI organizations. Quality control is important. Be sure you purchase semen from bona fide suppliers that have carefully followed quality control procedures. The CSS logo stamped on semen units indicates that the semen has been produced according to standards set by Certified Semen Services. These standards dictate bull health and minimum semen quality.

Probably the most important factors include: 1) numbers of live spermatozoa inseminated, 2) percentage of motile spermatozoa constituting the total number of live cells, and 3) the total percentage of cells considered as normal especially the integrity of the sperm acrosome. A minimal standard may include

(Table 3): 1) 10 x 10^6 live sperm per insemination dose, 2) more than 30% motile sperm cells, and 3) greater than 55% sperm cells with normal acrosomes. The number of live, normal spermatozoa inseminated has a profound effect on fertility (Figure 2). Studies show that inseminating less than 10 million sperm cells will decrease fertility. This certainly casts doubt on the advisability of splitting straws between two cows simultaneously in heat. Low sperm motility is also associated with lower fertility (Figure 3). Fertility is greatly reduced when percent sperm motility is less than 30% regardless of total live sperm cell numbers.

Table 3. Minimal semen quality after processing.

% motility	30+
% total abnormal	12-
% normal acrosomes	55+
% proximal droplets	0
Number live/normal/insemination	10,000,000

Figure 2.

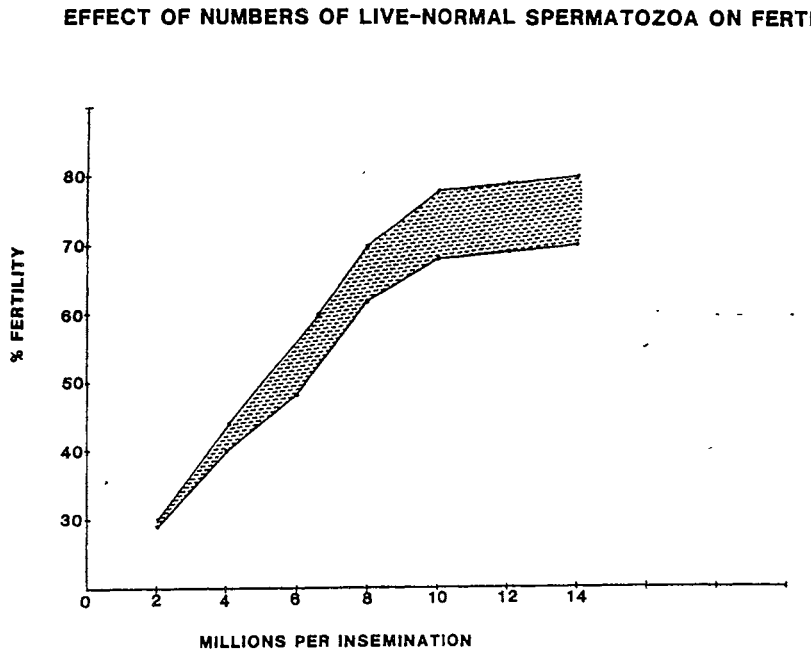
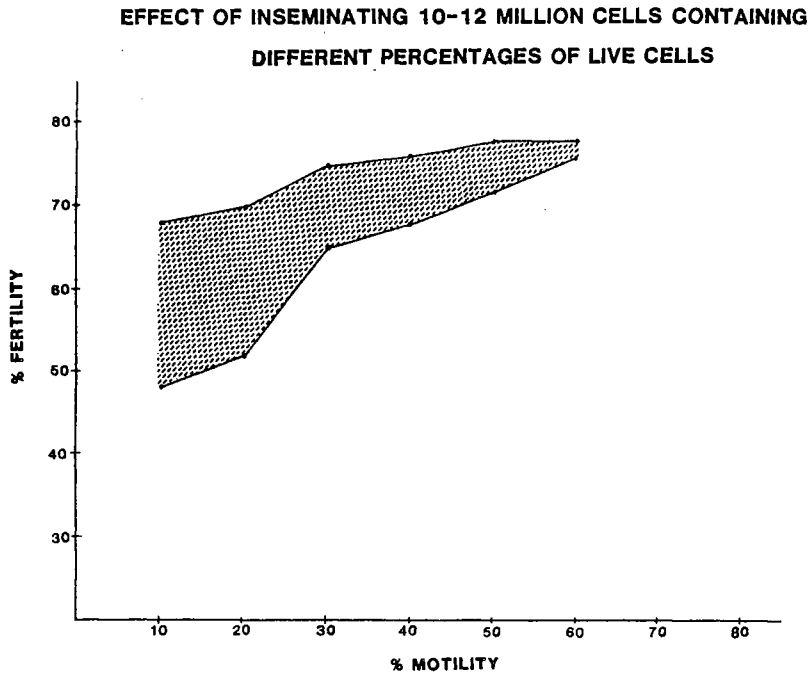


Figure 3.



If you are suspicious of semen quality, have it tested by a qualified lab. Semen evaluation is not for the novice. All AI organizations are willing to check suspect semen.

The Semen Tank: Most semen storage tanks are highly engineered to provide long term safe storage. They are ruggedly constructed but they need to be handled with care and common sense. Semen tanks are most often damaged while being transported. The tanks should never be dropped and should be tightly secured to prevent sudden jolts or spilling.

The semen tank should be kept in a clean, dry and well ventilated location. It should be stored off the floor preferably on a wood platform thus reducing chances of corrosion on the bottom surface. It should be convenient to facilitate ease of semen transfer from your supplier.

The semen tank should be strategically located for frequent observation so that any signs of tank failure will be detected early. Some of those more common indicators of tank failure are:

1. Frosting of the outer shell. This usually indicates there has been a sudden loss in the container vacuum. The cause is a major leak in the inner or outer shell. When this does occur, the owner must transfer the semen to another tank immediately.

2. Ice ring/frost around the cap and top of the outer shell. A frosting of the external surface of the neck and upper tank indicates a slow vacuum leak. This usually is found in old tanks with corroded external surfaces, etc. Occasionally a faulty new tank will display this symptom. Nitrogen holding time is adversely affected and the owner needs to have the tank repaired or replaced.

3. An ice spot on the outer shell. This may occur when the inner and outer shell of the tank touch. This is usually the result of a dented outer tank shell. Although this usually does not drastically effect the tank's inside temperature, the nitrogen holding time will be shortened.

Nitrogen levels should be measured weekly. A record (Figure 4) of nitrogen levels should be meticulously kept so that excessive nitrogen use can be detected. Nitrogen level should never be allowed to go below one inch from the bottom. If proper levels of nitrogen are maintained, the temperature within the tank will constantly remain an ideal -196° C (-320° F). Temperature fluctuations within the tank are undesirable. The effect on temperatures in the neck at different nitrogen levels are shown in Figure 5. Table 4 gives the expected holding time of several models of semen tanks. Expected nitrogen use should be given in the owners manual that accompanies every tank. Never assume your tank is operating properly, always be <u>sure</u> that it is operating correctly.

Figure 4.

LIQUID NITROGEN REFRIGERATOR SERVICE RECORD

DATE	WEEKS	INCHES OR CENTIMETERS REMAINING	DATE	WEEKS	INCHES OR CENTIMETERS REMAINING	DATE	WEEKS	INCHES OR CENTIMETERS REMAINING

Figure 5.

TEMPERATURES IN THE NECK WITH DIFFERENT LEVELS OF LIQUID NITROGEN

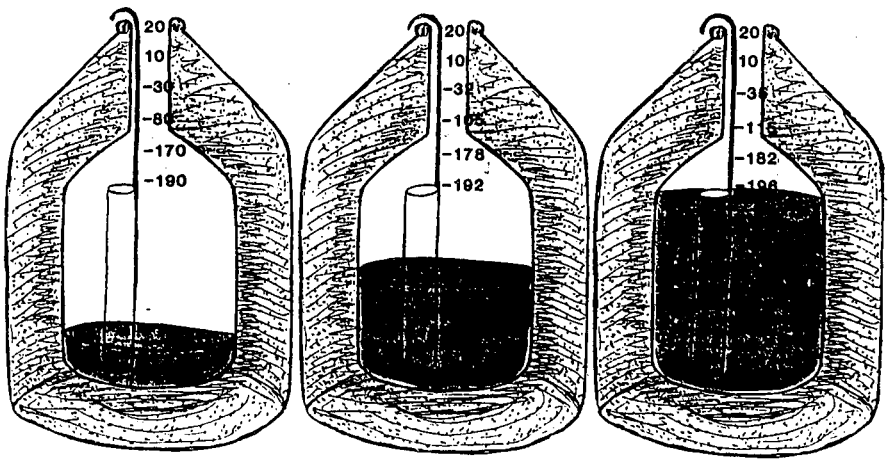


Table 4. Refrigerator designated holding time.

8 weeks	16 weeks	24 weeks
LR-31 Linde	XR-16 Linde	TF-34 MVE
LR-21 Linde	XR-16A Linde	
XR-12 Linde	XR-24 Linde	
XR-8 Linde	Super 31 Linde	26 weeks
Super 30A Linde	VR-16 Linde	Super 6 Linde
AL-20 MVE	AL-29 MVE	SM-33 MVE
AL-30 MVE	SX-17 MVE	SM-43 MVE
AL-39 MVE	SX-18 MVE	
ET-17 MVE	SX-22 MVE	
ET-22 MVE	SX-34 MVE	32 weeks
ET-39 MVE	SX-35 MVE	EM-32 MVE
ET-44 MVE	SX-44 MVE	
350 Cryenco	400 Cryenco	
450 Cryenco		

Removing Semen from the Tank: Every semen storage tank should have an inventory record. Knowing how much semen is in the tank and exactly where it is located in the tank will facilitate more efficient semen handling by the owner and semen supplier and avoid unnecessary and detrimental semen temperature fluctuations. A study showed that 56% of dairy herds in Washington state had no semen inventory records. There are many semen inventory record systems. Figure 6 is an example of one.

Figure 6.

SEMEN INVENTORY

Canister # 1		Canister # 2		Canister # 3	
BULL	UNITS USED	BULL	UNITS USED	BULL	UNITS USED
Canister # 4		Canister # 5		Canister # 6	
BULL	UNITS USED	BULL	UNITS USED	BULL	UNITS USED

Retrieval of semen straws from the tank must be done very carefully being sure that temperature fluctuations are held to a minimum. Successful long term storage of semen depends on semen being maintained at -130° C (-266° F) or

lower. To maintain the quality of the semen remaining in the tank, straw temperatures should be kept as low as possible. If the semen temperature is allowed to rise to -80° C (-176° F) then that unit should be used immediately or thrown away since return to the storage tank will result in reduced fertility. The temperature to which stored semen will rise is dependent on: 1) the level on nitrogen in the tank, 2) the height the semen is raised, 3) the time it is exposed to the higher temperature, 4) the number of times it is raised, and 5) the surface area to volume ratio of the straw. Table 5 shows the effect of exposing 0.5 ml straw to room temperature for various lengths of time and frequency of exposure. Figure 7 shows the temperature to which semen rises when exposed to room temperature depending on its surface area to volume ratios. Study of this figure shows that by the time a 0.5 ml french straw is exposed to room temperature for 5 seconds it has already exceeded the recommended -130° C and by 30 seconds has reached the critical -80° C temperature. Exposing a 0.5 ml french straw to room temperature (25° C) for 10 seconds and returning it to the tank is very detrimental to semen quality.

Table 5. The effect of exposure of 0.5 ml straw to 25 C air for various time with reentry into N_2 on motility of subsequently thawed bovine spermatozoa.

Time exposed to 25 C air	Temperature after exposure	Reentry to N_2	% motility exposure	
			1 time	3 times
0	-196	-196	42.5	----
10 seconds	-125	-196	42.5	42.0
20 seconds	- 72	-196	37.0	20.0
30 seconds	- 50	-196	21.0	10.6
40 seconds	- 32	-196	8.0	0.0
60 seconds	- 12	-196	0.0	0.0

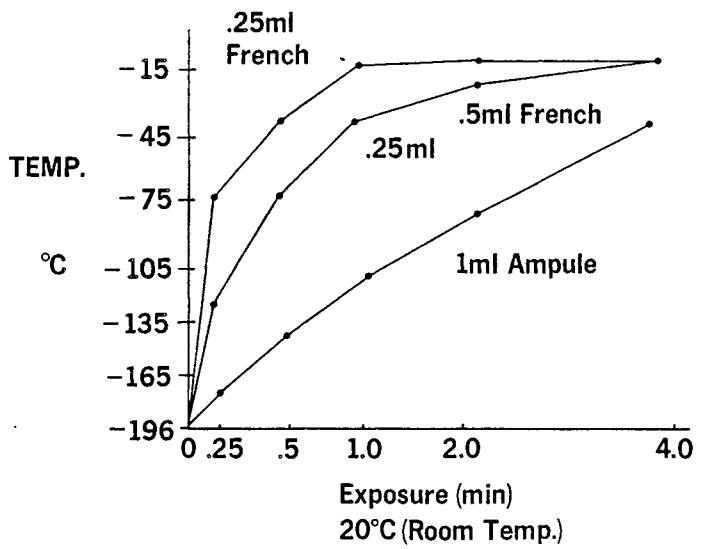


Figure 7. Temperature of semen within individual straws held by forceps or ampules clipped to canes during exposure to a 20 C ambient temperature from Berndtson et al., NAAB Tech. Conf., 1976.

From these data has come the recommendation that the canister not be raised above the frost line in the tank's neck and that the semen straw be retrieved within 5 seconds. If it takes more than 10 seconds to locate the proper cane, it is recommended that the canister be lowered back into the tank to allow it to cool.

Method of Thawing Semen: Most data suggest that a rapid thaw rate is best. The time required for the semen to go through the "critical recrystallization zone" (-20 to 0° C) is important (Figure 8). The faster this happens, the less sperm cell damage occurs. Table 6 shows a comparison of thaw methods.

Figure 8.

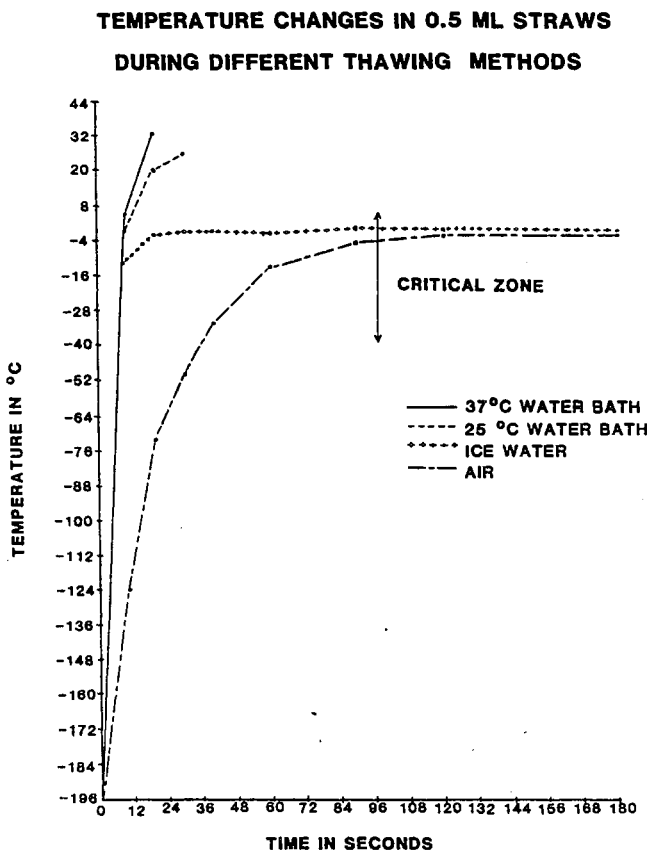


Table 6. Effect of thaw bath temperatures and cold shock on sperm recovery.

	After 3 hours incubation post thaw (37 C)	
Thaw method	% motile	% intact acrosomes
5 C	30.3[a,b]	31.2[a]
Air	21.4[c,d]	26.4[a]
35 C	51.4[b]	61.0[b]
35 C thaw and 5 C cold shock	41.1[a,b,c]	44.6[c]

Different superscripts designate differences (P<.05) in each column.

Not all AI organizations use the same thaw procedures. This does not necessarily mean that one method is better than another. Each AI organization uses the thaw method best suited to their specific semen packaging. In the event that you do not have or are unable to get specific thaw instructions, the NAAB has outlined a generic thaw method as follows:

1. Thaw straws 90-95° F.

2. Never thaw more straws at one time: a) than the number that can be immediately used, and b) than would cause water temperature to drop below 90° F.

3. Thaw for a minimum of 40 seconds. Inseminate cow as soon as possible, do not delay insemination longer than 15 minutes after thawing.

4. Avoid semen exposure to severe cold or heat.

Semen Handling from Thawing to Insemination: "Cold shock" can cause damage to sperm cells. Table 6 shows that sperm motility is significantly decreased in semen thawed at 35° C and then exposed to 5° C. The possibility of "cold shock" is likely in Minnesota. In cold climates perhaps two options should be considered: 1) provide a sheltered heated area for breeding, or 2) provide a sheltered heated area for semen thawing and loading of the inseminating pipette near the animals to be bred. Prewarming the insemination gun prior to loading semen and protecting the gun by insulating in a clean paper towel and/or tucking into your coveralls during weather 50° F or less is good practice. Figures 9 and 10 demonstrate the effectiveness of prewarming the AI gun by rubbing rapidly with a towel prior to loading at various ambient temperatures. In freezing weather the possibility of refreezing thawed semen exists. This can be only classified as a disaster with regard to semen quality. Regardless of the thaw procedure recommended, conditions causing a drop in temperature should be avoided.

Figure 9.

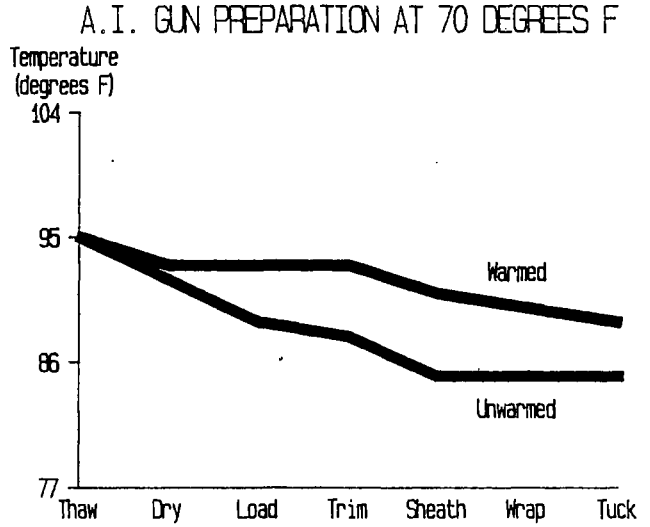
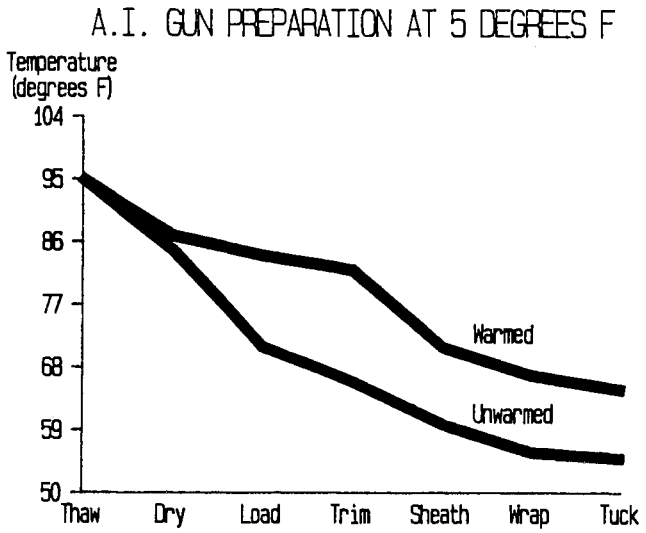


Figure 10.



A few reminders are given on semen handling after thawing.

1. Place the thawed straw into a prewarmed inseminating gun.

2. Clip the sealed end of the straw taking care to clip straight so that a proper seal exists when placing the protective sheath over the straw.

3. Tighten ring holder over the protective sheath to hold straw and sheath together to prevent back flow of semen.

4. Place a protective plastic over prepared apparatus to insure sanitation on passing through the vagina.

Insemination: Next to estrus detection errors and AI timing (Table 7) (Figure 11), semen placement errors are the cause of most infertility in dairy cattle. It is ironic but not surprising that these are all management errors. For proper deposition of semen a knowledge of the anatomy of the female reproductive tract must be understood. The body of the uterus is the target (Figure 12). In most cows it does not exceed 1 inch in length. For sperm to travel both horns, it should be deposited preferably into the body of the uterus. To illustrate the difficulty in preforming the proper site of deposition, several groups of technicians individually inseminating 2000-5000 cows per year were enrolled in a training session. All were instructed to place a dye (methylviolet) into the body of the uterus of live cows. Each technician made attempts on six cows. After dye deposition the animals were individually tagged and were slaughtered. On examination of the reproductive tracts the data in Table 8 was obtained. Most technicians were unable to properly place the dye during the first training sessions. After further training experience most technicians were able to properly place the dye in the

Figure 12.

Bovine Reproductive Tract

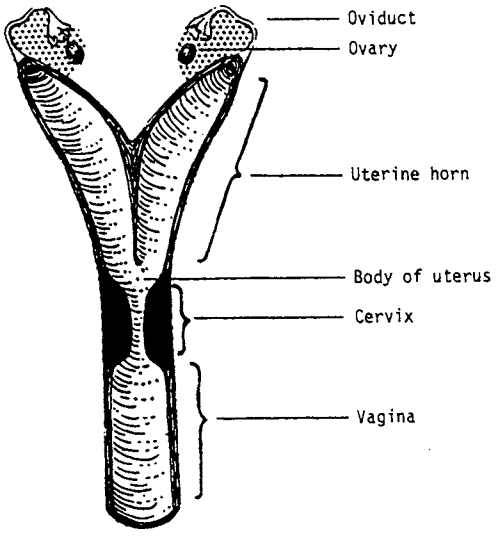


Table 8. Site of dye deposition in cows in vivo.

Site of dye deposition	Test A 297 checks	Test B 269 checks	Test C 138 checks	Test D* 256 checks	Test E** 28 checks
	%	%	%	%	%
Body of uterus	31	33	27	34	85.7
Right horn	40	42	27	31	14.3
Left horn	5	9	4	4	0
Anterior cervix	12	8	24	9	0
Posterior to center cervix	6	3	10	16	0
Anterior vagina	6	5	7	6	0

*Test D - men with 30-60 N.R. less than 70%.
**Test E - men with 30-60 N.R. greater than 78%.

Table 9. Effect of retraining technicians by use of dye deposition.

	(Station II)	
No. of technicians	4 mo. before retraining	4 mo. following retraining
	60-90 day N.R.	60-90 day N.R.
13	62.5	70.5

It should be pointed out that those inseminators involved in the above study were professional AI technicians with considerable experience. Most owner-inseminators in Minnesota may inseminate, at most, 200 animals per year. What about your AI insemination skills? Are you as good as you need to be?

Three things need to be considered when the semen is deposited:

1. Am I in the right place?

2. Are my fingers or hand obstructing or misdirecting semen flow into the body of the uterus.

3. Am I taking time (5 seconds) in releasing semen from the gun?

Good concentration coupled with gentle and accurate AI technique will assure that the semen is placed correctly in the uterus allowing for the maximum likelihood of conception.

Summary

To obtain high breeding efficiency with frozen semen, many management factors must be considered. These include:

1. Deal with reputable AI organizations; i.e., have confidence in the source of the semen and the research and recommendations of that organization -- if semen is purchased from other than AI organizations, be sure it has been adequately stored and handled.

2. Follow explicitly the producing organization's recommendations for handling and inseminating their product.

3. Stay alert for changes in that organizations's recommended procedures. Keep up to date -- we are in a period of marked transition.

4. Avoid experimenting on your own. It is almost impossible to draw valid conclusions from data accumulated in one herd.

5. Do a good job of heat detection and be sure AI timing is correct.

6. Be sure semen is deposited in the body of the uterus. Select the best inseminator on your farm and allow him or her to do most of the breeding. This will give that individual a better chance to develop and maintain AI skills.

7. Monitor your performance continually.