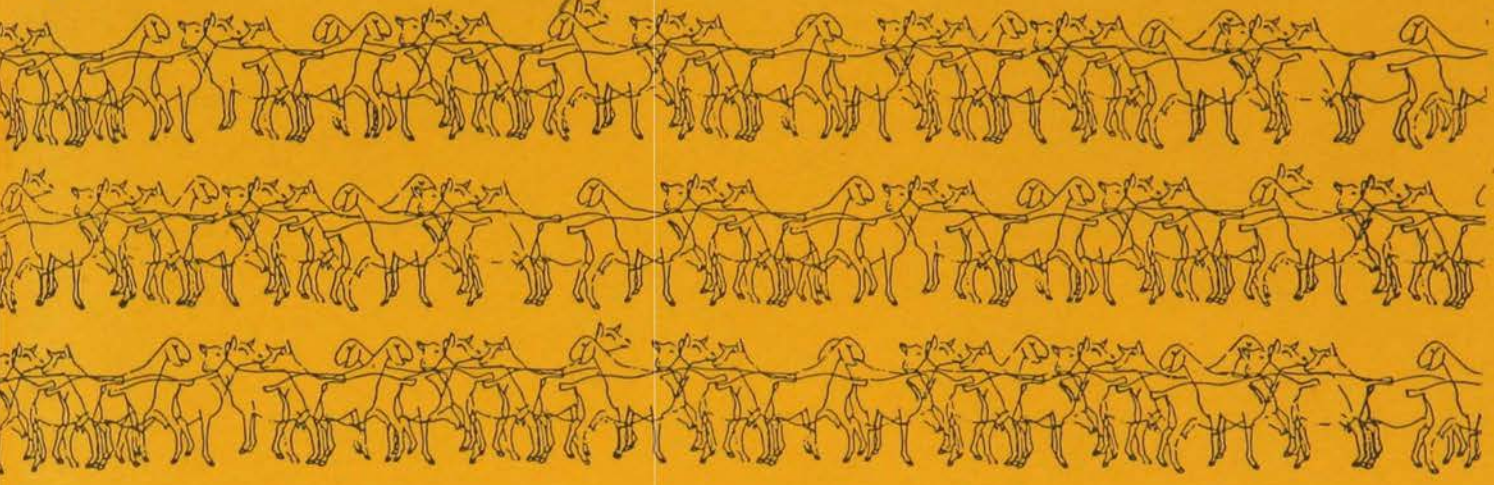
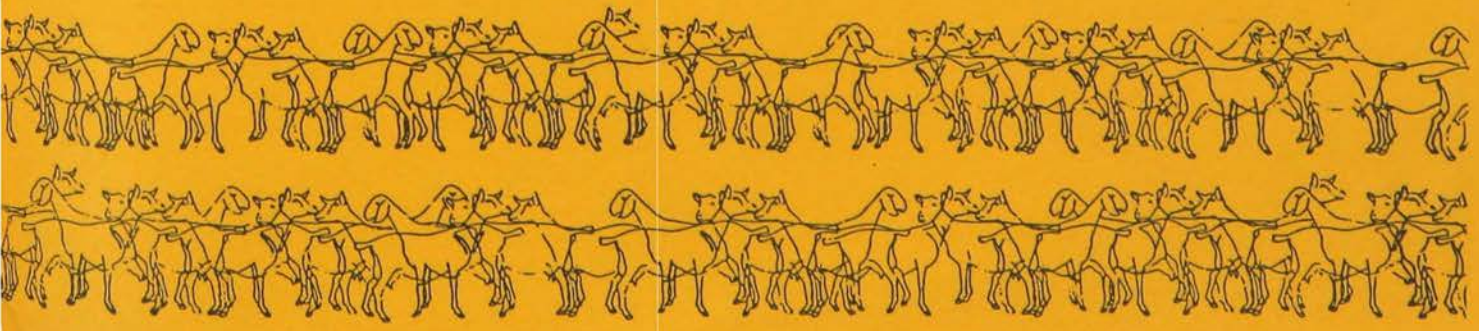


DAIRY GOATS

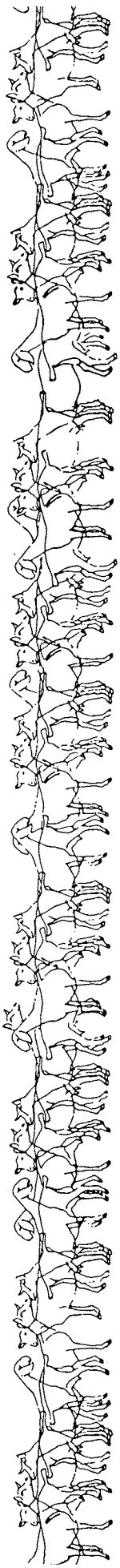
CONFERENCE

October 1 and 2, 1983

Agricultural Extension Service, University of Minnesota



6TH ANNUAL DAIRY GOAT CONFERENCE PROCEEDINGS COMPILED AND EDITED BY: GERALD WAGNER, EXTENSION SPECIALIST, PROGRAM DEVELOPMENT, AND VALERIE WALLINGFORD, SENIOR SECRETARY, OFFICE OF SPECIAL PROGRAMS, UNIVERSITY OF MINNESOTA, ST. PAUL



Saturday Session — St. Paul Student Center
University of Minnesota St. Paul campus

7:45 a.m. — Registration

8 a.m. — Films
for early arrivals: "Fitting and Showing," "Breeding and Kidding," and "Basic Management"

8:55 a.m. — Welcome
Vince Maefsky

9 a.m. — Why A.I.?
Ron Neely

9:30 a.m. — Basic Anatomy and Physiology of the Reproductive Tract
Dave Sherman

10:20 a.m. — Break

10:40 a.m. — A.I. Techniques film

10:50 a.m. — A.I. Techniques and Equipment
Ron Neely

11:25 a.m. — Heat Synchronization
Dave Sherman

12 p.m. — Lunch
on your own — food available at Student Center

1:15 p.m. — Concurrent Sessions

A. A. I. Semen Handling, Animal Retraint, Slides
Ron Neely

B. Cheesemaking
Marge Kitchen

C. DHI training for ring testing
Sharon Sayre

D. Basic Dairy Goat Management
Maxine Sheldon

3:30 p.m. — Break

3:45 p.m. — Goat Health Update
Dave Sherman

4:30 p.m. — Question Session

Sunday session — Poplar Hill Goat Dairy
12521 Mayberry Trail North, Scandia, Minn.

9 a.m.-12:30 p.m. — After attending the previous day's prerequisite lectures and slide presentations, you'll have the opportunity to artificially inseminate a dairy goat yourself under supervised instruction. Goats, synchronized in September, will be ready for artificial insemination on Oct. 2.

To take part in this unique clinic, you **must** register by Sept. 1. Your preregistration allows the Poplar Hill managers time to prepare an accurate number of goats for the clinic.

Who is presenting this course?

Marge Kitchen, MDGA, Grande

Vince Maefsky, MDGA director, Poplar Hill Goat Dairy, Scandia

Ron Neely, Zia Capri, Ashland, Mo.

Sharon Sayre, MDGA DHIA testing committee, Monticello

Maxine Sheldon, MDGA, Marine on St. Croix

Dave Sherman, DVM, assistant professor, College of Veterinary Medicine

Gerald Wagner, extension specialist, Office of Special Programs

Sponsored by University of Minnesota:
Office of Special Programs, Agricultural Extension Service, College of Veterinary Medicine, Department of Animal Science in cooperation with the Minnesota Dairy Goat Association

For more information call (612) 373-0725

6th ANNUAL DAIRY GOAT CONFERENCE

TABLE OF CONTENTS

WHY AI?

Ronald C. Neely
Zia Capri Dairy Goat A.I.
Ashland, Missouri

Interest in the use of artificial insemination in dairy goats has increased substantially in recent years in the United States. Factors contributing to this increased interest include the recent publication of the USDA-DHIA Dairy Goat Buck Evaluations for Milk and Fat and the ADGA Classification Summary, as well as the increased availablilty of semen from sires identified as potentially superior by these and other sources. In theory, A.I. offers a number of advantages to the goat breeder over those of direct natural service by the buck. These can be summarized as follows:

ACCESS TO GENETICALLY SUPERIOR SIRES

The widespread use of artificial insemination in the dairy cattle industry over the last thirty years has helped bring about dramatic increases in per capita milk production. The potential exists for similar production increases in dairy goats. However, before this potential can be realized, genetically superior families and individuals must be identified. Only recently have serious attempts been made to address this problem. Because goat populations are relatively small and the reproductive life expectancy of a buck is limited to approximately five years, it remains extremely difficult to identify superior sires while they are still in active service. Moreover, the seasonal breeding nature of the goat and the relatively small volume of ejaculate produced limit the amount of semen which can be processed from any given buck in a year. Although in theory, the most effective way to prove a young sire is through his use in a large scale artificial insemination program, in practice, the successful use of A.I. in goats remains quite limited, and as a consequence most sires available are still largely unproven. At the present time, the popularity of most bucks would appear to be correlated more directly with the amount of advertising devoted to promoting them than with any tangible proof of their genetic superiority.

ECONOMIC CONSIDERATIONS

There is no question that A.I. is very attractive from a financial standpoint. Typically the costs of an LN_2 refrigerator (with a useful life expectancy of at least ten years) and requisite insemination equipment do not exceed $750.00, while yearly service fees for liquid nitrogen average about $75.00. To this must be added the cost of semen, which is generally priced between $5.00-$25.00 per unit. With the cost of buck kids from the best known breeders falling in the range of $500.00-$1500.00, and feed and maintenance expenses averaging $150.00 per year per

head, the use of A.I., as an alternative to purchasing junior herdsires, would seem to offer definite economic advantages. Moreover, LN_2 refrigerators and equipment typically depreciate in value at a rate of less than 10% per year. Semen is available at a price of $20.00 or less from a number of sires whose natural service stud fee exceeds $100.00. Stored semen frequently appreciates in value, especially after the buck passes from active service.

HEALTH CONSIDERATIONS

Properly performed, A.I. is inherently more hygienic and less likely to be implicated in the spread of certain diseases than is natural service by a buck. Those breeders wishing to reduce exposure of their goats to the threat of infection from outside animals stand to profit especially from the use of A.I. Unfortunately, at the present time, the bulk of buck semen being offered for sale in the U.S. is from sires who have undergone minimal health testing. Virtually no research has been done to determine what, if any, diseases are transmissible in the seminal plasma of the dairy goat. As the A.I. industry matures, and as research indicates the need to do so, it is likely that more extensive health testing of bucks prior to collection for sale will become the norm. Even at the present time, the reported incidence of health problems which could be attributed to viable pathogens present in frozen semen is quite low.

BASIC ANATOMY AND PHYSIOLOGY OF THE REPRODUCTIVE TRACT OF THE DOE

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Department of Large Animal Clinical Sciences
College of Veterinary Medicine
University of Minnesota
St. Paul, Minnesota 55108

INTRODUCTION

In any livestock enterprise, reproductive performance and efficiency is of paramount importance to financial success. In the dairy goat industry, all desired end products including milk, replacement stock, and breeding stock for sale result from successful reproductive management. As our knowledge of reproductive physiology has improved over the years, it has become increasingly possible to manipulate the reproductive process to achieve specific goals of management and husbandry, improving the quality of our livestock and the products we derive from them. Artificial insemination, heat synchronization and superovulation are just some of these advances. In order to appreciate these technological gains and put them to work in your own herds, it is necessary to understand the basic anatomy and physiology of reproduction. The purpose of this paper is to provide background information on the reproductive anatomy and physiology of the female dairy goat.

ANATOMY

Ovaries

The two ovaries are located in the abdominal cavity just ahead of the pelvis. They are round to oval in shape and approximately 1 inch in diameter. The ovaries have two important functions. The first is gametogenic. That is, the ovary provides the egg, or gamete, which, when fertilized by the male sperm, gives rise to the developing fetus. The second function is endocrine, or hormonal. Structures within the ovary produce estrogen, responsible for signs of estrus or heat seen in the doe, and also progesterone which is responsible for maintaining pregnancy after fertilization of the egg.

Oviduct

The two oviducts are long, thin, coiled muscular tubes found adjacent to the ovaries and leading into the horns of the uterus. The end of each tube near the ovary flares out into a covering of the ovary known as the ovarian bursae. The oviduct has several roles. It is responsible for catching the eggs which are discharged from the surface of the ovary at the time of ovulation so they are not lost into the abdominal cavity. It provides an avenue for sperm to locate the egg and it serves as the site of fertilization. The developing embryo spends four to five days maturing in the oviduct before moving into the uterus.

Uterus

The uterus is a muscular organ with remarkable powers of expansion and contraction. In the goat, the uterus has a short body from which arise a pair of long coiled uterine horns. Approximately 115 to 120 button-like protrusions are arranged in four rows in the lining of each uterine horn. These protrusions, or caruncles, are the sites of placental attachment during pregnancy. The uterus serves as a passageway for sperm during migration to the oviduct. Most importantly, the uterus serves as a protective incubator for the developing fetus. The muscular strength of the uterus permits rapid delivery of the newborn at the time of labor. Muscular contraction and shrinking of the uterus after delivery expels the afterbirth and fluids to clean up the reproductive tract and avoid infection. This process is called involution. The lack of muscular contraction during pregnancy, which allows successful development of the fetus, is under the control of progesterone produced by the corpus luteum of the ovary. Uterine contractions associated with labor are associated with decreasing progesterone and increasing estrogen levels.

Cervix

The cervix is the doorway to the uterus. It separates the sterile uterus from the vagina, which is contaminated by bacteria from the external environment. The cervix is a muscular, fibrous, sphincter-like organ with several transverse folds or rings, usually 5, to help produce a physical barrier to the uterus. It also contains mucous secreting glands. When a speculum is inserted into the vagina, the cervix can be seen. Under the influence of estrogen the cervix will relax at estrus to allow sperm to enter the uterus and achieve fertilization and again at parturition or labor to allow the newborn kid, placenta and uterine fluid to be discharged. At other times, the cervix remains tightly closed, sealed with a mucous plug, to protect the fetus and prevent infection from entering the uterus.

Vagina

The vagina serves as a receptacle for semen during copulation and as a passageway for the fetus during labor. Furthermore, the urethra empties into the vagina, carrying urine from the urinary bladder. The length of the vaginal canal in the goat is 3.5 to 5 inches. Changes in the appearance of the cells lining the vagina occur in relation to the stages of estrus cycle. Whereas these changes can be used to accurately predict heat in dogs, the pattern is not so well defined in goats.

External Genitalia

That portion of the genital tract visible from the outside is known as the vulva. Swelling and reddening of the vulva as well as a mucous discharge may be good indicators of the onset of heat. The clitoris in normal goats is usually not visible between the lips of the vulva. If it is prominent in a doe, this may suggest the intersex condition of infertility associated with polled or naturally hornless goats.

THE REPRODUCTIVE OVARIAN CYCLE

Cyclic activity of the ovary is central to reproductive function in domestic animals. In response to environmental factors, nerve impulses from the brain, hormones from the pituitary gland and feedback from the uterus, the ovary produces a number of structures in a series of well-defined stages to control the following activities: 1) Initiation of heat and sexual receptivity to promote successful breeding behavior; 2) Delivery of the egg from the ovary, in conjunction with heat, at a time optimal for fertilization; 3) Preparation of the uterus for initiation of successful pregnancy; 4) Hormonal regulation to maintain successful pregnancy; and 5) Recycle for additional heat if successful fertilization or pregnancy do not occur.

The steps in the ovarian cycle and the related structures involved in the above activities are as follows:

Proestrus

Proestrus is defined as the period prior to estrus or heat and lasts one or two days in the goat. This is the time of follicle development. Early or primordial follicles which lie under the surface of the ovary consist of an immature ova or egg surrounded by a single layer of cells. During proestrus the single layer of cells multiplies to form several cell layers of specialized hormonal function and the center of the follicle around the ova fills with fluid. The follicle moves toward and bulges out from the surface of the ovary. This follicular development is under hormonal control. It is stimulated by release of follicle stimulating hormone (FSH) from the pituitary gland. The release of FSH is probably under the influence of rising blood estrogen levels and falling blood progesterone levels which occur at the end of the preceding estrous cycle. Some observers say there are no outward

visible signs of proestrus while others include the early signs of heat seen prior to the onset of standing heat as part of the proestrous period.

Estrus

Estrus is the period of heat, or maximum sexual receptivity, in domestic animals and coincides with or slightly precedes ovulation or release of the egg from the mature follicle. The developing ovarian follicle is responsible for the onset of heat because specialized theca cells lining the wall of the follicle secrete estrogen, the primary regulator of sexual behavior. Estrus in the doe can range from 24 to 96 hours with average heats lasting 32-40 hours. The period of maximum sexual receptivity or standing heat lasts 12-24 hours. Under the influence of luteinizing hormone (LH) from the pituitary gland, the mature or Graafian follicle ruptures releasing the ovum into the ovarian bursa. In the goat this rupture, or ovulation, occurs usually between 30 to 36 hours after the detectable onset of heat. More than one follicle may mature during any heat period leading to multiple offspring. Does should be bred within 24 hours of the onset of heat so that sperm is already present in the female reproductive tract prior to the time of ovulation. Sperm require a capacitation or maturation period in the uterus and oviduct before they are capable of fertilizing the egg.

Recognition of heat by the owner requires repeated, conscientious, daily observation of the doe herd and a knowledge of the signs of heat. Signs include horizontal persistent flagging of the tail, restless behavior with repeated or continuous bleating, frequent urination, swelling and reddening of the vulva and a mucous vulvar discharge. A slight drop in milk production and appetite may signal the onset of heat. A buck in the presence of a doe in heat will show interest by snorting and vocalizing, raising the head and lifting the upper lip (flehmen reaction), kicking at the doe with his

forelimbs and by urinating on himself. Most importantly, the doe in standing heat will allow the buck to mount and copulate, in order to deposit sperm in the anterior vagina.

Metestrus

After the ovum is discharged from the mature fluid filled follicle, the follicle collapses on itself and, fills with blood producing the corpora hemorrhagicum or blood filled body. At the same time the lining cells once again begin to multiply, this time to produce progesterone. When the hormone producing cells have replaced the blood clot, the structure becomes known as the corpus luteum or CL. This development of the CL is under the influence of the luteinizing hormone or LH from the pituitary gland. The CL is responsible, through the secretion of progesterone, for preparing the uterus for successful survival and implantation of the fertilized egg. Progesterone increases the glandularity of the uterine lining and promotes the secretion of "uterine milk" which protects and provides nutrition to the developing embryo before implantation and development of the placenta occur. The period from the end of standing heat to the formation of the functional CL is the period of metestrus, which lasts from 1 to 2 days.

Diestrus

This is the longest period of the estrus cycle and is often referred to as the phase of the corpus luteum. During this period the CL persists in the ovary, secreting progesterone and maintaining a suitable environment for successful implantation of the embryo. Furthermore, by suppressing muscular contraction of the uterus, progesterone secretion by the CL insures the continued development of the fetus through pregnancy. If a fertilized egg or zygote reaches the uterus from the oviduct and implantation occurs, hormonal signals from the uterus result in maintenance of the CL for the entire 150-day

duration of the doe's pregnancy. However, if mating was not successful, if the zygote dies, or if implantation does not occur, then the CL persists for only 16 or 17 days. The non-pregnant uterus produces a feedback substance termed luteolysin (prostaglandin $F_{2\alpha}$) which shuts off the CL and terminates progesterone secretion. This is the basis for the use of prostaglandins in heat synchronization. When the CL dies and progesterone secretion drops off, proestrus begins again. The entire cycle takes on the average 21 days.

The goat is considered a seasonal polyestrous breeder meaning that the doe has repeated estrous cycles, but only during a portion of the year. This is in contrast to the cow which cycles year round (continuously polyestrus) or the dog which only has a single heat cycle during breeding season (seasonally monoestrus). In Minnesota, the breeding season for goats usually begins in mid September and lasts through December. Onset of breeding season is triggered by the goat's sensory recognition of decreasing day length (photoperiodism). This allows the goat (and the sheep) to coordinate delivery of offspring with optimal conditions for their survival, i.e. growth on spring and summer pasture.

An interesting area of reproductive physiology has been the question of how sensory stimulation such as the change in day length is translated into hormonal regulation of breeding activity. It is now clear that sensory signals such as decreasing light registered by the optic nerve, or buck odor detected by the olfactory nerve, probably send nerve impulses to a region of the brain known as the hypothalamus which contains specialized nerve cells which can secrete a gonadotrophin releasing hormone (GnRH) which in turn acts on the adjacent pituitary gland to produce FSH or LH. These gonadotrophic hormones reach the ovary via the blood stream to stimulate the production of the steroid sex hormones previously discussed, namely estrogen and

progesterone. These hormones then feed back to the hypothalamus or pituitary to initiate or suppress further secretory activity by these higher centers. A similar pattern of neurohormonal control exists in the buck to initiate breeding behavior and improve sperm production via testosterone during the breeding season.

A summary of the various hormones involved in the reproductive cycle, their source, and their activities is provided in the attached table. By understanding the functions of these various compounds and their sequential relationship in the reproductive cycle, a better understanding of the techniques, drugs and strategies employed by veterinarians and producers to manipulate sexual behavior and improve reproductive efficiency can be achieved. Specific interventions used for heat synchronization will be discussed in the companion paper.

HORMONES OF REPRODUCTION

Hormone	Source	Important Functions in Female
Gonadotropin Releasing Hormone (Gn-RH)	Hypothalamus	- Release of luteinizing hormone from pituitary. - Release of follicle stimulating hormone from pituitary.
Prolactin Releasing Factor	Hypothalamus	- Release of prolactin from pituitary.
Prolactin Inhibitory Factor	Hypothalamus	- Inhibition of release of prolactin.
Follicle Stimulating Hormone (FSH)	Anterior Pituitary Gland (Adenohypophysis)	- Follicular growth - Estrogen secretion
Luteinizing Hormone (LH)	Anterior Pituitary Gland (Adenohypophysis)	- Estrogen secretion (along with FSH) - Ovulation - Formation and maintenance of CL. - Progesterone secretion
Prolactin (Role in goat unclear)	Anterior Pituitary Gland (Adenohypophysis)	- Maintenance of CL (along with LH) - Progesterone secretion (along with LH) - Lactation
Oxytocin	Posterior Pituitary Gland (Neurohypophysis)	- Ovum transport in oviduct - Uterine contraction at kidding - Milk letdown
Luteotrophin ? (existence not established in goat)	Placenta ? Fetus ?	- Maintenance of CL of pregnancy.
Luteolysin (Prostaglandin $F_{2\alpha}$)	Uterus	- Regression of Cl at end of diestrus.

Hormone	Source	Important Functions in Female
Estrogen	Ovary Placenta	- Estrus behavior - Feedback control of gonadotropins. - Maintenance of 2^{o} sex characteristics. - Increase uterine contraction. - Cervical relaxation and mucous production. - Mammary gland development.
Progesterone	Ovary	- Estrus behavior (with Estrogen) - Negative feedback on gonadotropins. - Promotes glandular development of uterine lining. - Inhibits uterine contractility. - Maintains pregnancy - Mammary gland development.

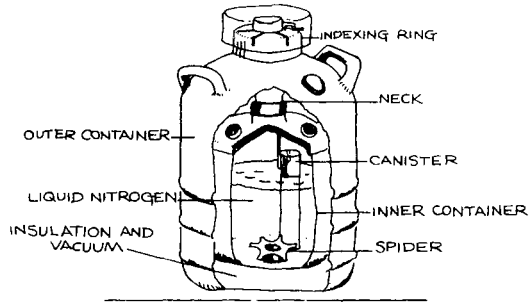
ARTIFICIAL INSEMINATION OF DAIRY GOATS

I. SEMEN STORAGE

Frozen goat semen is stored on the farm in a portable refrigerator or tank filled with liquid nitrogen. This unit is somewhat like a thermos bottle in design with a rugged outer jacket of aluminum or stainless steel and an inner compartment that contains liquid nitrogen and the canisters which hold racks (canes) of semen. The space between the inner and outer jackets is insulated and under extreme vacuum. A hard foam insulating plug extends from the top down into the neck of the unit to minimize evaporation and keep foreign objects out of the tank.

The temperature of liquid nitrogen is -196° C (-310° F), and the space above the refrigerant but below the neck of the tank is only a few degrees warmer. Rate of evaporation or holding time depends on tank construction and can vary from fourteen days to twenty-four weeks. The tank must be refilled before the nitrogen has completely evaporated (usually when there are approximately four inches of nitrogen left) in order to maintain the desired temperature.

The tank must be protected from injury at all times. Damage may result in a loss of vacuum which allows evaporation to occur rapidly. If this goes unnoticed the tank may go dry and the semen will be lost, sometimes in as little as twenty-four hours. A frost spot anywhere on the outer skin indicates that nitrogen is boiling away, and the semen should be transferred to another tank immediately. The nitrogen level should be checked frequently and recorded between scheduled refills to insure that the evaporation rate is not too great. The liquid nitrogen level in the tank can be measured by inserting a wooden yardstick into the tank for ten to thirty seconds then removing it and waving it vigorously in the air for five seconds. The position of the frost line is



SEMEN STORAGE TANK

equal to the depth of the liquid nitrogen in the tank.

Suspended from the top of the tank neck are six to eight canisters which hold a variable number of canes of semen. Each canister is a hollow metal cylinder open at the top with a perforated bottom. This construction allows access from the top while permitting liquid nitrogen and vapor to pass through the bottom.

Semen is usually packaged in 1.0 m. glass ampules or one-half ml. French straws. Straws are placed into containers called goblets, usually in groups of five or ten straws, and two goblets snap into each rack or cane, one above the other. Ampules are anchored directly onto the canes and are packaged six or eight to a cane. At the top of the cane a metal tab is marked with the buck's name or code number. To insure positive identification, each breeding unit is labeled with the buck's registered name, his registration number, processor's name and the processing date.

II. SEMEN HANDLING

Frozen semen is a fragile product and all temperature fluctuations decrease semen quality to some degree. For practical purposes, the most damaging temperatures begin in the neck of the tank where a transition to atmospheric temperature is evidenced by a frost line. The number of exposures to the warmer temperatures of the neck and the environment must be minimized. The following tips will reduce temperature fluctuation and damage to semen.

1) Keep a log of the contents of each canister recording the cane identification for each buck and the number of breeding units; amend this log as semen is removed to avoid needless inventory manipulations.

2) Don't overcrowd the canister: this makes cane withdrawal difficult and slow.

3) Learn to work well down in the neck of the tank.

4) *Never* keep canes or canisters raised for more than five seconds: if desired action cannot be completed within that time, stop and lower the canister for at least thirty seconds and try again.

5) Once a straw is removed from its goblet on the cane, use it; do not return it to the tank.

To remove a single straw from the tank, move the canister from its storage position into the center of the tank. Raise the canister slightly and, while it is still down below the neck, use a flashlight to locate the desired cane of semen within the canister. Lower the canister to the center floor of the tank for thirty seconds, then raise it again into the neck with the right hand and grasp the desired cane in the left. Lower the canister immediatly, then use straw tweezers to grasp the desired straw. Lower the cane immediately. Bending the tab up at the top of the cane may facilitate straw removal. Do not bend straws. When the top goblet is empty, move it all the way to the top of the cane

to facilitate removal of straws from the lower goblet. Do not remove the top goblet which prevents straws below from floating out of the lower goblet. Never keep canes up in the neck for more than five seconds.

To remove a single ampule, locate the appropriate cane with a flashlight as for straws, then lower the canister completely. After a thirty second wait, raise the canister with the right hand, pull out the desired cane with the left, gently drop the canister down to the floor and remove the desired ampule by grasping at the top only and gently but firmly tilting it away from the cane. Lower the cane immediately.

To transfer entire canes from a shipping tank to the farm storage tank, place the two refrigerators side by side. Position the receiving canister on the floor in the center of the tank. Raise the canister in the shipper just high enough to grasp a cane, then lower that canister immediately while the transfer is being completed. This transfer must be completed within five seconds as a longer exposure to warm temperatures will elevate the semen temperature to a critical point.

III. EQUIPMENT LIST

- 18" metal tool box or similar dust-free container for equipment
- sterile lubricant
- antiseptic wash
- cotton balls
- gloves (optional)
- flashlight
- goggles (optional)
- two penlights
- extra AA batteries
- extra penlight bulbs
- two to four large speculums
- two to four small speculums
- paper towels
- six inch ruler
- thaw box
- thermometer (for warm water thaw)

for ampule insemination:

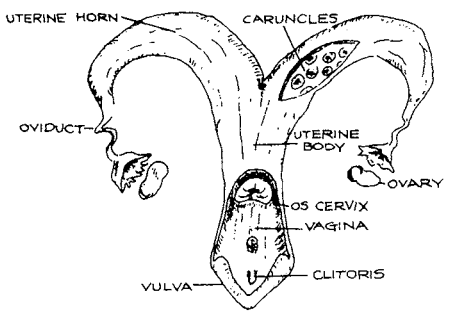
- 2½-3 cc. disposable syringe
- 18" x ⅛" surgical hose
- 16" pipets-several packages
- ampule scribe (optional)

for straw insemination:

- French straw gun
- French sheaths-several packages
- straw tweezers, preferably stainless steel
- straw cutters or scissors
- extra '0' rings

IV. TIMING OF INSEMINATION

Proper timing of insemination is essential for conception because sperm cells can only live for a short time in the female reproductive tract. The cervix is most relaxed and easiest to penetrate during standing heat, and utering motility favors sperm transport at this time. Ovulation tends to occur late in the heat period so, all things considered, it is advisable to breed late in standing heat. At this time cervical mucus is slightly cloudy and thick.



FEMALE REPRODUCTIVE TRACT

Does with regular, well-characterized heat periods are the best candidates for AI because it is easier to determine the proper insemination time than in a doe with irregular, subtle heats. The presence of a buck will help in eliciting characteristic behavior. Some of the signs of heat are: decreased feed intake, decreased milk production, restlessness, bleating more frequently than usual, spontaneous tail-wagging (or in response to pressure on the loin), reaction to buck or buck odor, pink or reddened vulva, and vulvar discharge or evidence of discharge on tail.

Animals should be observed through at least one entire cycle prior to attempting an artificial breeding. Make notations about the time heat was first observed, signs in evidence throughout heat, duration of heat, time heat apparently ends, etc. Does should be observed at least twice daily, first in a group if the herd is housed together, then individually.

V. SEMEN THAWING

There are three methods of thawing semen: warm water, ice water and shirt pocket thaws. The thawing method of choice is dependent upon the rate at which the semen was frozen and the type of extender used; therefore, it is best to use the thawing technique recommended by the semen processor. If no recommendation is offered use the warm water thaw.

To prepare for the warm water thaw, fill the thaw box with 35° to 37°C (95°-98°F) water and check it frequently to be sure that the temperature is constant, adding more hot water if necessary. Remove the desired straw or ampule from the tank as per the preceding instructions and immediately place it in the thaw box, handling it by the tip rather than the semen-filled center of the breeding unit unless tweezers are used. Remove the straw from the thaw water after twenty seconds, and remove an ampule as soon as the ice has melted. If the environmental temperature is below 60°F (16°C) thaw straws for ten seconds only. Dry the unit carefully using paper towels, once again handling it by the tip if touching it directly with the fingers. The warmth from one's fingers can cause the semen to warm unevenly thus lowering the number of live sperm post-thaw.

To prepare an ice water thaw for ampules or straws, fill the thaw box with a pint of cold water and several ice cubes thirty minutes before use (or stir it constantly for five minutes to reduce the temperature more quickly). The baffle provided with the thaw box will keep the ice cubes from touching the breeding unit and will avoid resultant temperature fluctuations. Remove the ampule or straw from the nitrogen tank and immediately place it in the thaw box. Straws will thaw in approximately three minutes, ampules in ten. When completely thawed, remove the unit by grasping the tip to avoid warming the semen unevenly and dry it thoroughly with paper towels.

For a shirt pocket thaw of straws, wrap the straw in a paper towel and insert it into a shirt pocket for five to ten minutes until thawed. Dry carefully.

VI. INSEMINATION PROCEDURE

1. Assemble equipment in one spot. A table close to the work area is especially handy for the inseminator who is working alone. Inspect speculum for cracks or chips.

2. Restrain doe. One method is to put the doe on the milk stand, then position oneself on the doe's left side (for right-handed inseminators), put the left knee under the doe's barrel back toward the flank and lift the doe onto your left thigh. This leaves both hands free to work but can be somewhat uncomfortable. An equally effective but less awkward method is to substitute a bale of hay for your leg. With the doe on the milk stand, lift her hind feet up and slide a bale of hay under her. The bale should be placed far enough back so that the doe's rump is more or less level when she rests on the bale.

Both of these methods have the disadvantage of compressing the doe's reproductive tract resulting from the pressure applied to her abdomen. A technique that avoids this problem and makes finding the cervix simple is used widely by the French. It involves standing the doe on her front legs. Standing with your back close to a wall and with the doe facing you, place your legs around her neck. Grasping her thighs, pull her up to you so that her

topline is against your chest. By leaning back against the wall you can hold her in this position with little effort. Surprisingly, the does do not usually object until their front legs tire.

3. Prepare to insert speculum. Scrub the doe's vulva and tail with antiseptic solution. Lubricate end of speculum and vulva with sterile lubricant.

4. Insert speculum. Use gentle but firm pressure to enter the doe following the slope of the doe's rump. Pass speculum to the end of the vagina.

5. Locate cervix. Using a penlight to assist visual inspection, rotate the speculum hole to six o'clock position if you are using a speculum with an off-center hole. If using an open-ended speculum, no rotation is necessary. The cervix is on the floor of the vagina, usually between five and seven o'clock, and will protrude slightly. It appears as a dark red spot or hole and may look like tiny pursed lips. If mucus interferes with this procedure, vacuum it out by sucking through a pipet (discard pipet).

6. Evaluate cervix and mucus. Does the cervix appear open? If it is closed and dry, the doe is not in heat. Mucus should be cloudy; if it is clear, delay insemination. Remove speculum.

7. Thaw semen and prepare inseminating tool. Avoid chilling semen after it has once been warmed. Dry thoroughly: water is spermicidal.

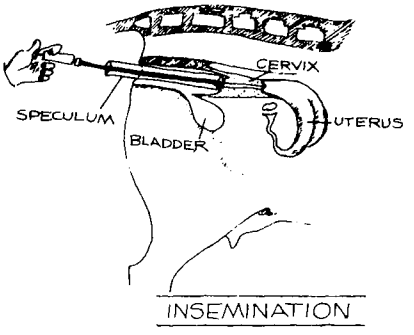
A) For straws: warm gun if necessary by rubbing rapidly between hands. Pull back plunger on straw gun five to seven inches. Insert straw, cotton plug end first. Cut off tip of straw making a square cut. Place sheath over straw and twist-lock 'O' ring to hold it firmly in place.

B) For ampules: attach a one inch length of surgical hose to syringe, then attach free end of the hose to the pipet. Pull the plunger back to ½ cc.mark. Holding the ampule upright wrapped in a paper towel, snap off the top of the ampule with the thumb. Insert the free end of the pipet and draw semen up into it with no air holes. Leave one inch of air below the bottom of the column of semen.

8. Repeat steps 1 through 5. Introduce tip of inseminating tool into external opening of cervix.

9. Guide inseminating tool through cervix. Occasionally the tool will pass with almost no pressure. Be alert for this and do not rake the uterine lining with the tool tip. More frequently, the tool must be carefully manipulated into the canal with firm pressure and a twisting motion. Often one can feel each cervical ring as the tool passes through.

10. Gauge depth of penetration. Insert second pipet or sheath to the cervix and measure difference in length. The cervix is usually one and one-half inches long. If depth of penetration is greater than this, withdraw to one and one-half inches of cervical penetration.



11. Deposit semen. Use slow and steady delivery, at least five seconds. Some persons recommend withdrawing to three-quarters or one inch of penetration to deposit the last third of the semen.

12. Remove speculum. Then remove inseminating tool. Apply five seconds clitoral massage (optional).

VII. RECORDKEEPING

A certain percentage of inseminations will fail to result in conceptions. The best way to determine why the attempt failed is to keep accurate records on each doe's cycle and each insemination. In addition to notations mentioned earlier in the timing section, one should record the following: time of insemination, appearance of cervix and cervical mucus, depth of penetration, and unusual circumstances that may occur. In evaluating a missed conception consider these questions: Was the doe in late standing heat? Was the insemination too early or late? Was the air temperature below freezing (this could chill thawed semen and kill sperm)? Was penetration insufficient? Is the doe cycling normally?

VIII. CLEANING EQUIPMENT

While AI cannot be completely aseptic, it should be performed in as clean a manner as possible. Insemination pipets and sheaths are disposable and should be used only once. Speculums should be soaked immediately after use and then washed in soapy water with a test tube brush. Rinse very thoroughly, then sterilize by boiling or baking, and wrap in individual paper towels to keep them clean until use.

IX. MAKING SPECULUMS

Speculums can be purchased from dairy goat AI supply houses or can be made at home from either Pyrex test tubes, stainless steel tubing or plexiglass tubing.

To make speculums from Pyrex test tubes, select 25 mm. by 200 mm. test tubes for mature does and 20 mm. by 175 mm. tubes for kids. You will also need a propane torch, an abrasive stone or grinding wheel and a piece of one-quarter or three-eights inch steel rod slightly longer than the test tubes. With the torch heat the end of the test tube until it is red hot. When it is properly heated the steel rod can be pushed through the bottom from the inside of the tube. The hole should be slightly off-center. The excess glass that has been pushed out is ground off by rubbing the test tube end on the stone. After the excess has been ground off, the edges of the hole can be smoothed by heating again with the torch.

To make speculums from plastic or stainless steel tubing, purchase three-quarter inch plexiglass or stainless steel tubing for older does and five-eighths inch tubing for young stock. A hacksaw can be used to cut the tubing into six to eight inch lengths. One end of the speculum should be cut at a 30° angle and the end should be sanded until it is smooth. Plexiglass and stainless steel can be boiled in water for sterilization.

X. BUYING SEMEN

While outstanding AI sires are available in most breeds, not all sires collected are of genetic merit. Accurate sire selection still rests on the skill of the breeder in interpreting available pedigree and progeny information. Few, if any, sires have enough objective information on progeny to be considered in any way proven, so sire selection is still difficult.

A further complication lies in the fact that there are no controls on semen quality in the dairy goat industry. It will behoove the prospective buyer to investigate the reputation of the processor or dealer and the buck's owner. Have other people settled does successfully with this semen? Do not hesitate to ask questions of the buck's owner concerning herd health and the health of the particular sire because some diseases may be transmitted through frozen semen. Try to determine semen quality. How many live sperm were packed per breeding unit? What is the expected post-thaw motility rate for this sire? One hundred million live sperm post-thaw seems to be the number needed for optimum conception rates, but this figure should not be regarded as a minimum.

CONTROL OF ESTRUS (HEAT SYNCHRONIZATION) IN DAIRY GOATS

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INTRODUCTION

The natural reproductive cycle and sexual behavior pattern of the non-domesticated goat is well suited for survival in the wild. Being seasonally polyestrus in the fall with kidding occurring in the spring, sexual activity is limited to a small portion of the year and the kids are born when their survival and growth are most likely. However under circumstances of domestication, the goat's reproductive pattern is often at odds with the management objectives, economic goals and daily routines of herd owners. Therefore, research on manipulation of the reproductive cycle has been a major pursuit of animal scientists, producers and veterinary researchers. Techniques for controlling the onset of estrus in individual does and synchronizing the onset of estrus in groups of does both during and out of the natural breeding season have been major objectives of animal research investigations.

REASONS FOR CONTROL OF ESTRUS

Practical techniques of estrous control allow goat owners increased convenience and flexibility in decision making in herd management. The number and frequency of visits by or to a preferred breeding buck can be reduced by grouping does in heat for service. Specific breeding and kidding dates can be selected for individual, valuable does. Heat dates can be predicted in problem does where heat detection has been difficult. The number and

fertility of does cycling early in the breeding season can be increased. Artificial insemination (AI) can be utilized more efficiently when the timing of estrus is controlled. Most importantly, the doe herd or portions of it can be induced to cycle out of season thus smoothing out the seasonal variation of milk supply which frustrates commercial milking operations.

THE PHYSIOLOGICAL BASIS OF ESTRUS CONTROL

Goats are seasonally polyestrus which means that both males and females are sexually inactive except during a well-defined breeding season. During that breeding season, the doe undergoes repeated heat or estrous cycles until such time that she becomes pregnant or the breeding season ends. The onset of heat at the beginning of the breeding season is triggered by decreasing daylight and further stimulated by the presence of an intact odoriferous buck. Between breeding seasons the ovary is inactive with no functioning structures. The stimuli of decreasing daylight hours and an active buck sends visual and olfactory impulses to the hypothalamic portion of the brain which in turn secretes gonadotropin releasing hormone (GnRH). This neurohormone in turn stimulates the adjacent pituitary gland to secrete follicle stimulating hormone (FSH) which reaches the ovary via the blood stream. The ovary is thereby awakened from its dormant, inactive state and begins to produce follicles. Each follicle contains an ovum which matures in preparation for ovulation. In addition, the follicle secretes estrogen, the hormone responsible for initiating estrous behavior or standing heat in the doe. High blood estrogen levels feed back on the pituitary gland to promote the release of luteinizing hormone (LH) either directly, or via the hypothalamus through the release of GnRH. LH triggers ovulation towards the end of standing heat or shortly after it, thus improving the chances that successful fertilization

of the egg will occur. In addition, LH promotes the conversion of the ovulated follicle into a corpus luteum (CL). The CL is a specialized ovarian structure which secretes progesterone, the hormone responsible for preparing the uterus for implantation of the fertilized egg and maintaining the uterus in a quiescent state during pregnancy.

If pregnancy is not established in the luteal phase of the estrus cycle (diestrus), the non-pregnant uterus produces prostaglandins whose effect on the ovary is to cause regression of the CL. As the CL regresses, usually on Day 16 of the estrous cycle, progesterone blood levels drop off. FSH secretion by the pituitary begins again and the cycle is reinitiated with renewed follicular development. Understanding the sequence of these events in the estrous cycle and the feedback mechanisms of the related hormones is essential to understanding the various techniques employed in controlling estrus.

TECHNIQUES FOR CONTROL OF ESTRUS

In Minnesota, three distinct periods can be defined with regard to estrous activity in does. These are: 1) the deep anestrous period between January and June when no breeding activity is observed; 2) a shallow anestrous period in July and August when some does may begin to show signs of heat, short estrous cycles or silent ovulations; and 3) the breeding season itself from September to December. In deep anestrus, the ovaries contain neither active follicles or corpora lutea and the goat's sensitivity to external stimuli such as buck odor is much diminished. Therefore, strategies and techniques for initiation or synchronization of estrus are different than during the other periods. During shallow anestrus, sensitivity to external stimuli is increased, but the majority of does still do not have active

ovaries and this limits the range of manipulative techniques. The breeding season itself offers the most opportunities for control of estrus since all normal does have active ovaries at this time. The techniques available during each season and their rationale for use are described below. Non-hormonal manipulations of estrus involve artifical regulation of exposure to light and introduction of a buck or buck odor to does. Hormonal manipulation of estrus falls into two broad categories: 1) techniques which stimulate the regression of an active CL; and 2) techniques which simulate the regression of an active CL. The former techniques involve prostaglandin administration and the latter involve administration and then withdrawal of progesterone or progesterone-like substances called progestins. In both situations the strategy is to create a pattern of decreasing blood progesterone concentration to trigger the release of FSH and subsequent development of estrous behavior approximately two to three days later.

Heat Synchronization in the Breeding Season

Method 1

Prostaglandin $F_2\alpha$ or synthetic analogues. To synchronize a large group of does two intramuscular doses of prostaglandin are given 11 days apart. The two-injection method insures that all does will have an active corpus luteum at the time of the second shot since some does may have been in the follicular (non-luteal) phase of the estrous cycle at the time of the first shot. Prostaglandin is only effective for heat synchronization when an active CL is present on the ovary since it is prostaglandin-induced regression of the CL which leads to decreased blood progesterone levels and the subsequent onset of heat.

Lutalyse[a] has been used successfully at doses of 2.5 mg per injection. Cloprostenol, a synthetic analogue of $PGF_{2\alpha}$, available as Estrumate[b] has been used at a dose of 50 ug. Onset of heat after the second injection ranges from 36 to 72 hours with a peak concentration of heat onset between 50 and 55 hours.

Method 2

Intravaginal progesterone. In this method progesterone or progestin soaked sponges or pessaries (45 mg fluorogesterone) are placed in the vagina for at least 17 to 22 days and then removed. The sudden drop in blood progesterone level will trigger onset of heat between 12 and 60 hours after removal of sponges. Unfortunately, commercially prepared sponges are not yet approved for use in the United States. It has been reported that the ovulation rate and subsequent fertility can be increased if pregnant mare serum gonadotropin (PMSG) is given to does at the time the sponge is withdrawn. PMSG, derived from the uterus of pregnant mares, has strong FSH-like activity. It is given intramuscularly at a dose of 400 to 500 I.U. depending on the size of the doe. A modification of this technique reported to further improve fertility is to follow-up with a 500 I.U. intramuscular injection of human chorionic gonadotropin (HCG) at the first sign of heat. This hormone, derived from the human placenta, has strong LH-like activity and is presumed to improve the likelihood of successful ovulation.

Method 3

Non-vaginal progesterone. Other routes of administration for progesterone have been reported. These include the intramuscular injection of progesterone at a dose of 10 mg once a day or 20 mg every other day for 16 to

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[a] The Upjohn Co., Kalamazoo, MI.
[b] BayVet Division, Cutter Laboratories Inc., Shawnee, KS.

20 days or oral administration of MAP (6 methyl-17 acetoxy progesterone) at a dose of 50 mg per day for 16 days with onset of heat occurring three to four days later. An ear implant of norgestomet (Syncro-Mate B)[c] is now available for estrous synchronization in non-lactating cattle. Its use has not yet been reported in goats.

Method 4

Introduction of buck. If does have not been exposed to a buck for several weeks, the introduction of a buck directly into the herd or via fenceline contact will stimulate the majority of does to come into heat from 3 to 7 days later. This is not a very tight synchronization but it can be useful and requires no hormonal intervention. When a buck is not available, individual does can be stimulated to cycle or can be checked for heat using a buck jar; a jar containing a cloth rubbed on the scent glands of an intact buck. The jar is warmed prior to teasing to cause emanation of the odor. If stored tightly sealed, the jar is useful for many months. Since the onset of heat cannot be accurately predicted in individual does using the buck or buck odor, breeding success depends heavily on careful heat detection by the herd owner.

Heat Synchronization During the Deep Anestrus Period

Method 1

Light manipulation. If does are confined to a barn, artificial light can be provided for 12 to 14 hours per day for at least sixty days, usually starting in January. If the artificial light is then abruptly or gradually reduced, a large number of does will begin to cycle 7 to 10 weeks later, with some cycling even sooner. Fertility may be improved if a light treated buck is introduced into the herd three to four weeks after the termination of the extra artificial light.

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[c] CEVA Laboratories, Overland Park, KS.

Method 2

Long term intravaginal progesterone. An intravaginal sponge is placed for 17 to 22 days. During anestrus, 600 to 700 I.U. of PMSG is then administered intramuscularly 48 hours before the removal of the intravaginal sponge. Onset of heat is usually between 12 and 60 hours after the sponge removal. The success of this technique is improved if applied only to does that have kidded at least four months previously.

Method 3

Short term intravaginal progesterone. Progesterone sponges are left in for 11 days. Forty-eight hours prior to removal of sponges, does are given intramuscularly both PMSG and Prostaglandin $F_{2\alpha}$. Synchronization is very tight with most does coming into heat between 12 and 36 hours after sponge removal. The rationale for administration of $F_{2\alpha}$ in this regimen is unexplained. This technique is highly thought of in France.

Method 4

GnRH administration (Cystorelin).[d] Gonatropin releasing hormone (GnRH) (Cystorelin) has been reported to induce heat during the anestrus season when 5 injections of 100 ug each are given one per day for 5 days. Onset of heat was reported to occur two days after the first injection.

It should be noted that during the deep anestrus period, the ovary does not maintain active CL's. Therefore, prostaglandin therapy is useless. Furthermore, if does are treated with any of these hormonal techniques and subsequently do not become pregnant, they will not automatically recycle. They will only cycle if re-treated or when the breeding season arrives.

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[d] CEVA Laboratories, Overland Park, KS.

Heat Synchronization During Shallow Anestrus

Method 1

Introduction of buck. During shallow anestrus, if does are exposed to an active buck, a loosely synchronized onset of heat will occur within 3-4 weeks.

Method 2

Progesterone techniques. The progesterone techniques described for use during deep anestrus are applicable also during shallow anestrus with even greater likelihood of successful ovulation and detectable heat.

PRACTICAL USE OF TECHNIQUES FOR CONTROL OF ESTRUS

The methods described for synchronizing heat during the breeding season have resultant fertility rates roughly equal to those occurring naturally. Results may be more variable during the deep and shallow anestrus periods but even then the French have reported fertility rates up to 73% in deep anestrus. It must be stressed emphatically that none of these methods are magical and success is largely dependent on the management abilities and conscientiousness of the herd owner. With all of these techniques, recognition of heat in individual does is of paramount importance. Thorough familiarity with signs of heat is essential before embarking on heat synchronization programs. The use of teaser bucks to aid in heat detection may be necessary. Furthermore, doe fertility depends greatly on general health. Parasite control and adequate nutrition are critical to successful breeding programs. Lastly, adequate knowledge of the techniques of artifical insemination and the availability of high quality semen are essential when AI is used in breeding.

A note of caution when using prostaglandins. Since an active corpus luteum is present during pregnancy, accidental administration of prostaglandin $F_{2\alpha}$ or its synthetic analogues will cause regression of the CL and resultant

abortion. This will occur not only in goats but in pregnant women as well. Therefore, caution is necessary when pregnant or possibly pregnant women are working with estrous control using prostaglandins in goats or any other species of farm animal.

Owners may be concerned about drug residues in milk with some of the techniques described. As is often the case, the drugs mentioned are not specifically approved for use in dairy goats. Information available about the use of these drugs in dairy cows can serve as a guideline, but safe use is not guaranteed in the goat. Both Lutalyse and Estrumate are now specifically approved for use in lactating cattle and no milk discard is required. Cystorelin and HCG are used in lactating dairy cattle, but no specific recommendations for milk discard are given in package inserts. PMSG and progesterone products, synthetic and natural, are currently not approved by the FDA for any use in lactating cows.

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making cheese at home

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Omar Khayyám once suggested that pleasure consisted of "a loaf of bread, a jug of wine and thou." He should have added "a piece of cheese" to make that suggestion complete, for cheese is as delectable and as old as both wine and bread and is made in a similar way. It is made through a fermentation process whereby the curds (solid portion) of the milk are removed from the whey (water portion) and changed into a delightful food.

Legend tells us that cheese was first made many centuries before Christ in the warm Mediterranean sea environs. The French maintain that cheese was first made by a shepherd who forgot a container of milk in a limestone cave, only to discover it several months later transformed into a piece of cheese. The English claim that cheese was first made in Somerset County in western England when another shepherd left milk in a cave. Returning several months later, he discovered cheese which to this day bears the name of those English caves in the Mendip Hills-Cheddar.

Regardless of who was the first to make it, cheese is a mainstay in the diet of many nationalities in the world and is made in every shape, size, and form imaginable from the milk of many mammals. Despite man's attempts to make a science out of cheesemaking, the finest cheeses are still made by those who know the art, who get their hands into the curds and treat it with the care and attention needed to produce a fine-flavored piece of cheese.

The purpose of this bulletin is to introduce you to the steps involved in cheesemaking so you can practice the art in your own home. Making cheese takes time, patience, and practice, but once you have mastered the techniques it becomes easy and a way of life. Start with small amounts of milk to help you learn the techniques. Then go to bigger batches when you have developed confidence.

This bulletin points out trouble spots and ways to correct them and gives some general methods for making various kinds of cheese. Read it thoroughly before you attempt to make cheese and use it as a reference once you start. Remember that it is you the cheesemaker who will determine the fineness of the cheese you make.

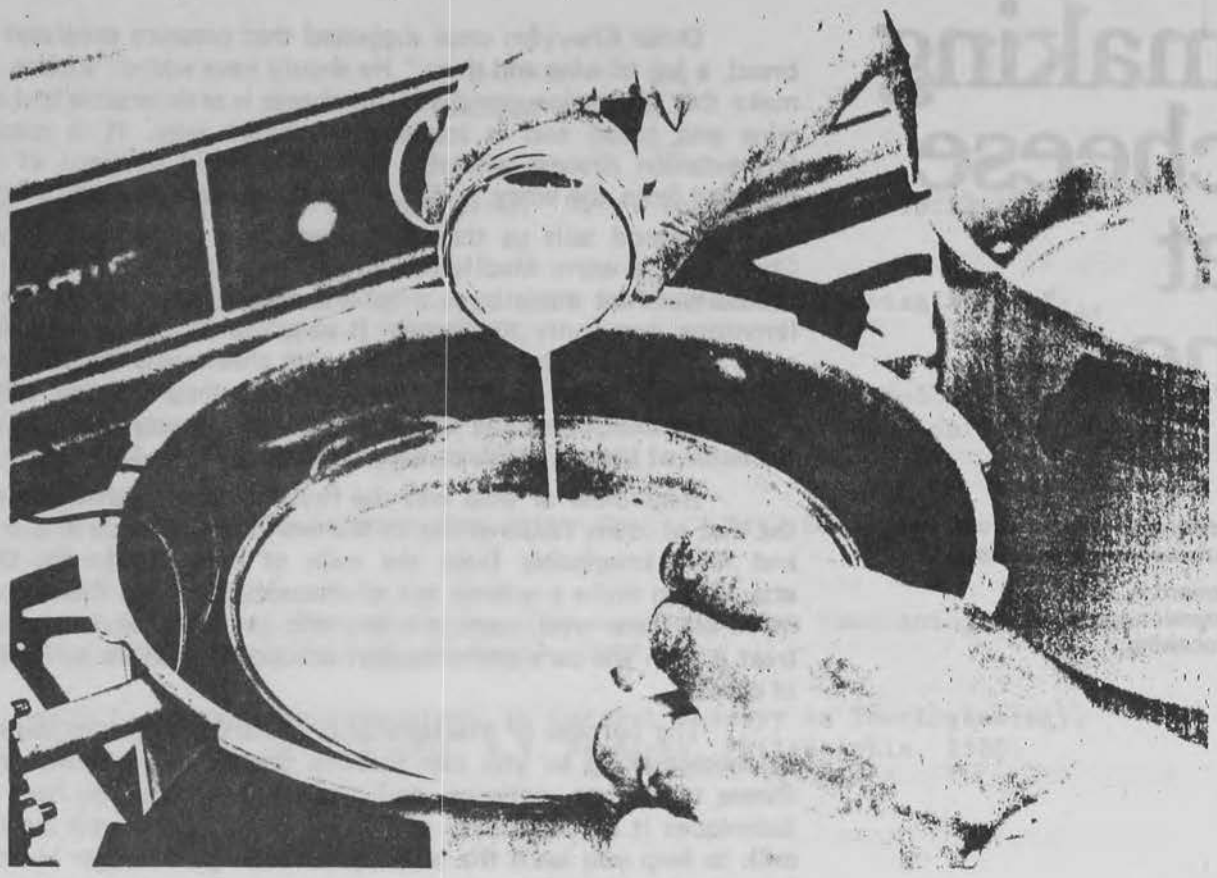
Basic Steps in the Manufacture of Cheese

OBTAINING GOOD MILK

The primary requirement for making cheese is a good supply of milk. The milk should be fresh, clean, and pasteurized. It is essential that the milk come from healthy animals. Pasteurization is necessary to destroy bacteria that could cause disease or that might cause undesirable fermentation and flavors in the cheese. The milk from any mammal can be used, but usually cow or goat milk is used. In France, sheep milk is used to make Roquefort cheese, and in some areas in Italy buffalo milk is used to make Mozzarella cheese.

You can use fresh milk obtained from a farm if you pasteurize it. A method for pasteurizing milk is given in the section preceding the cheesemaking methods. If you don't have access to milk from a farm, you can use milk from your local dairy. Milk that has not been homogenized is preferable for the cheese methods given in this bulletin.

Full fat milk, milk with skim milk added, and skim milk are used for the cheeses described. The higher the fat content of the milk used in making cheese, the better the flavor of the cheese will be. The composition of milk is shown in table 1.



Adding starter culture to milk.

Table 1. Gross composition of milk

Component	Approximate percentage
Water	86-88
Fat	3-5
Protein	
Casein	2.5
Others	0.7
Carbohydrates	
Lactose	4.5-5.0
Glucose	Trace

Enzymes: catalase, peroxidase, xanthine oxidase, phosphatases, aldolase, amylases, lipases, esterases, carbonic anhydrase, salolase

RIPENING THE MILK

Making cheese from milk is essentially a concentration process. A portion of the water in the milk is removed during the process. Water removal is aided by the development of lactic acid in the milk. This conversion of milk sugar (lactose) to lactic acid is caused by certain kinds of bacteria called lactic acid bacteria. As these bacteria grow in the milk they produce acid, which is the beginning of the cheesemaking process. As the process continues, acid development helps expel water from the curds. Much of the flavor that cheese develops is caused by bacteria and enzymes breaking down the milk constituents to flavor compounds.

When milk is pasteurized, any lactic acid bacteria that might be present are destroyed. So, to start the cheesemaking process, a culture of lactic acid bacteria grown in sterile milk is added to the cheese milk. Adding a starter culture has distinct advantages over depending on bacteria indigenous to the milk: fermentation is controlled, many undesirable flavors are prevented, and consistent quality cheese is obtained.

The most common type of lactic acid bacteria used are *Streptococcus lactis, Streptococcus cremoris, Streptococcus thermophilus, Lactobacillus bulgaricus,* and, in some cheeses, *Leuconostoc citrovorum.* When used in making cheese, these bacteria must be actively growing. Active growth is maintained by daily transfer into fresh milk. These procedures are explained in detail later.

The ripening period in cheesemaking is the time from addition of the starter culture to the cheese milk until the coagulating enzyme is added. During ripening, the lactic acid bacteria start to grow, increasing the acid content of the milk. The ripening time varies from a few minutes to several hours, depending on the variety of cheese being made.

This milk is not ready for cutting; the curd does not break clean from the spatula.

FORMING CURDS

Curdling and coagulation are terms used to describe the change of milk from a liquid to a semi-solid structure or gel. Curd formation, which is essential to cheesemaking, can be achieved by adding certain enzymes that act on the protein of milk, causing it to form the gel. Or it can be achieved by allowing lactic acid to develop to such a concentration that it will cause an acid precipitation of the protein. Most cheese curds are made by adding enzymes to the milk. Cottage cheese is one cheese that is made by the acid curd system.

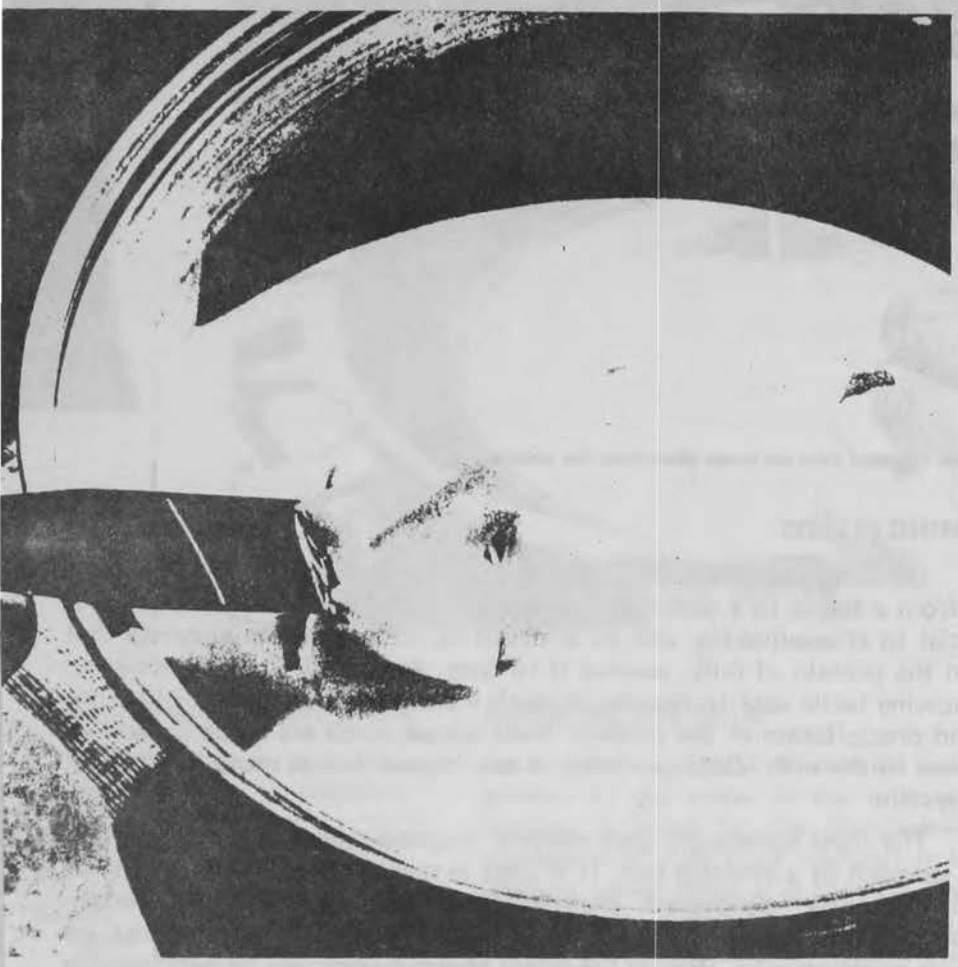
The most commonly used enzyme is called rennet, an extract of the third stomach of a suckling calf. It is used in making cheese throughout the world. Recently discovered enzymes that are produced by certain microorganisms also can be used for coagulating milk. These enzymes are available commercially. Rennet for home cheesemaking can be purchased in tablet form at most drug stores. Cheese factories may sell liquid rennet.

No matter what type of cheese is being made, the curd is forced to shrink, causing it to lose water and become firmer. The degree of shrinkage determines the moisture content of the curd and influences the final characteristics of the cheese. Curd shrinkage is enhanced by heat, lactic acid production by bacteria, and the action of the coagulating enzyme.

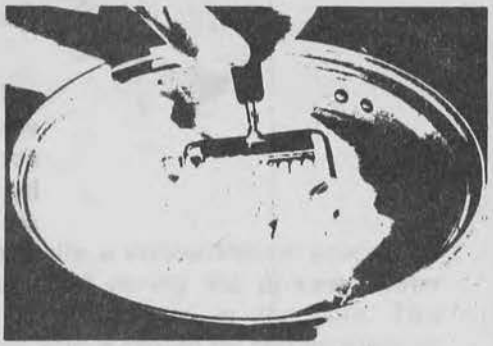
Escape of whey is facilitated by cutting the curd into small pieces, by stirring (along with a slow rise in temperature), and by applying pressure on the curd. To produce a cheese with low moisture and relatively low acid, the cheesemaker would do one or more of the following:

- heat the curd to a fairly high temperature.
- cut the curd into small pieces.
- assure rapid acid production early in the process.
- subject the curd to high pressure.

To make cheese with a high moisture content, the curd is heated very little, it is not cut or it is cut into large cubes, acid is allowed to develop in the cheese after the whey has stopped draining, and the curd is not pressed.



Coagulated milk at the point when it is ready to be cut. Note how the curd breaks clean from the spatula.



Cutting the curd into 1-inch cubes with a spatula and cutting more finely with a wire cutter.

COOKING THE CURD, DRAINING THE WHEY, FORMING THE CURD MAT

In cheesemaking, the term cooking refers to a slow heating of the curd while it is slowly stirred. The slow heating encourages the growth of the lactic acid bacteria, increasing acid production. The heat and the acid both contribute to curd shrinkage and water expulsion. This step in the cheesemaking process varies, depending on the type of cheese being made and the moisture content desired. Many methods are used to adjust moisture content. Several possibilities are:

1. The coagulated curd is carried directly from the vat into perforated molds or forms that hold the curd but allow the whey to escape. No pressure is applied. This technique produces cheese with high moisture, high acidity, and soft body. Brie and Camembert are two cheeses made in this manner.

2. The curd is cut into cubes and part of the whey is allowed to separate. Usually some stirring is involved, but no heat is applied. After a specific time

Cutting the curd to the desired final size with a wire cutter.

period the curd is transferred to forms as in method 1. Light pressure may be applied. This method produces cheese with high moisture, high acidity, and a firmer body than cheese made by method 1. Blue-veined cheeses are usually made in this way.

3. The curd is cut as in method 2. It is then heated and stirred slowly until it reaches the desired firmness. Curds are dipped into forms, where pressure may be applied. A high cooking temperature and high pressure on the curd result in cheese with low moisture and low acid. Brick and Muenster are typical of the cheeses made by this technique.

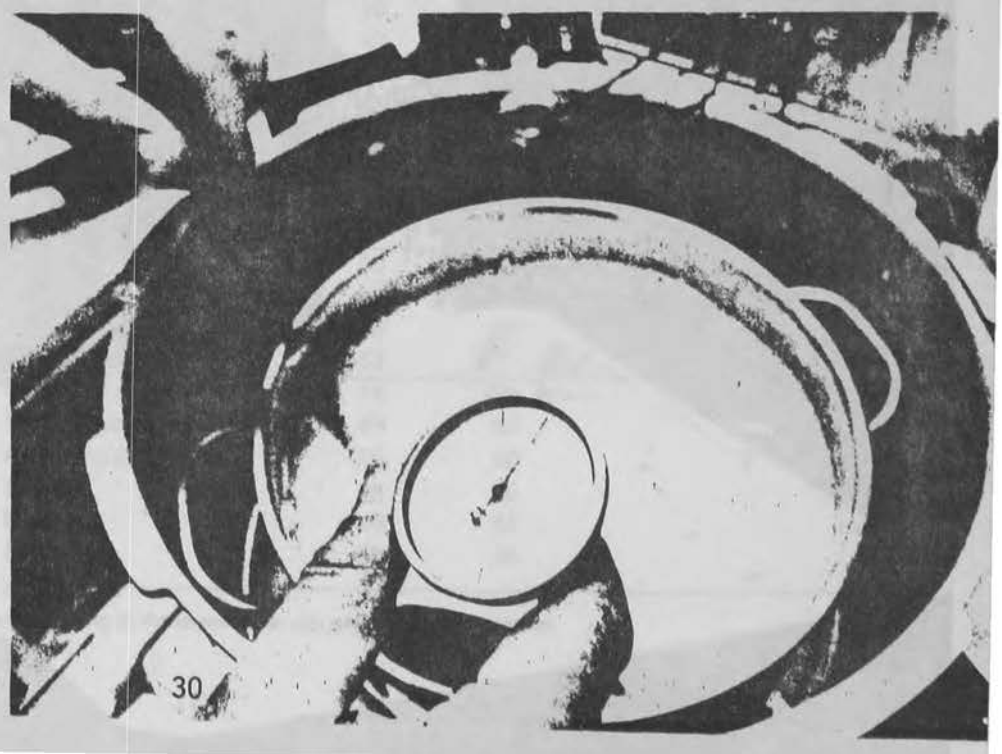
4. The curd is cut and cooked as in method 3, but it is left in the vat while the whey is drained off. The curd particles may be kept distinct by stirring, or the curd may be allowed to mat together. The mat may be cut into pieces that will fit into the forms, or it may be milled or chopped into smaller pieces, salted, and then packed into forms, where pressure is applied. The curd mat also may be formed under the whey and removed intact, cut into pieces, and placed in forms under high pressure. Cheddar and Colby are examples of cheese made by the first method; Gouda and Swiss are examples of cheese made by the latter technique. Most hard cheeses are made by this method.

SALTING THE CHEESE

Salt (sodium chloride) is added to almost all varieties of cheese at some point in their manufacture. Salt has several functions: it contributes flavor; it aids in whey expulsion, thus helping to control moisture and acid content; and it helps control the growth of undesirable microorganisms that might cause off-flavors in the cheese.

Salting usually occurs at the end of the cheesemaking process but prior to curing. Salt can be applied directly to the curd particles before the curd is put into the forms and pressed. Cheeses made by method 4 usually are salted in this way. Salt also can be incorporated by floating the cheese in salt brine or by rubbing the surface of the cheese with dry salt. The amount of salt taken up with these latter two methods depends on the concentration of the brine, the time and temperature of exposure, the ratio of surface to volume of the cheese, and the moisture content of the cheese. With these latter two methods, salt is at first concentrated near the surface, but it diffuses evenly throughout the cheese as it cures.

Checking the temperature of curds and whey during cooking.



RIPENING OR CURING THE CHEESE

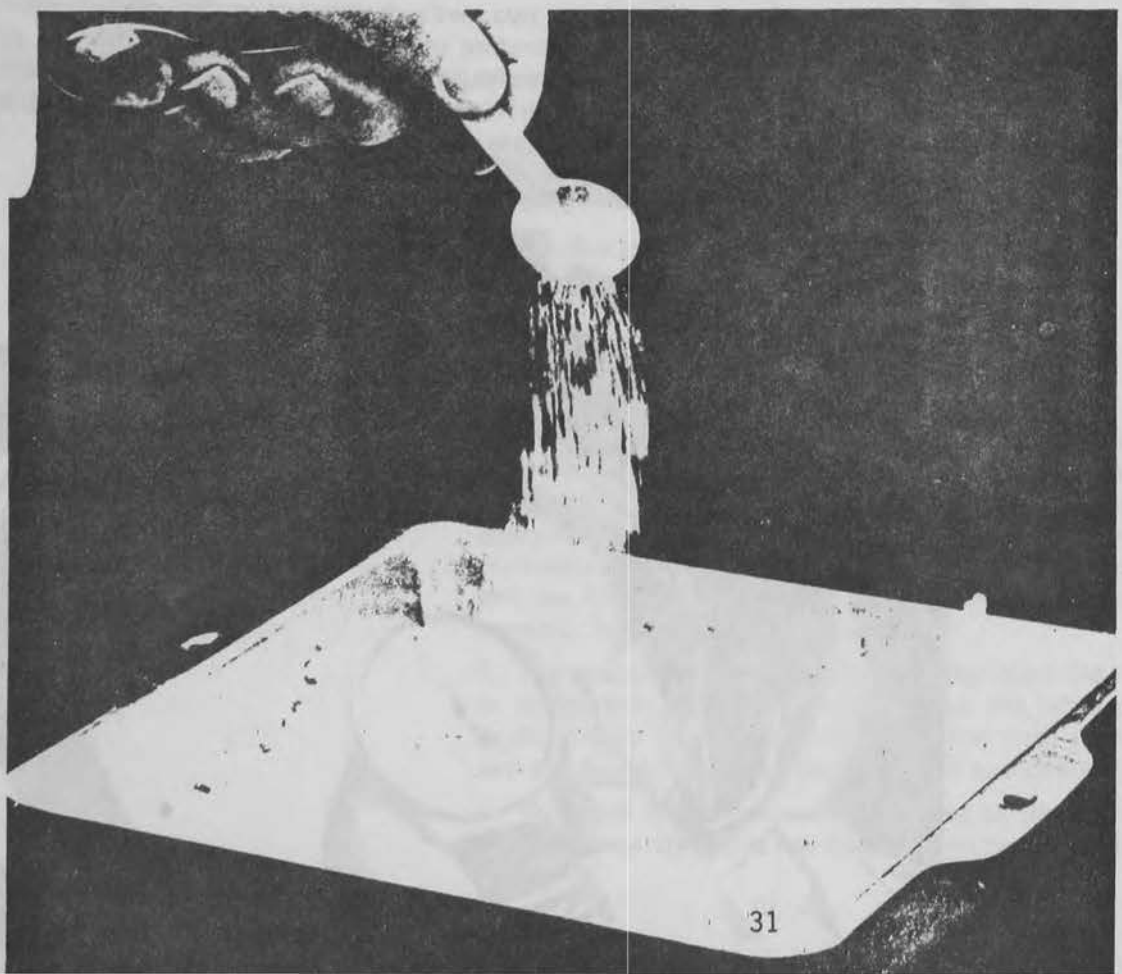
Up to this point, the techniques for producing various cheeses are similar. What happens during ripening determines the kind of cheese you will get.

The fresh curd has a bland, somewhat salty, sour taste and is tough and rubbery. Most cheeses are cured until they acquire a more desirable flavor and texture. The transformation of fresh curd into cured cheese is brought about by enzymes from three main sources: from the enzyme used to coagulate the milk, from microorganisms that grow within the cheese or on the cheese surface, and from the milk itself. The composition of the fresh curd and the conditions under which the cheese is held during curing determine the nature of the changes that take place. In general, cheeses with high moisture, high acidity, and soft body are cured under high temperature, high humidity conditions or are not cured at all. Cheeses with low moisture and low acid content may be cured for a longer time at lower temperatures and humidities.

Curing conditions for each type of cheese are explained later in this bulletin. A separate refrigerator or a cool, dry spot in the basement will serve as an adequate area for ripening cheese. It is important that you find a proper curing area, particularly if you want to make hard cheeses. Proper curing conditions will reduce undesirable mold growth and waste and will help develop the desired cheese flavor.

After the cheese has been cured, it should be refrigerated to slow down further ripening. Soft cheeses generally can be kept in a refrigerator for several weeks; hard cheeses can be cured for long time periods and refrigerated even longer.

Adding salt to the curd.



Classification of Cheeses

In general, cheeses are classified according to their moisture content, with soft cheeses having high moisture content and hard cheeses lower moisture content. Cheeses also can be classified by the microorganisms that bring about specific changes such as eye formation in Swiss cheese, mold growth in blue cheese, surface growth of mold on Brie cheese, or bacterial growth on brick cheese. Table 2 delineates these classifications. It also contains federal definitions and standards of identity for several varieties of natural cheese.

Table 2. Federal definitions and standards of identity for natural cheeses

Cheese	Maximum percentage moisture	Minimum percentage fat		Minimum ripening time (months)	Remarks
		In dry matter*	In total mass		
Class standards					
Hard grating	34	32		6	
Hard	39	50			
Semi-soft	50	50			
Soft	--	50			
Individual varieties					
Unripened (soft) cheeses					
Cottage	80		--		
Creamed cottage	80		4		
Cream	55		33		
Neufchatel	65		20		
Ripened cheeses					
Parmesan (Reggiano)	32	32		14	Primarily grating cheese
Asiago old	32	42		12	
Romano	34	38		5	
Asiago medium	35	45		6	
Sapsago	38	--		5	
Cheddar	39	50			
Granular (stirred-curd)	39	50			Similar to Cheddar
Colby	40	50			
Washed-curd	42	50			
Caciocavallo Siciliano	40	42		3	
Provolone	45	45			
Edam	45	40			Contain eyes
Gouda	45	46			
Swiss	41	43		2	
Gruyere	39	45		3	
Gorgonzola	42	50		3	Mold ripened
Roquefort	45	50		2	
Blue	46	50		2	
Gammelost	52	--			
Monterey	44	50			
High moisture jack	49	50			
Asiago fresh	45	50		2	
Brick	44	50			Smear ripened
Muenster	46	50			
Limburger	50	50			

*Fat remaining in the cheese after the water has been removed.

The Care and Handling of Starter Cultures

A primary problem for the home cheesemaker is finding adequate starter cultures and then maintaining them in a viable condition.

Local cheese factories may be willing to sell you some of their starter. Follow the directions given below to maintain the culture in a viable condition.

Commercial buttermilk, which is made by growing lactic acid bacteria in skim milk, can be used for a starter culture. Unfortunately, many dairies add salt to their buttermilk, making it unsuitable for cheesemaking. If you can obtain unsalted buttermilk, you can use it as a cheese starter.

Commercial yogurt is made by growing the lactic acid bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus* in milk. Plain yogurt (no fruit or sugar added) can be used as a source of these organisms when they are needed to make the desired cheese.

MAINTAINING THE STARTER CULTURE

Starter cultures should be grown in antibiotic-free milk. Cows and goats often are treated with antibiotics for udder infections, and the antibiotics get into the milk. Their presence prevents the growth of lactic acid bacteria. All milk and milk products sold commercially are tested to make sure no antibiotics are present, so it should be safe to use such milk for maintaining starter cultures. If you buy or obtain milk directly from a farmer, however, be sure you ask whether he has recently treated his cows with antibiotics.

Milk to be used for starter cultures has to be given a high heat treatment. This treatment destroys all microorganisms that might grow and cause problems; it also makes the milk more nutritious for the lactic acid bacteria. Two different methods are used for growing the cultures. The method to use depends on the type of lactic acid bacteria in the starter culture.

To heat-treat milk, you will need a boiling water bath canner or similar container and several ½ pint mason jars and lids.

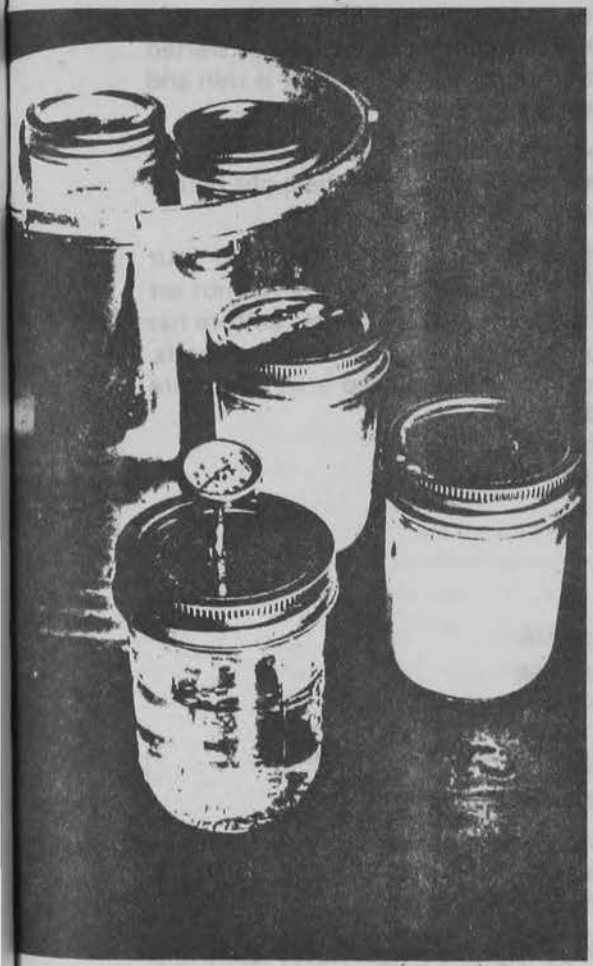
METHOD A

Starter organisms:

Streptococcus lactis,
Streptococcus cremoris,
Leuconostoc citrovorum,
buttermilk or sour cream cultures.

These are referred to as starter culture A in the cheesemaking section.

1. Clean the ½ pint mason jars and lids with hot soapy water and rinse them with hot water. Allow them to drain dry. (You can reuse the lids, since a seal is unnecessary after heating.)
2. Fill the jars with 6 ounces of milk. (You can use whole milk, skim milk, or reconstituted nonfat milk.) After filling, tighten lids.
3. Place filled jars in a water bath canner or similar pot and fill the pot with water until the jars are covered by about 1 inch of water.
4. Place pot on heat source and turn on the heat. When the water starts to boil gently, reduce the heat to maintain a gentle boil for 30 minutes. The desired heat treatment is 185°F. for 30 minutes. If the water is gently boiling, the temperature of the milk will be close to 185°F.



Equipment needed for preparing milk to be used for maintaining starter cultures. Note the thermometer in a jar filled with water for checking temperature.

Transferring starter culture to fresh milk.

5. After 30 minutes, remove pot from the heat source. Put it in a sink and run cool water into the pot to cool the jars of milk. Run water over them until the jars are cool enough to handle. Then remove them from the pot and put them in the refrigerator. Milk for the starter cultures treated in this way will keep for at least 2 weeks in the refrigerator. You can prepare milk ahead for transferring culture.
6. Prior to inoculation, remove the heated milk from the refrigerator and warm it to 70°F. You can do this by putting the jar of milk in a pan of water at 75°F. After a short time, the temperature of the milk will be close to 70°F. Do not put a thermometer into the milk to determine temperature; it may contaminate the milk. Instead, use a second jar filled with water to determine temperature.
7. Incubate these cultures at 70°F.(about room temperature). Locate in the kitchen or another room a spot where this temperature can be maintained. Using an unheated oven is one possibility.
8. To transfer the culture, carefully open the tempered jar of milk to be inoculated. Lay the lid on the jar. Open the jar of culture that you want to transfer. Lift the lid off the first jar and hold the lid in one hand so it doesn't get contaminated. With the other hand, pour a small amount of old culture into the new milk. Replace and tighten the lid and swirl the milk gently to mix it.
9. Set jar in the area you have chosen for incubation at 70°F. Allow it to incubate for 15-18 hours or until the milk has set. If the whey has started to show, the culture has been incubated too long. If the milk is thin and not coagulated, it has not been incubated long enough.
10. Place the culture in the refrigerator when it has reached the desired firmness. Always prepare fresh culture for cheesemaking the night before you want to make cheese.
11. To maintain viability, transfer cultures in this manner three to four times a week. Overincubation weakens a culture. If a culture has not set up in 24 hours, discard it and start a new one. After the new culture has set, you can use the old culture for buttermilk pancakes or other foods, or you can drink it as cultured buttermilk. Always keep a fresh culture on hand for future use.

METHOD B

Starter organisms:

Streptococcus thermophilus,
Lactobacillus bulgarius,
yogurt cultures.

These are referred to as starter culture B in the cheesemaking section.

Proceed as in method A, with the following exceptions.

Step 4. Heat the milk for 1 hour in boiling water or use a pressure cooker and heat it at 10 pounds per square inch for 20 minutes or 15 pounds per square inch for 10 minutes.

Steps 7 and 9. Incubate these cultures at higher temperatures than the cultures used for method A. They should be incubated at 100°F. ± 5° for 12-15 hours. You may want to use a water bath in an oven set at a very low temperature. You also can use home yogurt making equipment.

All other steps are the same as in method A.

Yield of Cheese

Milk is composed of approximately 87 percent water and 13 percent solids (see table 1). In general, cheesemaking results in a yield of 10 percent. Not all the milk solids are recovered nor is all the water removed. A good rule to follow is that 10 pounds of milk should yield 1 pound of cheese. Yields will be greater with high moisture cheeses and less with low moisture long cure cheeses.

Cost of Making Cheese at Home

Incidental costs in making cheese at home will be for a good thermometer, rennet, and culture. Most of the equipment needed is available in the average kitchen or can be improvised from materials around the home. These costs extended over several lots of cheese will be minor compared to the cost of the milk and have been omitted in the following calculations.

(If you are unable to find a suitable thermometer, you can purchase a stainless steel dial thermometer with an 8-inch stem directly from:

Hercules, Inc.
Lincoln Sales Division
2285 University Avenue
St. Paul, Minnesota 55114

Ask for Weston model number 4200. Specify a temperature range of either 0° to 220°F. or 25° to 125°F., and specify plastic or glass lens. The cost is approximately $15.)

The main cost will be for milk. Since cheese yield is related to the amount of milk used, you can calculate the cost of cheese by simple mathematics. For example, let's say you have made Queso Blanco, a high moisture cheese that yields about 1 pound per gallon of milk. The cost of this cheese (excluding labor and power usage) would be the cost of a gallon of milk. If the milk cost $1.25 per gallon, the cost of the cheese would be $1.25 per pound.

If you have made Romano, which is a low moisture long cure cheese, the cost would be different. One gallon of milk will make about 3/4 of a pound of cured Romano cheese. So, if the gallon of milk cost $1.25, the cost of the cheese would be $1.67 per pound.

Uses of Whey

Whey is the watery part of the milk that is removed from the curds during the cheesemaking process. It has several uses, so don't discard it, particularly if you make cheese regularly in any quantity. Collect the whey and store it in the refrigerator. If whole milk was used to make the cheese, cream will rise to the top of the whey. Skim off this cream and heat it to destroy the rennet, which will otherwise cause the cream to turn rancid. Use the cream to make butter or sour cream, or use it in cooking as heavy cream.

You can use the remaining whey in several ways. Use it to replace milk in recipes calling for milk, such as bread, soups, etc. Try flavoring it with fresh fruit to make a refreshing beverage. If you live on a farm, you can feed whey to chickens and pigs as part of their daily ration.

COLOR

Most of the popular cheeses consumed in the United States are colored with a harmless vegetable dye called annatto. The addition of color makes the cheese more appealing in the eyes of some consumers, but adding color is not an important part of the cheesemaking process. If you want to

color your cheese, you can obtain liquid cheese color from a cheese factory or you can obtain color in tablet form from the culture manufacturers listed previously. You also can make your own color by using carrots. Peel and grind up carrots mechanically, separating the juice from the carrot pieces. You will have to determine the amount needed to get the color you want. Add the color to the milk before adding the rennet and after adding the culture.

How to Pasteurize Milk

Use a double boiler to pasteurize milk. Don't heat milk directly over a burner; the milk will scorch and have a strong cooked or burned flavor and it won't clot very well. To pasteurize milk in a double boiler, follow these directions:

1. Fill the bottom section of a double boiler with water.
2. Add milk to the top section and cover it.
3. Heat milk to 160°F. using an accurate thermometer to check the temperature. Learn to estimate the time needed to bring the milk to 160°F.
4. As soon as the milk temperature reaches 160°F., cool it immediately by placing the top section of the double boiler in cold running water or ice water. Quick cooling minimizes the development of a cooked flavor and the growth of spoilage bacteria that might survive the heat treatment. If you plan to make cheese immediately, cool the milk to setting temperature.
5. If you need a second container for storing milk in the refrigerator, use glass jars (with covers) that have been sanitized in a boiling water bath or in a mechanical dishwasher. Keep your fingers out of the jars when filling them.
6. Store milk in the refrigerator. Properly handled home pasteurized milk should keep under refrigeration for 7-10 days.

Procedures for Making Several Different Varieties of Cheese

When cheese is made commercially, a continuing determination is made of the amount of acid in the milk or whey that has been produced by the growth of the lactic acid bacteria. Because most homemakers don't have the equipment necessary for determining acidity, the procedures listed here are based on average times required to obtain desired acidity. As you develop your cheesemaking techniques, you may want to change the times involved. The procedures given here are only guidelines to help you get started.

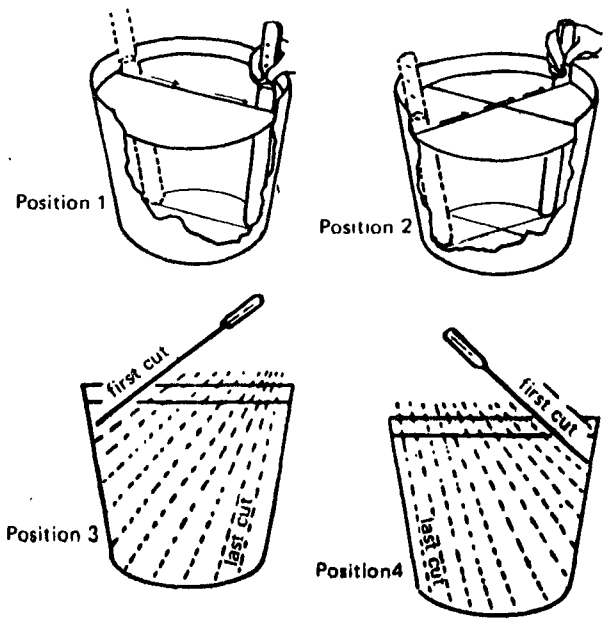
Times are listed from 0 time, which is when you add the starter culture to the milk. If you start your cheesemaking on the hour, the times given would be minutes after that hour. For example, in making Queso Blanco, if you add the starter at 9:00 a.m., then the setting temperature of 92°F. should be achieved by 9:30, rennet added at 9:35, and stirring stopped at 9:40. The curd would then be cut at 10:10 and so on.

Amounts of materials used are for 1 U.S. gallon (1 U.S. gallon of milk weighs 8.5 pounds). To increase the amounts used, multiply the amounts given by the number of gallons of milk you are using. For example, if you are using 5 gallons of milk, you would multiply the quantities given by 5.

The procedures described below were developed using Hansen's Cheese Rennet Tablets. If you are using another source of rennet, the amounts needed may not be the same as given here. Follow the directions that came with your rennet.

Cheese	QUESO BLANCO (white cheese)
Starter culture	A or B
Milk	Pasteurized whole, 2 percent, or skim milk
Time (hours, minutes)	
0.0	To 1 gallon of milk, add 8 ounces of buttermilk or 4 ounces of yogurt.
0.30	Stir and warm slowly to 92°-94° F.
0.35	Add ¼ tablet rennet dissolved in 4 ounces of cold, clean water. Stir gently for 3-5 minutes.
0.40	Stop stirring. Allow milk to stand until it coagulates (about 30 minutes).
1.10	Cut curd into 1-inch cubes. Stir gently for 30 minutes. Maintain temperature at 92°-94° F.
1.40	Remove whey; allow curd to settle to bottom.
1.50	Add salt according to personal taste. Mix 3 teaspoons into the curd in three portions 5 minutes apart (1 teaspoon three times).
2.05	Divide curd into two equal piles, line two forms with cheesecloth, and place curd in each. Fold cloth over curd.
2.15	Press for 3 hours with light pressure.
5.15	Remove cheese from forms and remove cheesecloth. Wrap the cheese in plastic wrap and refrigerate it. You can use this cheese immediately.

Follow your original cuts as nearly as possible; holding knife at angle as in position number 3—then as in position 4.



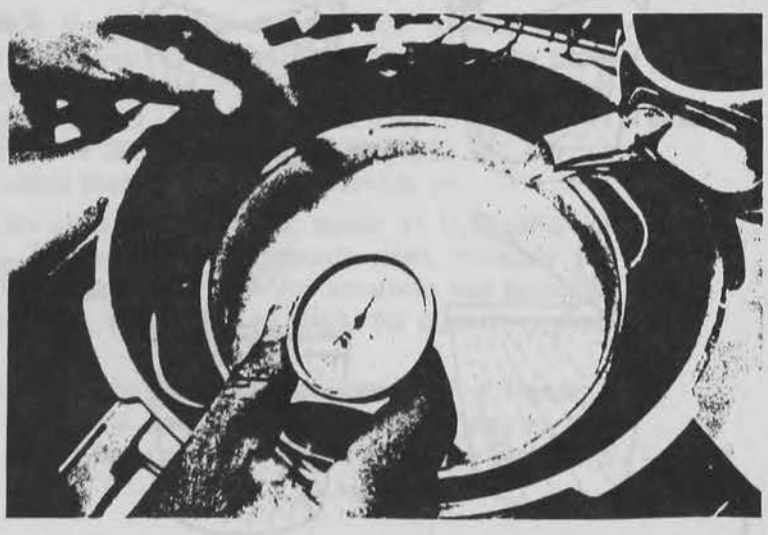
Cheese	COTTAGE CHEESE
Starter culture	A
Milk	Pasteurized skim milk or reconstituted nonfat dry milk
Time (hours, minutes)	
0.0	To 1 gallon of milk at 88° F., add 10 ounces of starter culture. Stir slowly for 30 minutes.
0.30	Cover and let milk remain quiet for 5 hours (keep milk at 88°-90° F.) or until curd is formed and whey begins to cover the curd.
5.30	Cut the curd to approximately ½-inch cubes. Leave the cubes undisturbed for 30 minutes.
6.00	Stir curds gently and add about 2 quarts of water at 110° F. Start cooking the curd by slowly increasing the temperature of the pot until the temperature reaches 125°-130° F. (3-degree increase in 10 minutes). Maintain this temperature until curd reaches desired firmness (about 90 minutes).
7.30	Drain whey off curd to point where curd is just barely covered. Add tap water until temperature is 80°- 90° F. Stir curd slowly in water-whey mixture to cool.
7.40	Drain water off curd and add cold water to chill curd thoroughly.
7.50	Drain water off curd by lining colander with cheesecloth and putting curd in colander. Allow to drain for 30 minutes.
8.20	Store in refrigerator as is, or add cream to the curd to make cottage cheese. To salt, mix in 1-3 teaspoons of salt to taste. Use half & half, coffee cream, or whipping cream for the creaming mixture. Add about 4 ounces per pound of dry curd.

Cheese	CREAM CHEESE
Starter culture	A
Milk	3½ quarts pasteurized whole milk
	1 pint pasteurized whipping cream
Time (hours, minutes)	
0.0	To 1 gallon of milk-cream mixture, add 6-8 ounces of culture. Warm to 85°F.
0.30	Add ¼ rennet tablet dissolved in 4 ounces of cold water. Stir gently for 3-5 minutes.
0.35	Cover and let milk set at 85°F. for about 1 hour until whey covers the curd and breaks clean from the side of the pot.
1.35	Cut curd into 1-inch cubes. Let cut curd set 5 minutes undisturbed.
1.45	Pour mixture into a muslin bag or colander lined with cheesecloth. Allow to drain overnight. Save whey, as it will contain considerable cream.
Next day	Work in 1½ teaspoons of salt. Package and store cream cheese in the refrigerator.

Removing or dipping whey from the curd.

Cheese	NEUFCHATEL
Starter culture	A
Milk	1 gallon pasteurized whole milk
	Proceed as with the manufacture of cream cheese.

Cheese	EDAM OR GOUDA
Starter culture	A
Milk	For Gouda: 1 gallon pasteurized whole milk
	For Edam: 1 gallon pasteurized 2 percent milk or 2 quarts whole milk mixed with 2 quarts skim milk
Time (hours, minutes)	
0.0	Adjust temperature of milk to 88°F. Add 2 ounces of starter culture. Stir in well.
0.05	Add ¼ rennet tablet dissolved in ½ cup cold, clean water and stir for 5 minutes.
0.10	Cover milk, keeping temperature at 88°F., and let milk set undisturbed until it coagulates (about 30 minutes).
0.40	Cut curd into ¼-inch cubes. Allow curd to stand for 5 minutes, then stir gently. Continue stirring gently for 30 minutes.
1.10	Stop stirring and allow curd to settle. Remove half of the whey.
1.20	Slowly add hot water (180°F.) to the curds and whey to raise



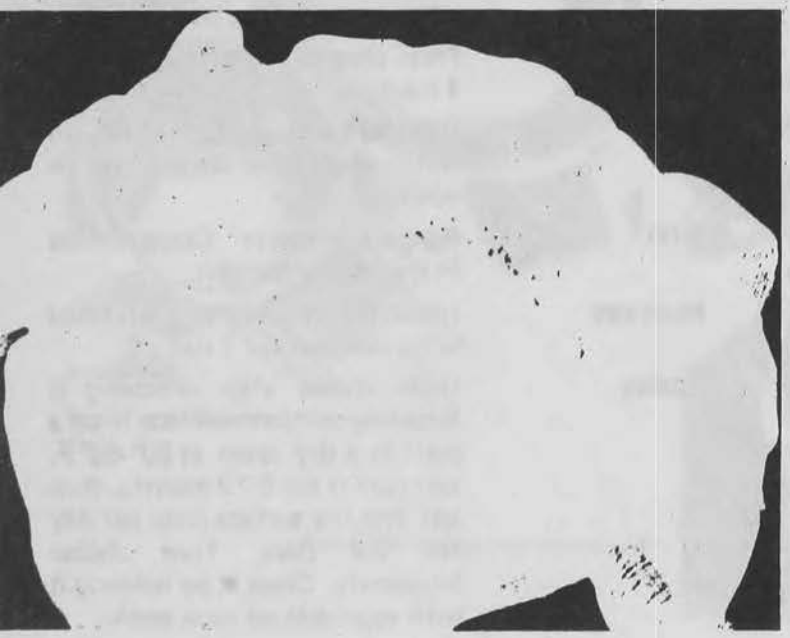
Adding hot water to cook Gouda curd.

	the temperature to 100°-102° F. Continue stirring slowly for an additional 45 minutes.
2.05	Stop stirring and allow curd to settle to bottom. Push curd to one side of the pot to make the curd mat the same thickness as you want the cheese.
2.10	With curd still under the whey, press curd slightly using a perforated plate and a quart jar full of water. Press for 10 minutes.
2.25	Drain off all whey and remove plate and pressure. Allow curd to mat for an additional 10 minutes.
2.35	Cut curd into two pieces the approximate size of the form. Place curd in unlined forms. Place one form on top of the other for 10 minutes, then reverse the forms for an additional 10 minutes.
2.55	Remove cheese from forms, line them with wet cheesecloth or muslin, and replace cheese in lined forms. Press lightly for 1 hour.
3.55	Release pressure, remove cheese from form, turn it over, and replace it in the cloth-lined form. Press at slightly higher pressure for an additional 3 hours.
6.55	Remove pressure, remove cheese from form, and hold cheese at 60° F. overnight.
Next day	Place cheese in saturated salt-brine solution at 60° F. Immerse cheese totally or cover the exposed surface with salt. Turn cheese daily and leave it in the brine for 2 days. (Brine time can be varied according to individual taste). Leave larger cheeses in the brine longer.
Curing	Remove cheese from brine and drain it for 1 day. Place cheese on clean, dry wooden shelves in a 50°-55° F. dry area. Turn cheese daily to maintain its shape and to achieve even drying, which will help prevent the growth of mold. After 3 days, wax the cheese and coat it with vegetable oil or apply a larded bandage to prevent further drying. This cheese can be aged for 1 year if desired.

Cheese	**ROMANO**
Starter culture	B
Milk	1 gallon pasteurized whole milk
Time (hours, minutes)	
0.0	Adjust temperature of milk to 88° F. Add 2 ounces of starter B to 1 gallon of milk. Stir gently for 30 minutes.
0.30	Add ¼ rennet tablet dissolved in ½ cup cold water. Stir for 3-5 minutes.
0.35	Cover, maintain milk temperature at 88° F., and let it set until the milk coagulates (about 30 minutes).
1.05	Cut curd into ¼-inch cubes. Allow curd to stand for 5 minutes before stirring.
1.10	Increase temperature slowly to 115° F. while stirring gently. Take 1 hour to reach this temperature.
2.10	When curd is firm, allow it to mat under the whey. Remove whey after a mat has formed.
2.30	Place curd in a cloth-lined form. Allow it to drain for an additional 20 minutes.
3.00	Press cheese in forms lightly for 1 hour.
4.00	Remove pressure, turn cheese in form, and press cheese for an additional hour.
5.00	Remove pressure. Leave cheese in the form overnight.
Next day	Immerse cheese in saturated brine solution for 1 day.
Curing	Drain cheese after removing it from the salt brine. Place it on a shelf in a dry room at 50°-60° F. and cure it for 5-12 months. Rub salt into the surface once per day for 2-3 days. Turn cheese frequently. Clean it by rubbing it with vegetable oil each week.

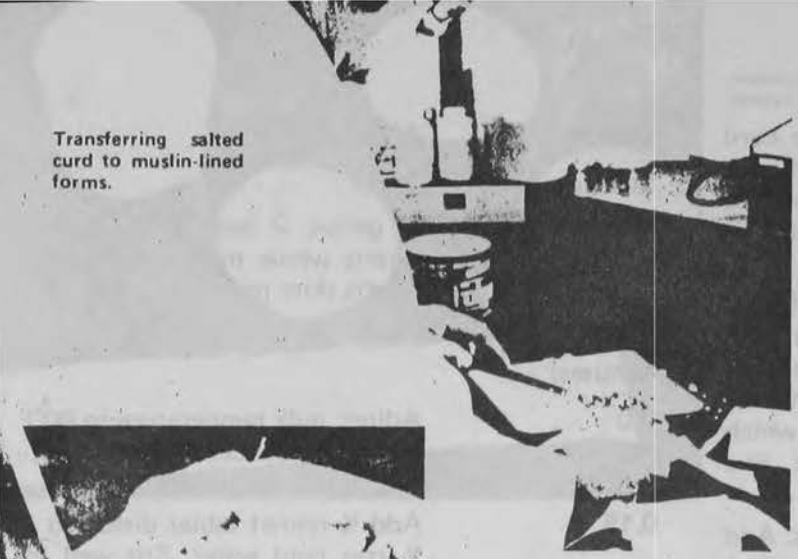
Cheese	**FETA**
Starter culture	B
Milk	1 gallon pasteurized whole milk
Time (hours, minutes)	
0.0	Adjust temperature of milk to 88°-90° F. Add 2 ounces of starter culture and stir slowly for 1 hour. Maintain temperature at 88°-90° F.
1.0	Add 1/8 rennet tablet dissolved in ½ cup cold, clean water. Stir for 5 minutes.
1.05	Cover and maintain temperature at 88°-90° F. Allow milk to set quietly until curd forms (about 1 hour).
2.05	Cut curd into 1-inch cubes. Allow it to set for 10 minutes undisturbed.
2.15	Stir curd gently every 10 minutes for 1 hour. Maintain temperature at 88°-90° F.
3.15	Transfer curd to open-ended forms on a perforated plate or in a muslin-lined colander. Allow curd to drain for 1 hour.
4.15	Invert curd in form so the top is on the bottom. Continue inverting it at 30-minute intervals for 3 hours.

Curd draining in a colander lined with cheesecloth.



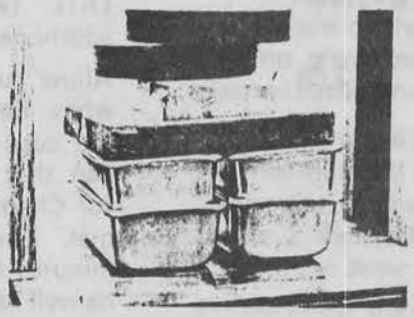
7.15	Sprinkle a layer of salt on all surfaces of the cheese and allow it to drain in the forms overnight.
Next day	Cut cheese into strips 3 by 3 by 6 inches. Loosely pack the pieces of cheese in a watertight container and cover them with cold, clean water containing 4-8 percent salt (according to taste). Seal the container and store it at 40° F. This cheese can be used immediately or stored for up to 2 months.

Cheese	**COLBY**
Starter culture	A
Milk	1 gallon pasteurized whole milk
Time (hours, minutes)	
0.0	Adjust temperature of milk to 88°-99° F. Add 4 ounces of starter culture and stir mixture slowly for 30 minutes.
0.30	Add ¼ rennet tablet dissolved in ½ cup cold water. Mix well for 3-5 minutes.
0.35	Cover milk. Maintain temperature at 88°-90° F. and allow milk to set quietly until coagulation occurs (about 30 minutes).
1.05	Cut curd into ¼-inch cubes. Allow curds to remain undisturbed for 5 minutes.
1.10	Stir curds slowly for 5 minutes.
1.15	Slowly increase temperature to 102° F. (2-degree increase in 5 minutes). Take about 40 minutes to reach this temperature. Maintain this temperature until the curd reaches desired firmness. Total time will be 1½-2 hours.
3.15	Drain whey to the point where the curd just shows at the top of the whey. Add cool water to decrease the temperature to 90° F. Stir for 20 minutes.
3.35	Remove the whey-water mixture, piling the curd on the bottom of the pot. Stir curd every 10



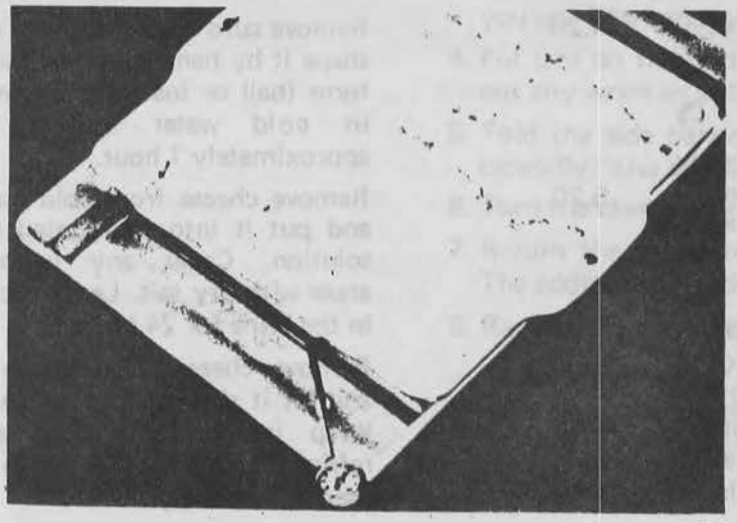
Transferring salted curd to muslin-lined forms.

Salted curd in a muslin-lined form, ready to be pressed.



Cheese in a press.

Curd in a "cheddaring" pan.



minutes to prevent matting. Drain curd by dumping it into a colander lined with cheesecloth. Then return it to the pot and salt it.

3.45 Add 3 teaspoons of salt to the curd in three applications (1 teaspoon of salt three times), stirring for 5 minutes after each application.

4.00 Place curd in a cloth-lined form and press it overnight.

Next day Remove cheese from press, remove the liner, and apply a larded bandage (see pages 20 and 21). Place the cheese in a dry, cool room (60°F.). Turn the cheese once a day to facilitate even drying. Cure this cheese for at least 2 months before you eat it. Curing should improve the flavor.

Cheese CHEDDAR

Starter culture A

Milk 1 gallon pasteurized whole milk

Time (hours, minutes)

0.0 Adjust temperature of milk to 88°-90° F. Add 2 ounces of starter culture. Stir slowly for 1 hour.

1.0 Add ¼ rennet tablet dissolved in ½ cup cold water and mix for 3-5 minutes.

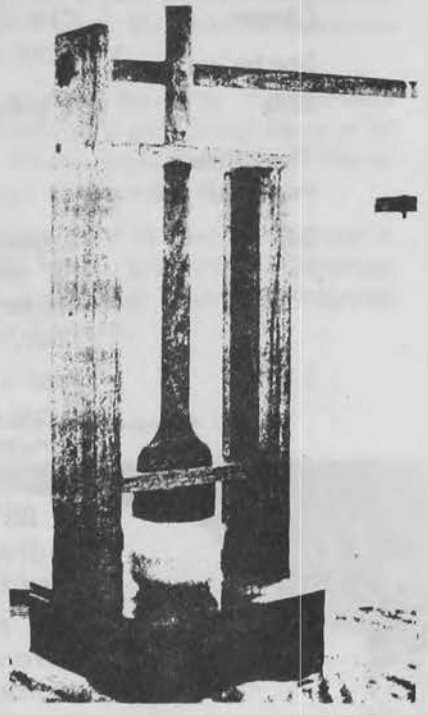
1.05 Cover, maintaining temperature of 88°-90° F., and let milk set undisturbed until coagulated (about 30 minutes).

1.35 Cut curd into ¼-inch cubes. Allow curds to remain undisturbed for 5 minutes.

1.45 Stir curds slowly. Start increasing the temperature slowly to 102° F. (about a 2-degree increase in 5 minutes). Take about 40 minutes to reach this temperature. Maintain this temperature until the curd reaches desired firmness. Total time will be about 1½-2 hours.

2.45 Stop stirring and allow the curd to settle to the bottom. Remove

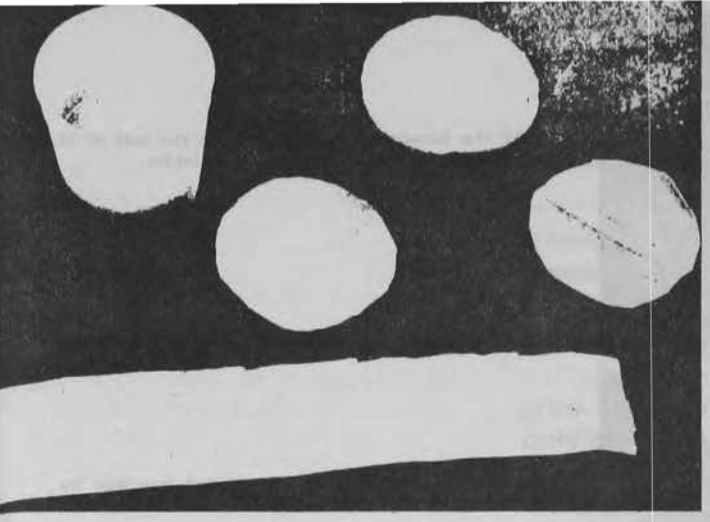
	the whey and transfer the curd to a flat bottom pan for cheddaring. The pan must be kept warm while the curd is being cheddared.
3.00	Cut curd mass into strips 3 inches wide and turn strips over. Continue turning strips every 15 minutes for 2 hours or until the curd forms a uniform mass which when pulled apart looks like cooked chicken breast.
5.00	Cut strips into ½-inch cubes. Add 3 teaspoons of salt in three increments (1 teaspoon three times) 5 minutes apart, stirring curds well each time. Salt is well worked into the curd when it has a shiny appearance and is rubbery.
5.20	Place curd in a cloth-lined form and press it overnight.



Cheese in a press.

Next day	Remove cheese from press, apply a larded bandage (see pages 20 and 21), and repress it an additional 8-12 hours to set the bandages.
Curing	Cure the cheese in a dry room at 50°-60°F. Turn it daily for 3 weeks to facilitate even drying and to help prevent mold growth. Turn it weekly thereafter. This cheese should be cured for at least 2 months.

Cheese,	**PIZZA**
Starter culture	B
Milk	1 gallon 2 percent milk or 2 quarts whole milk mixed with 2 quarts skim milk
Time (hours, minutes)	
0.0	Adjust milk temperature to 90°F. and add 4 ounces of starter. Stir slowly for 15 minutes.
0.15	Add ¼ rennet tablet dissolved in ½ cup cold water. Stir well for 3-5 minutes.
0.20	Cover, maintaining the temperature at 90°F., and let milk set until coagulated (about 30 minutes).
0.50	Cut curd into ½-inch cubes. Let curds set for 15 minutes with occasional stirring.
1.05	Slowly increase the temperature to 118°F. in 45 minutes. Hold this temperature for an additional 15 minutes.
2.05	Allow curd to settle under the whey. Remove whey and transfer the curd mat to a flat bottom pan that can be kept warm (as for Cheddar cheese). Do not cut mat. Turn mat over every 15 minutes for 2 hours. Mat should be well knitted when finished.
4.05	Cut mat into long strips (not cubes). Put curd in hot water (180°F.) and tumble and stretch it under the water using wooden spoons. It will become elastic after about 15 minutes.
4.20	Remove curd from hot water and shape it by hand into the desired form (ball or loaf). Place cheese in cold water (40°F.) for approximately 1 hour.
5.20	Remove cheese from cold water and put it into a saturated salt solution. Cover any exposed areas with dry salt. Leave cheese in the brine for 24 hours.
Curing	Remove cheese from the brine and let it dry for several hours. Wrap it in plastic wrap and refrigerate it. This cheese can be used immediately.



Materials needed for applying a larded bandage: cheese, a muslin bandage, and warm lard.

Miscellaneous Methods

MAKING BRINE SOLUTION

To make saturated salt solution for brining cheese, use 2 pounds of salt per gallon of water. Keep the brine cold (40°-50° F.) while cheese is in it. Saturated salt solution will always have excess salt that does not go into solution; there is no need to add more water. Even if you don't use it continually, change the brine no less than once a month. Saturated salt brine is corrosive, so be sure you put it in a heavy plastic or glass container.

MAKING AND APPLYING LARDED CHEESE BANDAGES

Applying cheese bandages with warm lard is an old method of sealing the surface of the cheese and helping prevent mold growth. Molds that do develop grow on the bandage, not on the cheese, and the cheese can be cleaned easily once curing is complete.

To make a larded cheese bandage, you will need lard that is slightly warmed but still solid, not liquid, and clean white muslin or similar cloth cut to the size of the cheese you want to bandage. Cut the cloth for the sides about 2 inches larger than the cheese. Make the circles for the top and bottom the same size as the cheese.

Follow these steps in applying the bandage:

1. Remove the cheese from the press and remove the form and cloth liner.
2. Smear warm lard on the top surface of the cheese. Put a muslin circle on the lard, working out any wrinkles. Use additional lard if necessary.
3. Turn the cheese over and smear lard on the sides. Carefully roll the muslin bandage around the side of the cheese, working out wrinkles as you go. The bandage should overlap the top and bottom about 1 inch.
4. Put lard on the bottom of the cheese and apply a muslin circle, working out any wrinkles as before.
5. Fold the side bandage overlap onto the top and work out any wrinkles carefully. Use additional lard as needed.
6. Turn the cheese over and fold the bandage overlap as in step 5.
7. Return the cheese to the form and press it for an additional 8-12 hours. The additional pressing will help set the bandage.
8. Remove the cheese from the press and store it in a cool, dry room.

As the cheese cures, use a stiff bristled brush to remove any mold growth from the bandage. When curing is complete, simply pull the larded bandage off the cheese. Always remove the bandage before cutting the cheese.

Laying the bandage over the lard on the side of the cheese; working out air bubbles and wrinkles.

Completing application of the larded bandage by working the corners smooth.

Applying the bandage to the bottom of the cheese.

WAXING CHEESE

Cheese can be coated with cheese wax after the surface is dry. It is difficult, however, to obtain cheese wax with the desired elasticity. A local cheese factory may have cheese wax they will sell. Or you can try making your own cheese wax by mixing vegetable oil and paraffin in various proportions. Start with a 50-50 mixture and vary the proportions as necessary.

To wax cheese, the cheese should be cold and the wax hot. Heat the wax slowly and carefully. If it gets too hot it may catch fire. Dip half the cheese into the wax for 30 seconds. Let the wax drip. Then turn the cheese over and dip the other half for 30 seconds. Return the cheese to the curing area. Turn it weekly.

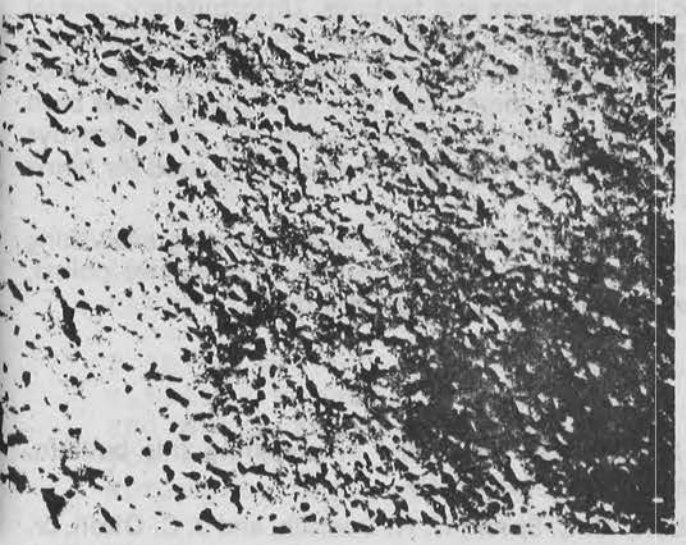
MOLD

One of the most constant problems affecting cheesemaking is the growth of undesirable mold. Besides affecting the aesthetic value of the cheese, mold growth may also have an adverse effect on the flavor. Musty and other objectionable flavors can be imparted to the cheese by mold growth, so make every effort to prevent mold from growing on your cheese.

Unfortunately, the molds that like to grow on cheese are also able to grow in the areas used for curing it, such as on wooden shelves, walls, and ceilings. One primary requirement for a cheese curing area is a rigid cleaning program. (The same holds true if you attempt to cure cheese in your refrigerator rather than in a separate location.) Cleaning the shelves and other cheese contact surfaces frequently is one method of reducing mold growth. Painting (after cleaning) the walls and ceilings frequently with mold resistant paint also will help.

Molds need moisture and air to grow, so keep cheese surfaces dry and prevent air from reaching the cheese. The underside of a cheese on a curing shelf will collect moisture, encouraging mold growth. Turn your cheeses frequently to keep all surfaces dry. Covering the cheese with wax, larded bandages, or other air-impermeable material also helps reduce the spoilage due to mold growth. If the covering material splits or cracks or if it is not sealed properly, mold will grow.

Once cheese has molded it is very difficult to prevent further mold growth. The best thing to do is cut away the molded areas and consume the cheese as quickly as possible.



Cheeses with small gas holes caused by undesirable fermentation.

Splits or large holes caused by undesirable gas fermentation.

GAS FORMATION

Occasionally an undesirable fermentation caused by unwanted microorganisms will occur, producing bloating or swelling of the cheese. The cheese will contain many small gas holes after such fermentation. Usually this gas is produced by a fairly common type of bacteria called coliforms. These bacteria like to grow in milk, converting lactose to acid and gas. Coliform organisms are common inhabitants of raw milk and thrive under unclean conditions. Control of this undesirable type of fermentation is generally achieved by using pasteurized milk and by making sure that all cheesemaking equipment is clean and sanitary.

RIND ROT

Excessive moisture on the surface of hard cheeses may allow yeasts, molds, proteolytic bacteria, and other microorganisms to grow and cause softening, discoloring, and undesirable odors. This condition is called rind rot. To prevent it, keep cheese surfaces dry.

CHEESE MITES

Cheese mites are extremely small spider-like creatures that will invade cheese surfaces and cause some undesirable changes. They appear as brown spots on cheese surfaces. Their presence indicates unsanitary and improper storage conditions. Control them by keeping your cheese curing area clean. Remember that frequent cleaning is essential to maintaining a good cheese curing room.

FLAVOR DEFECTS

Flavor defects in cheese can result from a variety of causes. Some off-flavors come directly from the milk the cheese is made from. Others may result from undesirable microorganisms that grow in the milk during cheesemaking or curing. Most of these defects can be avoided by using pasteurized milk and sanitary equipment and by keeping work and curing areas clean at all times.

Potential Hazards

Milk is a natural food for many organisms large and small. During cheesemaking, the growth of certain types of desirable bacteria is encouraged to develop characteristic cheese flavors and textures. Unfortunately, several kinds of pathogenic (disease-producing) bacteria also are capable of growing during the cheesemaking process. Many of these pathogenic bacteria can be in the milk, particularly if the milk comes from an animal that is or has been sick or from one that has mastitis. Pasteurization of milk destroys pathogenic bacteria, so it is absolutely essential that any milk used for home cheesemaking be pasteurized.

The importance of using pasteurized milk and keeping everything clean can't be overemphasized. If you are careful about these two points, you can be sure the cheese you make is tasty and healthful.

References

The references listed below were used in preparing this bulletin. Consult them if you want further information.

Foster, E. M., F. E. Nelson, M. C. Speck, R. N. Doetsch, and J. C. Olson, Jr. 1957. *Dairy Microbiology.* Prentice-Hall, Inc., Englewood Cliffs, N.J.

Kosikowski, F. V. 1970. *Cheese and Fermented Milk Foods.* Edwards Brothers, Inc., Ann Arbor, Michigan.

Wilster, G. H. 1964. *Practical Cheesemaking.* O.S.U. Bookstores, Corvallis, Oregon.

U.S. Department of Agriculture. 1969. *Cheese Varieties.* Agriculture Handbook 54. Government Printing Office, Washington, D.C.

You can obtain a copy of the last reference listed, *Cheese Varieties,* by writing to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The charge for this booklet is 65 cents; include payment with your order.

DHIA RING TEST

Sharon Sayre

I started with the first ring DHIA testing in 1976. There were eight goat owners who felt this was important enough to try. We met in Buffalo and Bill Mudge gave us the instructions and training. The first few tests felt strange but we got everything ironed out. Then it was comfortable because we knew what we were doing.

The ADGA says you cannot test the same herd oftener than every fourth month, A tests B, C, D, one each month than back to B. One person in the group has to determine the schedule and tell the others and the ADGA. All must have their ADGA paperwork done and approval before the first test.

Even after we were on test there was a learning period. The envelope you receive has three papers in it a barn sheet, cow report, and herd summary. What do all the numbers mean? We goat herd owners took advantage of the explanatory sessions for all DHI farmers and learned to read and use the information.

At first I continued my herd management as before. I usually had a two month span where all does were dry. My milking vacation. However, I learned about rolling herd average and year round milking. I learned about feeding to the doe's potential and getting star milkers and even two star milkers and a plus buck. One year I was in the top six herds for rolling herd average. I also have had a 3,000 pound milker.

Of the original eight I am the only one still here on ring test. People move or quit goat herding. I don't think I can right off name all the people who have come and gone.

I think everyone has enjoyed it. Every few months you are visiting someone's herd again. You enjoy their successes and share their sorrows. When the windchill is 40 below, you wonder why you are doing this. But on an early April spring morning, you are glad you are doing this.

Minnesota State Dairy Herd Improvement Association

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(612) 682-1091

Gary Thompson
Director of Field Services

GUIDELINES FOR DAIRY GOAT RING TESTING

1. There must be a minimum of 4 goat herds in each ring.
2. A member of the ring can not sample his/her own goats.
3. All members of a ring must be willing to sample other herds on schedule.
4. Herds must be sampled in such a sequence so that no person samples any particular herd more frequently than every fourth test.
5. At least one member of each goat ring must be an approved DHI Supervisor. This person must adhere to all supervisor regulations including supervisor continuing education seminars, etc.
6. All members of a goat ring must attend a DHI goat ring training session. Instruction will be provided in areas such as completion of barnsheets, instructions in sampling techniques, and care of samples.
7. All members of a goat ring, must belong to the same local DHIA.
8. Rates charged each herdowner will be determined by the local DHI Board.
9. Herds must comply with all applicable DHI, DHIR, and American Dairy Goat Assn. Rules and Regulations.
10. All equipment including scales, sample bottles, and sample boxes, must be DHIA approved. Each goat ring is responsible for providing their own equipment. Scales must be checked by MN State DHIA at least annually.
11. Samples must be taken care of in a DHI approved manner.
12. All samples will be tested in a central DHIA testing laboratory.
13. For herds enrolled in the DHIR program, the herdowner must agree to send one copy of all reports received to the American Dairy Goat Association to have lactations reported.

BEGINNERS BASIC MANAGEMENT OF DAIRY GOATS

Maxine Sheldon
Maple Island Alpines

Basic management of dairy goats has five separate areas that will make the difference between success or failure in your endeavor. It is the successful combination of these five things that makes for a good management program. The five areas to which I am referring are housing, feeding, health maintenance, milk handling and your breeding program.

HOUSING

In our climate, we must provide duel purpose housing that will keep the goats warm in the winter and cool in the summer. A building that is double-walled and insulated is ideal. This could be either a new structure or an adapted farm building already in existence. If an older barn, hog house or chicken coop is to be used, diligent cleaning and sanitizing should be completed before the goats are housed in them. If you are building a new building, the University of Minnesota has building plans for calf barns that work very well for dairy goats. Each goat should have a minimum of fifteen square feet of space. Overcrowding can be a severe stress factor letting more injuries occur, contributing to less milk production and more health problems. Plan generously. Goat herds have a tendency to grow quickly!

One of the most important things to be concerned about is ventilation. Not only will you need windows that are functional and provide good cross-ventilation, you will need a ventilation fan. Excessive humidity, not temperature control, is the biggest problem, and that is where a good exhaust fan will keep you out of trouble summer and winter. Your goats will be able to handle living in an uninsulated pole building with good ventilation much better than they would living ina double-walled, well insulated building with inadequate ventilation, resulting in a high humidity situation.

Along with dry air the goats need a dry floor that is well-bedded and warm. Gravel flooring in loose housing pens works very well. If your goats are housed on cement, be certain that adequate bedding is used, particularly after barn cleaning. Cement floors can be very damp and cold, especially in spring and fall, and it takes a large amount of straw to provide enough insulation between the animal and the floor to keep your goats warm and dry. With proper bedding you will also reduce the chance of knee and leg injuries. With the use of proper amounts of bedding it will be necessary to completely clean the barn about four times a year.

Insect control, mainly flies, is also important. The windows should be screened and the barn kept clean. You will still need help from fly strips,

dairy fly spray or fly traps. If you use fly spray, be sure it is safe to use in dairy barns and follow the directions for use and precautions carefully. Mosquitoes also like the taste of goats, and must be controlled in the barn. We have an electronic bug wacker in our barn and have found it does not control flies, but it does eliminate mosquitoes and night flying insects which are attracted to light.

Keeping goats confined does not have to be a hassle. A majority of our fencing is electric. We also use some hog panels and for our bucks we use woven wire with one strand of electric on the inside. The bucks thought the woven wire was an excellant scratching post, and the electric wire keeps them from stretching the fence out of shape. If you are planning to use electric fencing, we find that two strands, one12 inches from the ground and another 28-30 inches from the ground are adequate. However, you will need to "train"your younger animals when you first confine them with electric. The fastest way to teach them about electric fences is to walk with them inside the fence. Then they wander over to the fence to smell it, and ZAP! Once or twice does it! If you stay on the outside of the fence they will run through it to be by you and when they charge through that fast they do not feel the shock. We have found that keeping our goats well fed with adequate exercise area prevents them from wanting to get out. We also do not teach our kids how to jump or come over the fence. We always walk them through a gate instead of lifting them over the fence. Another thing to keep in mind when fencing, is not only keeping your goats in, but keeping out unwanted preditors. Strange dogs in goat pens are deadly.

FEEDING

Most important is getting on a good feeding program and being consistent. Talking to your extension agent will help you determine what dairy farmers in your area are feeding their cows, and where they are getting their feed. A good 16% protein dairy ration should be adequate. Most feed mills have a dairy ration available. There are also some commercial dairy goat rations on the market. If you use a cow feed, make sure it does not contain urea or estrogen. Goats do not tolerate these additives. We use a 14% or 20% protein pelleted dairy ration from the Doboy feed company, depending on the quality of the forage we are feeding. If we have a high quality, high protein hay, the 14% maintains them very well, but if we have a lower quality, grassier hay with lower protein, we feed the 20% protein. One of the services our feed mill provides is free hay analysis, which eliminates the guess work and gives us specific information to use is deciding the amount of protein to feed in the grain and to feed the loose minerals appropriately. This has worked the best for us and is the most economical way for us to feed grain. We feed about four pounds of grain per goat per day for eight pounds of milk. We increase that amount according to the individual goat's production. One pound of grain for two pounds of milk. A doe milking sixteen pounds per day would get eight pounds of grain. During the dry period we feed less than four pounds if the does are getting too heavy.

Another option may be having a feed mill use your recipe and grind and mix the feed for you. Below is a recipe for a 16-16½% protein feed that

worked fairly well for us:

Ground whole cob corn	350#
Soybean oil meal (48% protein)	200#
Rolled oats	350#
Liquid molasses	70#
Bone meal	20#
Trace mineral salt	10#
	1000# grain

We also added 1-1½# of vitamins A D & E. When we added the vitamins, it was recommended that we add cattle vitamins instead of dairy vitamins because there was no medication in the cattle vitamins, only iodine. You would have to check your sources of vitamins and determine which is best for your situation. One of the problems we encountered when using this recipe was the fluctuating food values and changes in type of grind and flavor. One month we would get Farmer Brown's corn which was super and the next month Farmer Green's, whose corn quality was questionable. These changes had the tendency to make the goats think it was a new and different feed, and they would hesitate to eat it the first couple of days, which resulted in a drop in milk production every time we started a new batch of feed. The other problem resulted when we fed this grain mix with a super quality hay. The better the hay the higher the calcium content. The high calcium in the hay plus the 20# of bone meal in the feed mix gave us a very phosphorus deficient herd. Equal amounts of calcium and phosporus should be fed. This is where knowing the calcium and protein content of your grain and hay is important. The calcium and phosphorus levels being fed also determine what should be available in loose minerals.

Along with our pelleted grain our goats have alfalfa/grass hay available to them at all times. A good quality dairy hay is best. Grass hay with many weeds and coarse stems is not as palatible for the goats and strong weeds make strong tasting milk. Loose salt and minerals should also be available at all times. Your feed person would be the best person to advise you on what minerals to use with your particular hay and grain, based on your ratio of calcium and phosphorus being fed.

Grain and hay should be fed in feeders off the floor, with both being non-accessible for playing in or sleepingin. Manure droppings should also be kept out. Key hole feeders work well to keep feed and water clean. Clean water should be available at all times, and if possible it should be warm summer and winter.

HEALTH MAINTENANCE

Prevention is much easier and much cheaper than curing, which means you should keep your goats as healthy as possible. There are some routine management procedures that should always be done.

Hoof trimming is important for proper maintenance of feet and legs. That should be done as needed, which turns out to be about every two months. Some goats'hooves grow faster than others and will need to be done more frequently.

All kids should be disbudded at four to five days of age. If you have adults with horns, they can be dehorned when there are no flies, but you should have some help from your veterinarian when doing this.

Routine worming should be done at least twice yearly. This should be done before breeding season in the fall, and after kidding in the spring. It is better to rotate worming medication, not using the same wormer twice in a row. Thibenzole and Panacur are very effective. If you have coccidia in your herd a wormer for that specifically must be used. If you have had any trouble with kid deaths or lack of growth in your kids for the first six months of life and the cause has been pneumonia, diarrhea or just plain unthriftiness, a fecal floatation should be done by your veterinarian to check for coccidia. Mature does can handle larger infestations of coccidia with only a small amount of trouble, but kids are much more vulnerable. If you have had trouble with coccidia, you may have to go on a monthly preventative program, or whatever your veterinarian recommends. If your veterinarian is unfamiliar with goats,you might mention to him that goat kids do not display the same characteristic symptom that calves do, mainly bloody, mucus type diarrhea. Goat kids with high levels of coccidia may never have any diarrhea. Diagnosis should be made by fecal flotation and not symptoms. Keeping hay, grain and water feces free, and keeping your barn clean is also important for controlling parasites. Any new animals being brought into the herd should also be isolated for one month and wormed before putting them with the rest of your animals.

You should also check for external parasites and treat as necessary. If your animals are rubbing and scratching excessively, loosing their hair or have dull coats, they may have lice, fleas or mange. If these goats are in milk, make sure you use a treatment that is for dairy animals. Clipping your goats in the spring will help you to evaluate their skin condition more accurately.

Vaccinations should be discussed with your veterinarian and given as he suggests. He will be aware of the health problems you are having and the health problems in your area. We vaccinate everything yearly for enterotoxemia and tetanus. If you vaccinate for enterotoxemia and tetanus, we have found it is best to give the serum deep in a muscle. The bottle says it can be given safely under the skin or in a muscle, but when it is given under the skin it can develope into a sterile abcess. Tetanus is especially important if you have horses, or if there has ever been horses on your farm.

Another thing that should be done yearly is testing for tuberculosis and brucellosis (bangs), particularly if you drink your milk unpasteurized. These tests are also required before you can take your animals to any fairs or goat shows.

When you are planning your housing, you should include an area where you can isolate an animal if it is sick or injured. It is also a good idea to isolate any new animal that is coming into your herd, for a minimum of thirty days.

An important part of health care is finding a good veterinarian before you have sick animals and need him. Get to know him and give him a chance to get to know your animals so that when you call him a 3:00 a.m. for a sick

doe, he knows to whom he is speaking and he knows where you live, and what kind of set-up you run. In an emergency time saved can be precious.

MILK HANDLING

Milk is one of the rewards for the hard work with your goats. Taking care of the milk properly is of utmost importance to insure a quality product for human consumption.

A separate, clean room for milking is needed. A cement floor is preferred, with an elevated milking stand, and a shelf for milking utensils during milking. The doe should have a dairy clip including her flanks, tail, udder and underneath her belly. The entire animal should be brushed to remove loose hair and dirt from her coat. Just prior to milking all of the equipment that touches the milk should be sanitized in a water and chlorox solution and allowed to drain and air dry.

The doe's udder and teats should be washed with warm water containing an udder wash solution such as chlorahexidine. Next dry the doe with a disposible paper towel. Leave the paper towel under the doe and use it for a blotter for milk splashes. After the doe is dried with the paper towel, strip two squirts of milk from each teat into the strip cup to check for blood spots or milk clogs. This also removes the milk with the most bacteria from the teat. Proceed to milk the doe into a stainless steel pail. If a stainless steel goat milking pail is not available, a stainless steel mixing bowl or sauce pan would suffice. When you have emptied the udder, massage it for a minute or two to work down any milk that was high up in the udder. After the massage, milk the udder empty again. Then the teats should both be dipped in teat dip to seal the teat oriface. When choosing teat dip and udder wash, be sure to have the same chemical base for both of them, or you will end up with red, dry, chapped udders and sore hands.

The milk should then be strained into a glass jar and cooled immediately. Submerging the jar in ice water cools the milk faster than just setting it in the refrigerator. When you have finished milking, the equipment should be rinsed in tepid water, then washed in a dairy detergent and again rinsed in the water/chlorox solution and allowed to air dry. A brush works best for washing the utensils. The milk stand should be wiped off and the floor swept after milking. Fly control is mandatory for clean milk.

BREEDING PROGRAM

A successful breeding program is vitally important because it determines the type and quality of animals that will be in your herd in the future. Each mating should have a purpose other than getting the doe bred to bring her into milk. A successful breeding is one is which the offspring is an improvement over the dam.

The buck used for servicing should have characteristics of superior quality in the areas in which your does need to improve. If the pasterns are weak on your doe, breed to a buck with strong pasterns and whose offspring have strong pasterns. A purebred buck should always be used so that you can check backgrounds of his parents, plus have a record of his own offspring.

If you are planning to purchase buck service from another breeder, make

the arrangements prior to the day you would like your doe serviced. Be prepared to meet the requirements of the breeder, such as having a negative brucellosis and tuberculosis certificate. Talk over the strengths and weaknesses of your doe and let the buck owner help you decide which of his bucks could do the most for your doe's kids. Discuss what time of day is best to bring your doe over, and if possible, let the breeder know in advance when your doe is due to come into heat. Discuss cost of the service and be prepared to pay cash at the time of servicing. After the service has been completed and paid for, be sure you get a signed Sire Service Memo from the breeder. This piece of paper proves you have had your doe bred by this buck and makes it possible for you to register the offspring with the American Dairy Goat Association.

There is nothing more difficult in the breeding process than determining for sure that the doe is is standing heat. The signs are red, swollen vulva, clear vaginal discharge, "flagging" with the tail, more talkative and change in her disposition. Sometimes milkers will also have a marked reduction in their milk production when they are in heat. Heat cycles last from twelve hours to two days, and occur at about twenty-one day intervals. Unfortunately, it is usually the doe with the slightest signs of heat that stays in heat only twelve or fourteen hours. If you are having trouble detecting heat in your does and you do not own a buck, try to get a buck rag from a buck owner. All this is is a rag rubbed on the buck's head so it acquires the buck smell. Keep the rag in a tight container and open it for your does to smell two or three times per day during the breeding season, which is from September through December. If your doe is in heat she will probably (hopefully!) respond positively to the buck smell. If it is in the month in which you wish to breed her, you should have her serviced as soon as possible after you have detected heat. If you decided to wait until tomorrow because it might be nicer outside or more convenient for you, you may possibly have to wait three more weeks to catch her in heat again.

If you own your own buck it is best to house him separately from the does and take the doe to him when you have detected her in heat. The bucks can really hassle your does and cut down on your milk production. By hand breeding you will know for sure if an animal has been serviced and by whom on what day. It makes it much easier to plot your milk supply and plan your kidding times for your convenience.

Doe kids should be bred when they are six or seven months old, providing they are a minimum of eighty to eighty-five pounds in weight. It is better to freshen the animal close to its first birthday than to let them go until they are two years old. It is difficult to get an overweight doe bred and into good production, and it is very hard not to let yearlings become overweight if they are not producing milk.

Milking doe should be bred to freshen about the same time every year. They should give you a full ten month lactation with a two month rest period prior to kidding. They should be dried off no later than six weeks before kidding. Most milkers will start to dry themselves off and are very cooperative about

getting their two months rest. Others need more persuasion and you will need to quit their grain temporarily, feed a poorer quality hay and allow them to have only cold water. When the does start dropping in milk quantity, then go to once per day milking. When the doe is giving less than five pounds of milk at the once per day milking, you can stop milking her. If she is still giving more than five pounds at the once a day milking, you may have to skip two milkings so that you are milking her once every thrity-six hours. Never milk out just part of the milk to take the pressure off. If you have determined that she needs to be milked because her udder is too full and tight, milk her out completely.

When your does are bred make sure they receive adequate daily exercise, outside if possible. Walk them to the mailbox and back or take them for a stroll in the woods. Just don't make them walk in deep snow so that they freeze their teats, or make them stay out in the cold for long periods of time.

Prevent over-crowding in your barn so that injuries to pregnant does do not occur. When it comestime for kidding you may want to pen them separately but that is not necessary until the actual kidding is about to happen. Plan to be present when the kids arrive. A doe that is having trouble kidding needs your help then, not after work when you get home. If you cannot be present, at least make arrangements for someone to check the doe two or three times a day, and he should know how to reach you in the event your doe is having trouble kidding. The gestation period for goats is one hundred fifty days and they usually kid within five days before their due date to five days after their due date.

After the doe has freshened, it is best not to milk her empty for the first twenty-four hours. If you leave the kids on the dam, make sure you check the udder and don't let it get too full. This is the one time you do not milk the udder empty. If you are planning to bottle or pan feed the kids, do not leave them on the doe for more than twenty-four hours or you will have a great deal of difficulty convincing the kids that the bottle is just as good as mom.

If the kids are left on the dam until weaning time at three to four months of age, the dam's udder should be milked twice a day to make sure the udder gets emptied and to check for mastitis or udder injury. We have found that we get the best production by taking the kids from the dam at twenty-four hours and bottle feeding them. There is also less trouble with mastitis and udder injury. We have also noted that when the kids are taken from their dam at twenty-four hours, you become their mother substitue and they love you dearly. That makes an animal want to cooperate with you later on when they become a milker. Good dairy temperment makes for a much more pleasant time at milking time.

If space permits it is best to house kids away from the does. If you don't have a separate pen in your barn for the kids, calf hutches outside provide

good housing for kids. A hutch will comfortably handle six or seven kids. Calf panels make good portable fencing for the hutches and makes moving them from one area to another possible. The kids should have access to loose salt and minerals, and good quality hay and fresh warm water at all times. They should have feed troughs that are up off the ground and easily cleaned. A dry floor and fresh bedding is essential. Buck and doe kids should be separated by two to three months of age or breedings can occur.

Last but not least, take time out to enjoy your goats. Goats are devoted and loving animals that will give you many years of service for the price of some common sense and lot of TLC.

LIST OF FORAGE TESTING LABORATORIES IN MINNESOTA FOR 1980-1981

Ingman Laboratory
324 4th Ave. S.
Minneapolis, Mn. 55415
612-333-6419

MN Valley Testing Laboratory
Center and German Street
New Ulm, Mn. 56073
507-354-8517

Markley Laboratory
1853 N. Old Highway 8
New Brighton, Mn. 55112
612-633-5477

Dairyland Laboratory
Arcadia, Wisconsin 54612
608-323-3988

Quality Control Lab
Freeport Roller Mills, Inc.
P.O. Box 7
Freeport, Minn. 56331
612-836-2145

This list was taken from a list published by the University of Minnesota Agricultural Extension Service in 1980-81.

SOURCES OF INFORMATION ON DAIRY GOATS

By: R.D. Appleman, Extension Dairyman, University of Minnesota

LEAFLETS, CIRCULARS, AND BULLETINS

A. Dairy Goat Management and Production

1. Dairy Goat Production Guide, NE-2
   L. R. Brown, Department of Animal Industries, University of Connecticut,Storrs, Connecticut 06268; and B. Harris and R. L. Richter, Dairy Science Department, Gainesville, Florida 32611 (1975) -- 18 pages.

2. "Dairy Goat Management"
   G. F. W. Haenlein, Department of Animal Science and Agricultural Biochemistry, University of Delaware, Newark, Delaware 19711, Journal of Dairy Science, Vol. 61, No. 7, (July 1978) --1011-1022.

3. The Dairy Goat, Information Bulletin 78
   W. F. Brannon, Animal Science Department, Cornell University, Ithaca, New York 14853 (1975) -- 12 pages.

4. Dairy Goats: An Introduction to Management
   W. A. Gross and R. I. Millar, Animal Science Department,University of Rhode Island, Kingston, Rhode Island 02881, mimeo (1978) -- 13 pages.

5. Dairy Goat Care and Management
   A. M. Meekma and Jack L. Groff, Department of Animal Science, Texas A & M University, College Station, Texas 77843 (1975) -- 8 pages.

6. Dairy Goats - Breeding, Feeding, Management
   B. E. Colby, D. A. Evans, S. L. Lyford, W. B. Nutting, and D. W. Stearn. University of Massachusetts. Available from American Dairy Goat Association, Box 865, Spindale, N.C. 28160 -- 78 pages.

B. Dairy Goat Genetics

1. Own a Dairy Goat
   The American Dairy Goat Association, P. O. Box 865, Spindale, North Carolina 28160 -- 8 pages.

2. "Genetics of Dairy Goats: A Review"
   M. U. Iloeje and L. D. VanVleck, Animal Science Department, Cornell University, Ithaca, New York 14853, Journal of Dairy Science, Vol. 61, No. 8 (1978) -- pages 1521-1528.

3. Breeds of Dairy Goats, Guide 400, D-702
   Borden Ells, Department of Animal and Range Sciences, New Mexico State University, Las Cruces, New Mexico 88003, (revised 1975) -- 3 pages.

C. Dairy Goat Reproduction & Breeding

1. The Artificial Insemination of Dairy Goats
H. A. Herman, American Supply House, Box 1114, Columbia, Missouri 65201 (1972) -- 24 pages.

2. "Reproduction and Breeding of Goats"
Maurice Shelton, Texas A & M University, Texas Agricultural Experiment Station, San Angelo, Texas 76901. Journal of Dairy Science, Vol. 61, No. 7, (1978) --pages 994-1010.

3. Management of Reproduction in Sheep and Goat Symposium
Sheep Industry Development Program, American Society of Animal Science and American Association of Sheep and Goat Practitioners, Chairman Clair E. Terrill, National Program Staff, Agricultural Research, Science and Education Administration, USDA (1977) --149 pages.

D. Dairy Goat Feeding

1. Feeding Dairy Goats - Current Inf. Series No. 296
E. A. Fiez, Department of Animal Sciences, University of Idaho, Moscow, Idaho 83843 (1975) -- 2 pages.

2. "Dairy Goats Do Well on Free-Choice Feeding"
G. F. W. Haenlein, Hoard's Dairyman, October 10, 1978 -- 2 pages.

3. "Forage Utilization and Nutrient Requirements of the Goat"
J. E. Huston, Texas Agricultural Experiment Station, Texas A & M University, Agricultural Research and Extension Center, San Angelo, Texas 76901, Journal of Dairy Science, Vol. 61, No. 7, (1978) -- 988-993 pages.

4. Feeding the Dairy Goat, Special Circular 233
D. L. Ace Dairy Animal Sciences Department, Pennsylvania State University, University Park, Pennsylvania 16802 -- 2 pages.

E. Dairy Goat Housing and Equipment

1. Barns and Buildings for Dairy Goats
A. L. Klingbeil, Tiger Press, Columbia, Missouri 65201, for American Supply House, P. O. Box 1114, Columbia, Missouri 65201 -- 47 pages.

2. Housing Equipment and Care of Dairy Goats, D-235
D. V. Armstrong, Department of Animal Sciences, University of Arizona, Tucson, Arizona 85721 -- 4 pages.

3. Housing and Equipment for Dairy Goats, Guide 400 D-703
Borden Ells, Department of Animal Science and Range Sciences, New Mexico State University, Las Cruces, New Mexico 88003, (1977) -- 2 pages.

4. Dairy Goat Housing and Care
D. A. Anderson, Animal Science Department, Oregon State University, Corvallis, Oregon 97331 (revised April 1976) -- 4 pages.

5. Housing for Dairy Goats, Special Circular 236
D. L. Ace, Dairy and Animal Sciences Department, Pennsylvania State University, University Park, Pennsylvania 16802, (1978) -- 2 pages.

F. 4-H Publications

1. Dairy Kids and Goats, 4-H Publication B-12
4-H Office, 475 Coffey Hall, University of Minnesota, St. Paul,MN 55108 -- 37 pages.

2. Indiana 4-H Dairy Goat Club Record (4-H 589) -- 16 pages.
Jack L. Albright and co-workers, Cooperative Extension Service, Purdue University, West Lafayette, Indiana.

3. The Dairy Goat -- 4-H Member's Guide
C. W. Richardson, Department of Animal Sciences and Industry; Sue Blakely, Agricultural Information Services, Oklahoma State University, Stillwater, Oklahoma 74074 (1976) -- 24 pages.

4. 4-H Dairy Goat Work Manual, Units 1 through 7
Darrel Bolz and Ed Fiez, University of Idaho, Moscow, Idaho (1978).

G. Books

1. Making Your Own Cheese and Yogurt
Max Alth, Funk and Wagnalls, New York.

2. Raising Milk Goats the Modern Way
Jerry Belanger, Garden Way Publishing Co., Charlotte, Vermont 05445.

3. Kidding Around: Goat Cartoons
Betsy, Hall Press, P. O. Box 5275C, San Bernadino, California 92412.

4. Dairy Goat Judging Techniques
Harvey Considine and George Trimberger, Dairy Goat Journal, Box 1808 Scottsdale, Arizona 85252 (1978).

5. Goat Production in the Tropics
C. Devendra and Marca Burns, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks, England (1970) -- 184 pages.

6. Good Beginnings with Dairy Goats
Josephine Emily Eberhardt, Dairy Goat Journal, Box 1908, Scottsdale, Arizona 85252 (1975) -- 192 pages.

7. Observations on the Dairy Goat, FAO 1970
Unipub. Inc., 650 1st Avenue, Box 433, Murray Hill Station, New York, New York 10016.

8. Feed and Nutrition, Chapter 22, "Feeding Goats"
Dr. M. E. Ensmiger and Dr. C. G. Oletine, The Ensmiger Publishing Company, 3699 East Sierra Avenue,Clovis, California 93612 (1978) -- pages 787-813.

9. Management and Diseases of Dairy Goats
Dr. Samuel B. Guss, V. D. M., Dairy Goat Journal Publishing Corporation, Scottsdale, Arizona 85252 (1977) -- 222 pages.

10. Dairy Goats: Selecting, Fitting and Showing
Alice Hall, Hall Press, P. O. Box 5375, San Bernadino, California 92412 (1975) -- 87 pages.

11. Goats
H. E. Jeffrey, Diamond Farm Book Publishers, Dept. DG, Box 266, Alexandria Bay, New York 13607.

12. The Goat Owner's Scrapbook
Dr. C. E. Leach, American Supply House, Columbia, Missouri 65201 (Second printing 1971) -- 386 pages.

13. Aids to Goatkeeping
Dr. C. E. Leach, Dairy Goat Journal, P. O. Box 1908, Scottsdale, Arizona 85252 (8th Edition 1974) -- 277 pages.

14. "Nutrition and Feeding of Goats in Digestive Physiology and Nutrition of Ruminants," Vol.3, Practical Nutrition (Ivan L. Lindahl, SEA-AR, USDA, Beltsville, Maryland).
D. C. Church, Senior Author and Editor, Oregon State University Bookstores, Inc., Box 489, Corvallis, Oregon 97330.

15. Goat Husbandry
Davis MacKenzie, 5th Edition, 1975, Diamond Farm Book Publishers, Dept. DG, Box 266, Alexandria Bay, New York 13607.

16. The Book of the Goat
H. S. Holmes Pegler, "The Bazaar Exchange and Mart," LTD Link House, 24 Store Street, London WC-1,England, published by American Supply House, P. O. Box 304, Columbia, Missouri 65202 (1965) -- 251 pages.

17. The Modern Dairy Goat
Joan and Harry Shields, C. Arthur Pearson, LTD Tower House, Southhampton Street, Strand WC-2, London, England, published by Tiger Press, Columbia, Missouri 65201, or the Dairy Goat Journal, Inc., P. O. Box 190, Scottsdale, Arizona 85252 (1949) -- 172 pages.

18. Living on a Few Acres, the 1978 Yearbook of Agriculture, USDA
"Dairy Goats Require Lots of Care Just to Break Even," Donald L. Ace, pages 357-364.

19. The Illustrated Standard of the Dairy Goat -- A Guide for Evaluating and Judging Conformation
Nancy Lee Owens, Dairy Goat Journal Publication Corporation, P. O. Box 1908, Scottsdale, Arizona 85252 (revised edition 1977) -- 131 pages.

20. Starting Right with Milk Goats
Helen Walsh, Garden Way Publishing Co., Charlotte, Vermont 05445,1972.

21. The Role of Sheep and Goats in Agricultural Development
Winrock International Livestock Research and Training Center, Morrilton, Arkansas 72110 (1976) -- 43 pages.

H. Miscellaneous Materials

1. Proceedings, 1st Annual Dairy Goat Conference.
Office of Special Programs, 405 Coffey Hall, University of Minnesota, St. Paul,MN. 55108 -- 56 pages.

2. California Dairy Goat Publications -- 1975, 1976, 1977, and 1978
Frank D. Murrill, Animal Science Department, University of California, Davis, California 95616.

3. Dairy Goat -- Correspondence Course 105
Correspondence courses in Agriculture and Home Economics, 307 Agricultural Administration Building, The Pennsylvania State University, University Park, Pennsylvania 16802.

4. Dairy Goat Films
Genus Capra Films, 8780 Trinkle Road, Dexter, Michigan 48130.
("AI Techniques," "Fitting and Showing," "Breeding and Kidding," and "Basic Management.")

ORGANIZATIONS AND SUPPLIERS

A. Dairy Goat Associations

1. The American Dairy Goat Association
Don Wilson, Secretary Treasurer, Box 865, Spindale, North Carolina 28160.

2. The American Goat Society
H. Wayne Hamrick, Secretary, Route 2, Box 112, DeLeon, Texas 76444.

3. Dairy Goat Club Directory is published annually in the February issue of the "Dairy Goat Journal."

B. National Dairy Goat Breed Associations

1. Alpine International Club
Yvonne Roberts, Secretary-Treasurer, Rt. 1, Box 2065, Ft. Pierce, FL 33451

2. American LaMancha Club
Mrs. Virginia Marhefka, Secretary-Treasurer, Star Route 1, Box 573, Chino Valley, AZ 86323

3. International Nubian Breeders Association
Mrs. Linda Brake, Secretary-Treasurer, 5225 East Pershing Avenue, Scottsdale, Arizona 85254.

4. National Saanen Breeders Association
Mrs. Minnie Waterman, Secretary-Treasurer, RFD 2, Kerr Road, Canterbury, Connecticut 06331.

5. National Toggenburg Club
Joan Kilhem, Secretary-Treasurer, Chestnut Hill Rd., E. Hampton, CT 06424

6. Oberhasli Breeders of America
Judy Marshall, Secretary-Treasurer, 1929 Centerville Turnpike, Virginia Beach, VA 23464

C. National Dairy Goat Magazines

1. "Dairy Goat Journal"
   Kent Leach, Editor, Box 1808, Scottsdale, Arizona 85252.

2. "The News Dispatch"
   Published by the American Goat Society, Inc., Route 2, Box 112, DeLeon, Texas 76444.

D. Dairy Goat Equipment Suppliers

1. NASCO
   901 Janesville Avenue, Fort Atkinson, Wisconsin 53538.

2. American Supply House
   P. O. Box 114, Columbia, Missouri 65201

3. Hoegger's Supply Company
   P. O. Box 490232, "Dept. J," College Park, Georgia 30349.

4. Goat Gifts Galore (Thomas E. Hicks)
   P.O. Box 284, Clearwater, MN 55320 (612) 558-2280

5. Caprine Supply
   6657 Woodland, Shawnee, KS 66218 (913) 441-1848

E. Minnesota Dairy Goat Association Chapters

East Central Dairy Goat Club
Robin Raudabaugh
Rt. 1 Box 117
Pine City, Minn. 55063
612-629-7147

Headwaters Dairy Goat Club
Bonnie Nolan
Star Rt. Box 132
Bemidji, Minn. 56601
218-715-8154

Jack Pines Dairy Goat Club
Dorothy Marchwick
Star Route 1
Pequot Lakes, Minn. 56472

Head of the Lakes Dairy Goat Club
Sue Stoltz
Route 2 Box 169
Superior, Wisconsin 54880
715-399-8477

Lone Oak Dairy Goat Club
Nancy Heimaness
Route 3 Box 17
Austin, Minn. 55912
507-433-5698

Three Rivers Dairy Goat Club
Frieda Bruck
Rt. 3 Box 376A
Zimmerman, Minn. 55398

MilleLacs County 4-H Club
Deb Killmen
Rt. 3
Milaca, Minn. 56353

612 Chapter Dairy Goat Club
Tom Larson
7660 W. 280th Street
New Prague, Minn. 56071
612-758-4602

Town & Country Dairy Goat Club
Shirley Cuyler
13995 220th Street East
Hastings, Minn. 55033
612-437-8761