Goat Meat Production in Asia

Proceedings of a workshop held in Tando Jam, Pakistan, 13–18 March 1988
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Editor: C. Devendra
Abstract/Résumé/Resumen

Abstract: This publication presents the results of a workshop held in Tando Jam, Pakistan, 13–18 March 1988, that focused specifically on all aspects of goat meat production in Asia. The workshop addressed the factors affecting meat production (breeding, nutrition, reproduction, sex, management, animal health, and diseases), the nutritional value of goat meat, methods of slaughter, processing techniques, consumer preferences, and the national and international marketing of goats. The detailed discussions on these aspects were further highlighted by country case studies, prevailing situations, issues and policies, and potential for improving the prevailing patterns of production. An important session covered broader issues concerned with research and development, strategies for increasing production, and export potential, especially in Near East markets. These discussions enabled a definition of research and development priorities and the scope for increasing goat meat production.

Résumé: Cette publication fait le compte rendu d’un atelier tenu à Tando Jam, au Pakistan, du 13 au 18 mars 1988 et qui a porté sur tous les aspects de la production de la viande de chèvre en Asie. Il y a été question notamment des facteurs influant sur la production de la viande (sélection des espèces, nutrition, reproduction, sexe, gestion, santé animale et maladies), de la valeur nutritive de la viande de chèvre, des méthodes d’abattage, des techniques de transformation, des préférences des consommateurs et du marketing national et international des chèvres. En plus de discuter de ces questions en profondeur, les participants ont aussi abordé les points suivants : études de cas de certains pays, situations actuelles, enjeux et politiques, et possibilités d’améliorer les tendances actuelles de la production. Lors d’une séance importante, les participants se sont penchés sur des questions plus vastes concernant la recherche et le développement, les stratégies qui permettraient d’augmenter la production et les possibilités d’exportation, particulièrement vers les marchés du Proche-Orient. Ces discussions ont permis de définir des priorités en matière de recherche et de développement et de déterminer le potentiel de croissance de la production de la viande de chèvre.

Resumen: Esta publicación contiene los resultados de un taller celebrado en Tando Jam, Paquistán, del 13 al 18 de marzo de 1988, dedicado específicamente a todos los aspectos de la producción de carne de cabra en Asia. El taller estudió los factores que afectan la producción de carne de cabra (cruce, nutrición, reproducción, sexo, manejo, salud y enfermedades), el valor nutricional de la carne caprina, los métodos de sacrificio, las técnicas de procesamiento, las preferencias del consumidor y el mercado caprino nacional e internacional. Las discusiones detalladas sobre estos aspectos se vieron además enriquecidas con el potencial para mejorar los patrones prevalecientes de producción. Una de las sesiones importantes cubrió los aspectos más amplios de investigación y desarrollo, estrategias para el aumento de la producción, potencial de exportación, especialmente en los mercados del cercano oriente. Las discusiones permitieron determinar las prioridades de investigación y desarrollo así como las posibilidades para aumentar la producción de carne caprina.
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Reproductive factors affecting meat production

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Abstract: The lower growth rate and delayed sexual maturity in female kids as a result of poor nutrition and management or diseased results in a poor kid crop, seriously affecting goat meat (chevon) production. An inadequate plane of nutrition and poor hygiene result in delayed age at first heat of 24, 12–14, and 8–11 months in large, medium-size, and small and dwarf breeds, respectively. Age at sexual maturity in female kids can be reduced by 4–6 months for large and medium-size breeds through improved nutrition and prevention of early intestinal infection. An interkidding period of about 210 days is appropriate but is seldom achieved in large or medium-size breeds. The milk breeds (e.g., Jamunapari and Beetal) have an interkidding period of 310–440 days, which can be reduced to improve kid production. Reproductive disorders causing perinatal kid losses can be divided into occasional uterine infection as a result of pyogenic bacteria, early embryonic loss because of Vibrio fetus and chlamydial infection, late abortions associated with Brucella melitensis and Mycoplasma infections, and stillbirths and kid diarrhoea as a result of Escherichia coli and coccidiosis. The extent of the losses as a result of these reproductive disorders is estimated at 20–30%. The methods available for the augmentation of kidding rates and for the improvement of lifetime reproductive performance (early sexual maturity, reduced interkidding period, and prevention of reproductive disorders) are discussed. The value of artificial insemination and the wider use of superior bucks are emphasized. Other initiatives such as pregnancy detection using milk or blood, the control of reproductive diseases, regular serological tests for Brucella in bucks and does, examination for V. fetus infection to reduce the incidence of abortion, vaccination against Mycoplasma, and early diagnosis of Johne’s disease are essential to reduce perinatal kid mortality. Good hygiene of the sheds used by does in late pregnancy is essential to control E. coli and coccidiosis. The application of improved reproductive techniques requires improved feeding and management of does in late pregnancy. Improvement of reproductive performance at the village level is dependent to a large extent on the training of farmers and good extension services.

Résumé: Le ralentissement du taux de croissance et le retard de la maturité sexuelle des femelles dus à une nutrition et à une exploitation déficientes ou à la maladie entraînent une diminution des portées qui influe sérieusement sur la production de viande de chèvre. Un niveau de nutrition insuffisant et une mauvaise hygiène retardent l’apparition des premières chaleurs à 24, 12 à 14 et de 8 à 11 mois respectivement chez les races de grande taille, de taille moyenne et de taille naine. Une meilleure nutrition et la prévention des infections intestinales en bas âge permettent d’abaisser l’âge de la maturité sexuelle de 4 à 6 mois chez les femelles des races de grande taille et de taille moyenne. Un espacement des mises bas d’environ 210 jours est approprié, quoique rarement atteint chez les races de grande taille ou de taille moyenne. Chez les races laitières (p. ex., Jamunapari et Beetal), la période entre les mises bas est de 310 à 440 jours, mais peut être réduite pour accroître la production de chevreaux. Les troubles de reproduction responsables de la mortalité perinatale sont les suivants : infections utérines occasionnelles causées par une bactérie pyogène, perte hâtive de l’embryon causée par infection à Vibrio fetus ou à Chlamydia parvignatissiae, avortements tardifs causés par Brucella melitensis ou des infections à mycoplasmes, de même que les morts à la naissance et la diarrhée des chevreaux provoquées par Escherichia coli et la coccidiose. Le taux des pertes provoquées par ces troubles de reproduction est d’environ 20 à 30 %. Les méthodes existantes pour augmenter le taux de parturition et améliorer la vie reproductive (précoce sexuelle, réduction de l’espace entre les mises bas et prévention des troubles de reproduction) sont l’objet de discussions. On insiste aussi sur la valeur de l’insémination artificielle et une plus vaste utilisation de meilleurs bucks. D’autres mesures comme la détection des gestations par
l'examen du lait ou du sang, la lutte contre les maladies de reproduction, la régularité des tests sérologiques pour détecter la présence de Brucella chez les boucs et les chèvres, l'examen pour détecter l'infection à V. fetus comme moyen de réduire l'incidence des avortements, le vaccin contre le mycoplasme et le diagnostic précoce de la maladie de Johnne sont essentiels pour réduire la mortalité périnatale des cheveaux. Le maintien d'une bonne hygiène dans les étables réservés aux chèvres en fin de gestation est essentiel pour lutter contre E. coli et la coccidiose. Le recours à de meilleures techniques de reproduction exige d'accorder une alimentation et des soins de meilleure qualité aux chèvres en fin de gestation. L'augmentation du taux de reproduction des chèvres dans les villages est fonction dans une large mesure de la formation des agriculteurs et de la qualité des services de vulgarisation.

Resumen: Un índice menor de crecimiento y una mala reproducción retardada en las hembras en su etapa temprana, como resultado de una mala nutrición y una explotación deficiente o enfermedades, trae como resultado la obtención de una reducida cantidad de cabritos, afectando seriamente la producción de carne de caprinos. Una nutrición inadecuada y una higiene pobre originan, con las primeras temperaturas calientes, un retardo en el crecimiento de 24, 12-14 y 8-11 meses en las razas de tamaño grande, mediano y pequeño respectivamente. La edad de madurez sexual en las cabras se puede reducir en 4-6 meses para las clases de mediano tamaño a través de una nutrición mejorada y la prevención de infecciones intestinales tempranas. Un período interparto de aproximadamente 210 días es apropiado pero rara vez se logra con los ejemplares de tamaño mediano. Las razas lecheras (por ejemplo, Jamunaupari y Beetal) tienen un período interparto de 310 a 440 días, que puede ser reducido para mejorar la producción de cabritos. Los desórdenes reproductivos que causan pérdidas perinatales de cabritos se pueden dividir en infecciones uterinas ocasionales, como resultado de bacterias biogénicas, pérdida embrionaria temprana debido al Vibrio fetus o infección chlamydial, abortos tardíos asociados con infecciones causadas por la Brucella melitensis y la Mycoplasma, y partos con el feto muerto y diarrea de cabritos como resultado de la Escherichia coli y la coccidiosis. El nivel de las pérdidas como resultado de estos desórdenes reproductivos se estima en un 20-30%.

También se discuten aquí los métodos disponibles para aumentar los índices de partos y para mejorar el rendimiento reproductivo de por vida (madurez sexual temprana, período de interparto reducido, y prevención de desórdenes reproductivos). Se enfatiza el valor de la inseminación artificial y un amplio uso de machos cabrinos. Otras iniciativas tales como la detección de la preñez utilizando leche o sangre, el control de enfermedades reproductivas, las pruebas serológicas regulares para detectar la brucelosis en los machos cabrinos y hembras, el examen para detectar la infección provocada por el V. fetus para reducir la frecuencia de abortos, la vacunación contra el Mycoplasma, y una diagnosis temprana de la enfermedad de Johnne, son esenciales para reducir la mortalidad périnatal en cabritos. Una buena higiene en las cabrerizas utilizadas por las cabras hembra en la preñez tardía es esencial para controlar el E. coli y la coccidiosis. La aplicación de técnicas reproductoras mejoradas requiere una alimentación y explotación mejoradas de las cabras en la preñez tardía. El mejoramiento en el rendimiento reproductivo en la aldea depende en gran medida del entrenamiento de los granjeros y de buenos servicios de extensión.

Meat is a product of the slaughter of animals. The higher the reproductive efficiency and production of offspring per unit time, the higher the availability of animals for slaughter. Any factor that repressed reproductive rate is obviously detrimental to the meat industry.

Reproductive factors that repress goat meat production

Breeding season and delayed sexual maturity of female kids

Different breeds of Indian goats are believed to have developed through genetic isolation, adaptation, and natural selection with reference to colour, conformation, fertility, and, possibly, taste of meat. Environment plays an important role in developing reproductive traits in recognized breeds. Certain periods of the year and season modulate reproductive phenomena in goats (Prasad and Bhattacharya 1979). The large and medium-size breeds, e.g., Beetal and most of the northwestern breeds, have a tendency to breed twice during the comfortable
months of the year: February, March, and April and September, October, and November. The Pashmina goats, located 12,000–14,000 ft (3,660–4,770 m) above sea level in the Himalayas, have developed characteristics of kidding only once a year during spring (March, April, or May) befitting the need of the geoclimate. The small and dwarf goats (e.g., Barbari, Black Bengal) reproduce almost year-round (Table 1).

The lower growth rate and delayed sexual maturity of female kids as a result of poor nutrition and management or disease invariably result in a reduced lifetime kid crop and, consequently, a reduced goat meat production. An inadequate plane of nutrition and poor hygiene result in the age of the first heat being delayed to 24, 12–14, and 8–11 months in large, medium-size, and small and dwarf breeds, respectively. Age at sexual maturity of female kids can, therefore, be reduced 4–6 months for large and medium-size breeds by improved nutrition and the prevention of uterine infection.

There are indications that the season of birth has a significant effect on the age of puberty and first kidding. The incidence of multiple births appears to increase with age and reaches a maximum at 5–6 years of age in small and medium-size animals (Bhattacharyya 1982).

Prolonged interkidding period

Ideally, does should be mated within 45–60 days after kidding at the first postpartum heat. An interkidding period of about 210 days should be the target. This target is seldom achieved in large or medium-size breeds. The milch breeds (e.g., Jamunapari, Beetal) often show an interkidding period of 310–440 days (Table 2), which can be reduced to improve lifetime kid production.

Perinatal kid loss

Reproductive disorders causing perinatal kid losses can be divided into occasional uterine infection as a result of pyogenic bacteria, early embryonic loss because of *Vibrio foetus* and chlamydial infection, late abortions associated with *Brucella melitensis* and *Mycoplasma* infections (Dhanda et al. 1959; Pathak 1968), and stillbirths and kid diarrhoea as a result of *Escherichia coli* and *Coccidiosis*. Early embryonic losses can also occur because of thermal stress if mating is induced during the extreme peak of summer. The chronic infection of Johne’s disease appears to interfere and the function of endocrine glands (Singh et al. 1986). The loss as a result of all these complications is estimated to be 20–30% (Table 3).

Augmentation of kidding rate and kid protection

Practices that can increase kidding rate are important for meat production. In recent years, methods have been used experimentally for this purpose (summarized in Table 4). It is possible to improve the lifetime reproductive performance of does by promoting sexual maturity, reducing interkidding period, and controlling reproductive disorders associated with perinatal losses.

Superovulation and synchronization of estrus

The normal ovulation rates of large breeds of goats have not been studied adequately. In dwarf goats, the ovulation rate can be as high as 4.0 (Rao and
# Table 1. Breeding season and sexual maturity of Indian goats.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Breeding season</th>
<th>Age at puberty (days)</th>
<th>Age at first conception (days)</th>
<th>Age at first kidding (days)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbari</td>
<td>Year-round, winter depression and summer peaks</td>
<td>174±13</td>
<td>344</td>
<td>422</td>
<td>Prasad and Bhattacharyya (1979)</td>
</tr>
<tr>
<td>Beetal</td>
<td>Year-round, winter depression and summer peaks</td>
<td>-</td>
<td>375±21</td>
<td>526</td>
<td>AICRP (1985), Misra (1979)</td>
</tr>
<tr>
<td>Black Bengal</td>
<td>Year-round, winter depression and summer peaks</td>
<td>150-330</td>
<td>303</td>
<td>450</td>
<td>Ali et al. (1973)</td>
</tr>
<tr>
<td>Jhakrana</td>
<td>Feb.-May, Oct.-Dec.</td>
<td>450</td>
<td>-</td>
<td>-</td>
<td>Singh et al. (1986)</td>
</tr>
<tr>
<td>Jamunapari</td>
<td>May-Nov.</td>
<td></td>
<td>518</td>
<td>643-849</td>
<td>Singh et al. (1986)</td>
</tr>
<tr>
<td>Malabari</td>
<td>Year-round, winter depression and summer peaks</td>
<td>437±21</td>
<td>469</td>
<td>616±52</td>
<td>Mukundan et al. (1983)</td>
</tr>
</tbody>
</table>
Table 2. Reproductive traits in Indian goats.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Estrous cycle length (days)</th>
<th>Duration of estrus (h)</th>
<th>Gestation period (days)</th>
<th>First post-partum estrus period (days)</th>
<th>Inter-kidding period (days)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angora</td>
<td>19.4</td>
<td>29.7</td>
<td>145.9±0.8</td>
<td>-</td>
<td>450.1±15.9</td>
<td>Shelton (1961), Marincowitz (1962), AICRP (1985)</td>
</tr>
<tr>
<td>Barbari</td>
<td>19±0.4</td>
<td>38±0.9</td>
<td>145±0.3</td>
<td>50.5</td>
<td>238.0</td>
<td>Bhattacharyya (1982)</td>
</tr>
<tr>
<td>Beetal</td>
<td>-</td>
<td>24.0</td>
<td>146.0</td>
<td>-</td>
<td>346.5</td>
<td>K.P. Agrawal and A.K. Goel (personal communication), Kumar (1978)</td>
</tr>
<tr>
<td>Black Bengal</td>
<td>20±1.7</td>
<td>40.5</td>
<td>143.0</td>
<td>61.2</td>
<td>223.8</td>
<td>Ali et al. (1973), Bhattacharyya (1982)</td>
</tr>
<tr>
<td>Jhakrana</td>
<td>18.5</td>
<td>29.6</td>
<td>148.1</td>
<td>-</td>
<td>-</td>
<td>K.P. Agrawal and A.K. Goel (personal communication)</td>
</tr>
<tr>
<td>Jamunapari</td>
<td>17.3</td>
<td>39.1</td>
<td>147.7-148.5</td>
<td>161-223</td>
<td>306-437</td>
<td>Sing et al. (1986), CTRG (1979), Mukundan et al. (1983), Bhattacharyya (1982)</td>
</tr>
<tr>
<td>Malabari</td>
<td>-</td>
<td>-</td>
<td>147.1</td>
<td>65.0</td>
<td>299.0</td>
<td>AICRP (1985)</td>
</tr>
<tr>
<td>Sirohi</td>
<td>-</td>
<td>-</td>
<td>146.4</td>
<td>-</td>
<td>359±21</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3. Perinatal losses in Indian goats.

<table>
<thead>
<tr>
<th>Reproductive diseases/disorders</th>
<th>Incidence of infection (%)</th>
<th>Pregnancy loss (%)</th>
<th>Major causes&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterine infection</td>
<td>17.1</td>
<td>-</td>
<td>Chlamydia, Mycoplasma, Cornebacterium, E. coli, Pseudomonas</td>
<td>Singh (1973)</td>
</tr>
<tr>
<td>Early abortion, embryonic loss</td>
<td>-</td>
<td>23.3</td>
<td>B. melitensis</td>
<td>Kulshresta et al. (1978)</td>
</tr>
<tr>
<td>Late abortion</td>
<td>-</td>
<td>1-1.6</td>
<td></td>
<td>Pathak (1968)</td>
</tr>
<tr>
<td>Stillbirth</td>
<td>20-30</td>
<td>-</td>
<td>Chlamydia, others</td>
<td>Krishna Lal and Rajya (1985)</td>
</tr>
<tr>
<td>Kid loss up to 3 months</td>
<td></td>
<td></td>
<td></td>
<td>Vihan et al. (1987), Jain (1977), Krishna Lal and Rajya (1985)</td>
</tr>
<tr>
<td>0-1 week</td>
<td>39.3</td>
<td>7.7-18.6</td>
<td>Colibacillosis</td>
<td>Vihan et al. (1987)</td>
</tr>
<tr>
<td>1-4 weeks</td>
<td>40.2</td>
<td>11.0-18.3</td>
<td>Colisepticaemia</td>
<td></td>
</tr>
<tr>
<td>1-3 months</td>
<td>10.0</td>
<td>2.2-8.2</td>
<td>Chlamydia, coccidiosis, FMD</td>
<td>Singh and Senger (1979), Vihan et al. (1986)</td>
</tr>
</tbody>
</table>

<sup>a</sup>FMD, foot-and-mouth disease.
### Table 4. Multiovulation and synchronization agents for goats.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Agenta</th>
<th>Supplier</th>
<th>Dosea</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Multiovulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angora</td>
<td>PMSG (Folligon)</td>
<td>Intervet Burns, Omaha, NE, USA</td>
<td>1000 IU</td>
<td>Armstrong et al. (1983a,b), Patil et al. (1984)</td>
</tr>
<tr>
<td></td>
<td>FSH-P (decreasing dose, divided into two at 12-h interval)</td>
<td>Intervet Burns, Omaha, NE, USA</td>
<td>15 and 18 mg</td>
<td>Armstrong et al. (1983a,b)</td>
</tr>
<tr>
<td>Barbari</td>
<td>PMSG, PMSG+hCG</td>
<td>Sigma Chemicals, St. Louis, MO, USA</td>
<td>400-1000 IU</td>
<td>Agrawal (1986), Rao and Bhattacharyya (1986)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sinha (1976)</td>
</tr>
<tr>
<td>Black Bengal</td>
<td>PMSG</td>
<td>Sigma Chemicals, St. Louis, MO, USA</td>
<td>400-1000 IU</td>
<td>Rao et al. (1982)</td>
</tr>
<tr>
<td></td>
<td>Audiovisual, olfactory and coital stimuli</td>
<td>-</td>
<td>Stimuli at 36 h postestrus</td>
<td>Rao et al. (1982)</td>
</tr>
<tr>
<td></td>
<td>Oxytocin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Synchronization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angora</td>
<td>Progestagen (in vaginal sponges)</td>
<td>Upjohn, Kalamazoo, MI, USA</td>
<td>60 mg</td>
<td>Armstrong et al. (1983a,b)</td>
</tr>
<tr>
<td></td>
<td>PGE₂a or analogue MGA</td>
<td>-</td>
<td>8 mg, 11 days apart</td>
<td>Otts et al. (1980)</td>
</tr>
<tr>
<td>Barbari</td>
<td></td>
<td>Upjohn, London, U.K.</td>
<td>0.15 mg/goat, 1 day for 15 or 16 days</td>
<td>Agrawal (1987), Rao and Bhattacharyya (1986)</td>
</tr>
<tr>
<td>Black Bengal</td>
<td>MGA</td>
<td>Upjohn, London, U.K.</td>
<td>0.15 mg/goat, 1 day for 15 or 16 days</td>
<td>Sinha (1976)</td>
</tr>
<tr>
<td>Black Bengal</td>
<td>PGE₂a</td>
<td>Upjohn, London, U.K.</td>
<td>11 days apart</td>
<td>Sanwal et al. (1981)</td>
</tr>
<tr>
<td>Jhakrana</td>
<td>Progestagen (in vaginal sponges)</td>
<td>-</td>
<td>60 mg (medroxy progesterone acetate)</td>
<td>A.K. Goel (personal communication)</td>
</tr>
<tr>
<td>Nondescript (local)</td>
<td>PGE₂a analogue</td>
<td>Upjohn, London, U.K.</td>
<td>100-125 g, two doses 11 days apart</td>
<td>Nandy et al. (1987)</td>
</tr>
</tbody>
</table>

aIU, international units.
The ovulation sequence of some of the polyestrous breeds has been studied (Bhattacharyya and Prasad 1974; Rao and Bhattacharyya 1980). With the advent of drugs (PMSG, Gn-RH, and FSH), the induction of superovulation or multiovulation is possible in large flocks of goats. In practice, the minor problems of seasonal depression in goat breeding could be corrected by the synchronization of estrus with the induction of multiovulation (Table 4).

**Artificial insemination and frozen semen technology**

For a flock of three to five goats, the farmers often do not prefer to maintain a buck. They usually depend on sharing one or two bucks in the village, maintained by a flock owner who may have 10–15 does. These bucks are seldom managed properly and are often subfertile. There is a great demand for fertile, tested bucks among farmers. No government agency is presently undertaking a progeny-testing program for the production of superior bucks for farmers in India; neither is there any farm for rearing bucks with superior genetic merit. Obviously, the value of artificial insemination and the wider use of a limited number of superior bucks is essential. Table 5 provides a comprehensive summary of recommended protocols for artificial insemination in goats using freshly diluted and frozen–thawed semen.

**Early detection of pregnancy**

In the villages, farmers have no means of detecting pregnancy early and often miss the opportunity to promptly mate the does. This delays conception and the interkidding interval. ELISA tests can be introduced in the field to successfully detect pregnancy using milk or blood as biological materials.

**Possibility of year-round breeding**

To avoid kid mortality, farmers of northern India often avoid kidding during the peak of winter and summer and, in this way, restrict the annual kidding rate. Dwarf breeds (e.g., Black Bengal) have the potential to breed twice a year; medium-size breeds, at least twice in 14–16 months. Year-round kidding would, however, be beneficial if kids were protected against the adverse weather of the winter and the summer. The continuous, year-round availability of fertile bucks with the flocks at the village level is the only answer because artificial insemination and frozen semen technology cannot be easily practiced.

**Control of reproductive diseases**

Regular serological tests for *Brucella* in bucks and does, examination for *V. foetus* infection to reduce the incidence of abortion, vaccination against mycoplasma, and early diagnosis of Johne’s disease are needed to reduce perinatal kid mortality. Proper hygiene of the sheds for does in late pregnancy and during kidding is essential, as is the clinical control of *E. coli* and coccidiosis in the flock.

**Practical problems and constraints**

There are several opportunities for improving the reproductive efficiency of goats for meat production. However, there are serious practical problems concern-
Table 5. Recommended method for artificial insemination with freshly diluted and frozen-thawed semen in goats.

<table>
<thead>
<tr>
<th>Fresh semen(^a)</th>
<th>Frozen semen(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Select and train bucks for artificial vagina collection</td>
<td>* Select and train bucks for artificial vagina collection</td>
</tr>
<tr>
<td>* Collect semen on alternate days</td>
<td>* Collect semen on alternate days</td>
</tr>
<tr>
<td>* Evaluate semen for volume, motility, sperm density, percent live, and abnormal spermatozoa</td>
<td>* Evaluate semen for volume, motility, sperm density, percent live/dead, and abnormal spermatozoa</td>
</tr>
<tr>
<td>* Good ejaculate should contain: volume, (&gt;0.3) mL; motility, +5; sperm density, (&gt;3000 \times 10^6); percent live, (&gt;80%); percent abnormal, (&lt;10%)</td>
<td>* Good ejaculate should contain: volume, (&gt;0.3) mL; motility, +5; sperm density, (&gt;3000 \times 10^6); percent live, (&gt;80%); percent abnormal, (&lt;10%)</td>
</tr>
<tr>
<td>* Dilute semen in processed goat or cow milk at (60 \times 10^6) live, normal sperms/milliliter per inseminating dose (0.1 mL)</td>
<td>* Dilute the semen in Tris diluent at (80 \times 10^6) live and normal spermatozoa in 0.1 mL diluted semen</td>
</tr>
<tr>
<td>* Inseminate does in estrus within 2–3 h of collection and dilution; locate the opening of cervix; deposit the semen with inseminating pipette on the opening of the cervix</td>
<td>* Equilibrate glycerolized semen for 4 h at 4-7(^\circ)C</td>
</tr>
<tr>
<td>* Postfreezing evaluation is done by thawing straw directly at 4(^\circ)C for 1 min</td>
<td>* Freeze the straw horizontally in liquid nitrogen vapour for 10 min at a temperature from (-50) to (-170)(^\circ)C</td>
</tr>
<tr>
<td>* Inseminate does in estrus after assembling the inseminating gun with thawed straw and sheath; locate opening of the cervix and deposit semen with the help of inseminating gun on the opening of the cervix</td>
<td>* Plunge the frozen straw into liquid nitrogen (-196(^\circ)C)</td>
</tr>
<tr>
<td>* Note: Expected overall fertility rate with one insemination in each estrus in three consecutive cycles, 70-80%; storage beyond 8 h at 4-7(^\circ)C gives poor sperm motility and fertility</td>
<td>* Note: Expected overall fertility rate with frozen semen and double insemination in one estrus, 30-40%</td>
</tr>
</tbody>
</table>

\(^a\)Source: Tiwari et al. (1968).
\(^b\)Source: Tiwari and Bhattacharyya (1987).

...ing the use of improved methods and the transfer of knowledge to farmers at the village level.

**Distribution pattern of goats in the country**

The goat industry in India depends on the rearing of goats by many farmers below the poverty line and the distribution of products throughout the country. Economic constraints discourage the wide application of known reproduction technology. The problem is associated with farmers who have no resources and
access to common grazing lands. The application of any improved reproduction technique will require supplementary feeding and improved management of the does.

**Lack of farmer training**

Many farmers have a limited knowledge about the sequence of events in the reproduction of goats other than the detection of heat from spontaneous bleating, mounting behaviour, and mucous discharge. This deficiency results in repeated services and prolonged interkidding periods. The care and management of does in late pregnancy is often neglected because of ignorance, resulting in abortions not caused by infections. Training of farmers at the village level would obviously be beneficial.

**Availability of reproduction data**

The farmers do not have the urge or incentive to record reproduction data, which is essential to maintain high reproductive efficiency. This situation must be improved so that the reproductive potential of the goat population may be achieved.

**Availability of health care**

At the village level, there are hardly any specialists who can help with problems of reproduction in goats. Also, the veterinarians or other subordinate staff are inadequate to handle problem cases in the villages.

**Proven bucks and artificial insemination**

The establishment of frozen semen banks and a chain of artificial insemination centres for goats in the country is necessary to ensure improved meat production in goats.

**References**


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