PACKAGE OF PRACTICES

FOR

SCIENTIFIC MITHUN (*Bos frontalis*) HUSBANDRY

ICAR-NATIONAL RESEARCH CENTRE ON MITHUN

(An ISO 9001:2015 Certified Institute)

MEDZIPHEMA, NAGALAND – 797 106

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Citation

L Sunitibala Devi, Harshit Kumar, Sapunii Stephen Hanah, Kobu Khate, Jyoti, Nazrul Haque and Girish Patil, S. (2024). Package of Practices for Scientific Mithun (*Bos frontalis*) Husbandry. Published by ICAR – NRC on Mithun, Nagaland.

Published by

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Design and Printed by:

M/s. Royal Offset Printers, A-89/1, Naraina Industrial Area, Phase-I, New Delhi-110 028

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Preface

It gives me immense pleasure to present this comprehensive "**Package of Practices for Scientific Mithun (*Bos frontalis*) Husbandry**." The endeavor to compile and disseminate this package is to advancing the sustainable Mithun farming practices in the unique agro-ecological landscape of the Northeastern Hilly Region. Mithun, a bovine species native to this region, holds immense socio-economic and cultural significance for the indigenous communities. Recognizing its potential, the need for a structured and scientific approach to Mithun rearing becomes paramount. This package aims to bridge the gap between traditional knowledge and modern scientific practices, offering a holistic guide for semi-intensive Mithun rearing.

The contents of this package have been meticulously curated to cover every aspect of Mithun husbandry, from understanding the distribution and demography to embracing advanced technologies for scientific Mithun production. The inclusion of topics such as breeding, health management and value addition to Mithun products underscores the holistic approach required for successful Mithun farming. I express my gratitude to the dedicated team at ICAR-NRC Mithun, whose collective expertise and tireless efforts have contributed to the development of this package. The collaborative spirit and commitment to the cause of Mithun farming have been the driving force behind this initiative.

I am confident that this package will serve as a valuable resource for Mithun farmers, researchers, and policymakers, fostering the sustainable growth of Mithun husbandry in the Northeastern Hilly Region. It is my sincere hope that the adoption of these practices will not only enhance the productivity of Mithun farming but also contribute to the overall well-being of the communities involved in this age-old practice.

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Foreword

We are delighted to present this comprehensive "**Package of Practices for Scientific Mithun (*Bos frontalis*) Husbandry**" As authors, it has been both an honor and a fulfilling endeavor to contribute to the knowledge base surrounding Mithun husbandry, drawing from a combination of traditional practices and contemporary scientific insights. Mithun rearing holds a special place in the cultural and agricultural fabric of the Northeastern Hilly Region. With a rich history of traditional knowledge passed down through generations, our objective has been to integrate this wisdom with modern, research-backed methodologies. This package is not merely a compilation of guidelines but a holistic approach that encompasses the diverse facets of Mithun farming.

The journey of crafting this package involved a collaborative effort, combining the expertise of researchers, scientists, and practitioners. Each section of this package is meticulously designed to address the intricacies of Mithun rearing, from understanding the distribution and demography to the finer nuances of breeding, health management, and value addition to Mithun products. The inclusion of technologies for scientific Mithun production underscores the commitment to sustainability and productivity enhancement.

We extend our sincere appreciation to the Mithun farming communities, whose deep-rooted knowledge and experiences have shaped the foundation of this package. It is our hope that this resource becomes a guiding light for farmers, empowering them with the tools needed to enhance the efficiency and profitability of their Mithun farming practices. As authors, we envisage a future where this package serves as a catalyst for positive change in the Mithun farming landscape. May it contribute to the prosperity of Mithun farmers, the preservation of cultural heritage, and the overall development of the Northeastern Hilly Region.

Authors

1. INTRODUCTION

Mithun (*Bos frontalis*) is a unique bovine species believed to have originated 8000 years ago. It belongs to the family Bovidae, order Artiodactyla and class Mammalia and has 58 chromosome number. The unique characteristic which differentiate Mithun from rest of bovine species include its ash colour broad fore head, large horns, black body coat and white stocking. However, white body coat and complete black body coat animals are also available in different parts of Arunachal Pradesh and Manipur. In Nagaland, majority of Mithuns are black coat with white stocking. They are found in four northeastern state of India namely, Arunachal Pradesh, Nagaland, Manipur and Mizoram. They are mainly reared for meat purpose, however has the potential for milk and draught as well. This animal plays significant role in socio-economic and cultural life of the population of the north-east India. The rearing practice is mainly free range system where the animals are reared in community grazing land. However, ICAR-National Research Centre on Mithun is popularising the semi-intensive system of rearing Mithun. This system helps in managing the Mithun in a scientific manner. With the declaration of Mithun as food animal by the Food Safety and Standards Authority of India (FSSAI) in 2023, there is opening of huge entrepreneurial opportunity of this animal in meat and milk sector. The incorporation into the Domestic Animal Diversity Information System (DAD-IS) of the Food and Agricultural Organization (FAO) represent a significant milestone. This recognition underscores the importance of Mithun in the culinary landscape and opens new avenues for its utilization and conservation. The management of Mithun scientifically in semi-intensive system will help farmers in improving the productivity of animals. The farmers should never negotiate the managemental practices required for better productivity, such as housing, breeding, feeding, health care etc.

2. DISTRIBUTION AND DEMOGRAPHY

Mithun inhabit a major portion of Southeast Asia. The world's highest concentration of Mithuns is distributed throughout India's Northeast (NE) area, with Arunachal Pradesh having the most Mithun population. The altitude range in which the Mithuns are found is 300–3000 metres above mean sea level. They prefer a cooler environment and try to avoid bright sunlight. However, Mithun are also being reared successfully in different regions with tropical regions like Assam, Kerala, Maharashtra, Kerela, West Bengal and Gujarat.

Mithun are also found in Bangladesh, Myanmar, China and Bhutan. As per the 20th Livestock Census India has 3.86 lakhs with 90% of population in Arunachal Pradesh followed by Nagaland, Manipur and Mizoram. Recent census indicated a positive growth of Mithun population

Table: Recent Trends in Population of Mithun in India

State	2003	2007	2012	2019
Arunachal Pradesh	1,84,346	2,18,931	2,49,000	3,50,154
Nagaland	40,452	33,385	34,871	23,123
Manipur	19,737	10,024	10,131	9,059
Mizoram	1,783	1,939	3,287	3,957
TOTAL	2,46,315	2,64,279	2,97,289	3,86,293

3. TRADITIONAL MITHUN REARING PRACTICES IN NEH

Traditionally, Mithun animals are reared in a free-range system in forest areas without any additional housing or feeding facilities. Often, farmers bring back their female Mithun right before parturition and then return them to the forest after giving birth. The boundaries for grazing areas are typically demarcated by the presence of streams, lakes, and ponds. Fencing of these grazing areas is usually done with locally available materials such as bamboo, wood, or stones. Once the fencing is completed, all the animals are herded into this area for grazing.

Rotational grazing for Mithun is practiced in Jhum cultivation areas. Farmers alternate cultivation of the land for 8–10 years as part of the rotational grazing practice in Mithun ranges. This method offers benefits in reducing the harm that Mithun and other grazing animals pose to agricultural activities. Mithun owners assign a few individuals, either men or boys, to look after the Mithun. They are responsible for containing the animals within the fencing, cutting fodder trees for Mithun, repairing any damaged fences, and taking care of sick animals. These caretakers typically stay in makeshift shelters constructed in the jungle. They provide salt for licking on stone slabs or available wooden structures near their shelters. In return for their services, they are compensated with cash, rice, paddy, or a young calf of the Mithun.

In Mithun grazing areas, leaching of mineral elements frequently occurs in steep hilly slopes, particularly during the wet season. Consequently, the soil in a particular hilly grazing area may lack some essential mineral elements. This deficiency can extend to the plants in that area, leading to mineral deficiencies in the animals. Mineral supplements are the primary solution to this problem. However, the natural way for these animals to obtain the necessary minerals is through their behavior of licking salt and drinking from sources of mineral water in the hills.

Figure: Bio-fencing of Mithun grazing area with bamboos, plantation and boulders

4. UTILITIES OF MITHUN

Mithun has been an integral part of the culture and livelihoods of tribal communities in North-East India. Mithun had been used as a meat animal and for barter trade since long. However, it is having high potential for milk and draught potential as well.

4.1 Meat Production

Mithun meat is highly preferred by the consumers in north-eastern region. The demand of meat is very high which gives tremendous opportunity to Mithun animal farmers. Mithun is mostly reared in the forest grazing areas without any supplementation from its owner except for salt. The meat produced from such animals is naturally organic. Mithun meat also known as **"wishi"** is a lean and nutritious source of protein, making it a valuable commodity for income generation. The growth rate of this animal is comparable to that of cattle and buffalo and varies from 450-600 g/day under adequate managemental condition. Different products prepared from Mithun meat includes, Mithun nuggets, meat balls, sausages, pickle, etc.

Table: Proximate Composition of Mithun meat

Composition	% ± SD
Moisture	73.66±0.35
Protein	23.87±0.86
Fat	0.66±0.10
Ash	1.07±0.04

Figure: Value added Mithun meat products

4.2 Milk Production

Female Mithun produces approximately 1.5 to 2 kg milk per day. However, among the herd some good milking animals were also present which produces as high as 3 kg/ day. While their milk production doesn't match that of traditional dairy cattle, it stands out for its exceptional nutritional value, boasting high levels of fat, protein, and solid-not-fat (SNF). This nutrient-rich milk serves as a key ingredient in various dairy products such as paneer, lassi, rasgulla, among others. It is crucial to tap into the underutilized milk production potential of Mithun to its maximum capacity, ensuring the health and nutrition of farmers and, consequently, contributing to the overall well-being of the country. Mithun milk stands as an ideal base for crafting various dairy products, with a single litre capable of yielding approximately 200 grams of high-quality paneer and 3 lit lassi. The versatility of Mithun extends beyond paneer to encompass the preparation of diverse dairy items such as curd, lassi, rasgulla, and more. Notably, Mithun milk is rich in polyunsaturated fatty acids, essential amino acids, and key vitamins (A, D, and E), along with a significant calcium content (Devi et al., 2023). Nevertheless, the primary challenge on the horizon is the optimal exploitation of the milk production potential inherent in this unique bovine species. This necessitates the implementation of a scientific management system, carefully considering economic aspects. By adopting an efficient and strategic managerial approach, we can unlock the full spectrum of benefits offered by Mithun milk

Table: Proximate composition of Mithun milk

Particulars	Mean ± SE
Fat (%)	7.3 ± 0.48
Solids-not-Fat (%)	10.28 ± 0.13
Protein (%)	4.0 ± 0.05
Lactose (%)	5.7 ± 0.08
Density (g/mL)	1.20 ± 0.01

Figure: Mithun milk products

4.3 Draught Power

Mithuns are renowned for their strength and endurance, making them excellent draught animals. They are utilized for ploughing fields, transporting heavy loads, and engaging in various other agricultural activities. Their contributions in these roles significantly enhance agricultural productivity and reduce the manual labour involved in farming. The draught power of a particular species largely depends on the animal's anatomical structure and specific physiological tolerance to fatigue. It is believed that a heavier animal possesses more pulling capacity compared to a lighter one. In the northeastern hilly region of India, a considerable portion of cultivated land is under Jhum cultivation. However, agricultural experts discourage the Jhum system, and in many areas, farmers have adopted terrace cultivation.

In this region, under the terrace cultivation system, cattle and buffalo bullocks are the animals of choice for ploughing. Nevertheless, considering some of the unique features of Mithuns, such as excellent climbing capacity on steep hill slopes, substantial body size, and well-developed physiological adaptability in the North-East hill ecosystem, this species can serve as a valuable draught animal.

Studies conducted on Mithun bullocks indicate that they can be efficiently used for ploughing and carting operations without showing signs of fatigue. However, the fatigue level of the animal depends on its training and the duration of work. Proper training is essential before any operation. The animal chosen for draught purposes should be selected and castrated to ensure docility while handling, typically before the age of 1-1.5 years. The training process usually takes 1-2 months and involves acclimatizing the animal to the yoke on its neck and various pulling activities. They should be trained to obey commands such as stop, start, turn left, and turn right.

Mithun animals being used as draught animal (Bullock cart)

Mithun animals being used as draught animal (Ploughing the fields)

Figure: Draught abilities of Mithun in the field conditions for carting and ploughing

4.4 Leather Production

The potential for producing superior quality leather from Mithun hides represents a valuable addition to the traditional Mithun rearing system. In collaboration with the Government College of Engineering and Leather Technology, Kolkata, ICAR – National Research Centre on Mithun, Nagaland has delved into the prospect of manufacturing Mithun leather. Preliminary studies have revealed that leather goods processed from Mithun hides surpass their counterparts made from other bovine hides. Notably, leather bags, shoe upper leather, and garment leather derived from Mithun hides exhibit outstanding quality and stand as promising substitutes for conventional leathers.

With proper management and veterinary care, the production of Mithun hides becomes an essential value addition for farmers. The Institute has already been granted four patents for its innovative leather processing technique, showcasing our commitment to advancing this sector and contributing to the economic prosperity of those involved in Mithun rearing.

Leather bag made from Mithun hide

Leather shoes made from Mithun hide

Figure: Leather products made out of the Mithun hide

5. IDENTIFICATION OF MITHUN

Identification of animal is one of the main management aspects for systematic records of all the available animals with the owner for keeping accurate production records of herds. Proper identification will prevent any dispute arising for the ownership of animals. Mithun are traditionally identified by typical ear notching by their owner. Individual owner has his own unique style of cutting ear of Mithun on one ear or both with one or more cuts. However, this method is not the scientific way of identification of animal with higher chances of manipulation by some farmers.

Recommended method for identification of Mithun is by ear tagging. The plastic ear tags with blank or pre numbered one is the most commonly used ear tags. The individual owner has his own records of ear tag number so that in some instances of ear tag loss they can replace it with the same number. The tags are pierced through the ear avoiding any major vein properly by ear tag applicator. Other identification methods include micro chipping of Mithun animals or through muzzle biometrics. Identification of animal should be done as early as possible. Other methods available for Mithun identification are tattooing, nose printing, radio frequency identification device (RFID), etc. However, ear tagging is the most commonly used method for Mithun identification. In the year 2017, Government of India has implemented unique animal identification system for livestock across the country. As per this, livestock are identified using the visible cum bar coded yellow coloured ear tags containing 12 digit unique number. These tags are provided free of cost and can be collected from the Livestock Development Boards of their respective states. After registration, information pertaining to each animal is uploaded on to the Information Network for Animal Productivity and Health (INAPH) database managed by National Dairy Development Board (NDDB), Anand, Gujarat. Mithun farmers can take the help of nearest veterinary hospital for getting the bar coded tags, tagging and uploading the information on to the INAPH database.

Figure: Ear tagging of Mithun with ear tag applicator

6. HOUSING MANAGEMENT

Generally, Mithun are reared under semi domestication system wherein they are allowed to graze and live in forest without any housing. ICAR – National Research Centre on Mithun, Nagaland has established and is promoting a semi-intensive system of rearing in which the animals are allowed to graze but return to night shelter at the end of the day. Night shelter gives a place to Mithun to rest during inclement weather conditions. Further, any animal showing symptoms of diseases can be attended to. Pregnant animals can be segregated and calves can be taken care of. Night shelters can be arranged using the locally available bamboo and other forest derived materials. Feeders can be arranged for providing supplementary feeding. For augmenting the productivity of Mithun, there is a need to move the Mithun production from open grazing system to semi-intensive system. Under existing system of free range rearing, farmers do not have the opportunity to monitor the health and animal nutritional status for better productivity. As a consequence, the productive and reproductive ability of animal are likely to be compromised. Considering the availability of huge forest grazing area in the northeastern hilly region, adopting semi-intensive system is probably the most suitable alternative for practical and profitable Mithun production. Intensive Mithun production can also be practiced in areas where grazing lands are scarce. However, growing and providing fodder to Mithun is an essential requirement for ensuring profitability.

For effective housing management, the following factors must be taken into account:

- The shed should be constructed on a raised ground to prevent water logging
- To reduce the cost, locally available materials can be utilized
- Proper fencing of the grazing area must be ensured to prevent Mithun from straying into the crop field
- The shed should be cleaned from time to time by disposing the dung and urine properly
- Shelter area should have manger for feeding of concentrate/ roughage/ mineral mixture/ salt and waterer of adequate capacity

Floor space required for bovines as per the Bureau of Indian Standards (BIS) is given in Table below. Exclusive standards for Mithun housing have not yet been developed. In the absence of the exclusive Mithun standards, the standards available for bovine can be followed.

Table: Floor space requirement for bovines

Category	Covered area (m^2)	Height of the shed (cm)
Young calves	1	175
Growing males and females	2.0	200
Adult cows	3.5	200
Down calver	12	200
Bull	12	200

(Reference: IS 6027-1970, Thomas and Sastry, 1991)

Feed and water trough may be made of wooden planks, bricks lined with cement concrete. The surface of the trough should be rounded and smooth. The dimensions of feed and water trough should be such that animal will have comfortable access to feed and water. Space requirements for feed and water trough for adult and calves as per BIS is 60-75 cm and 40-50 cm space per animal respectively.

Figure: Semi-intensive housing in farm setting

Figure: Semi-intensive housing in field setting

Figure: Semi-intensive housing model

7. HANDLING AND RESTRAINING OF MITHUN

The goal of animal handling is to employ deliberate techniques and safe handling facilities to reduce the stress and enhance animal welfare. Handling farm animals involves using techniques that allow a handler to understand and respond to the inherent behaviour of livestock. These techniques have been refined over the time because proper animal handling is an essential tool for preventing injury to both the animal and the handler. The stockman should always grasp the temperament of the animal (how an animal may react to handling) as it is one of the most important tools in handling any farm animal. Good stockman-ship begins with a calm demeanour, it is important to note that all livestock can be trained and acclimatized to human interaction. When handling animals, it's best to use low-stress techniques to encourage a positive handling experience. Animals that have previously experienced stressful handling will need more time to become accustomed to these techniques. Nonetheless, low-stress animal handling is essential for improved productivity and the well-being of animals in all livestock operations.

7.1 Body Parts of Mithun and Basics of Handling

First and foremost, the animal health worker must understand the various body parts of the animals.

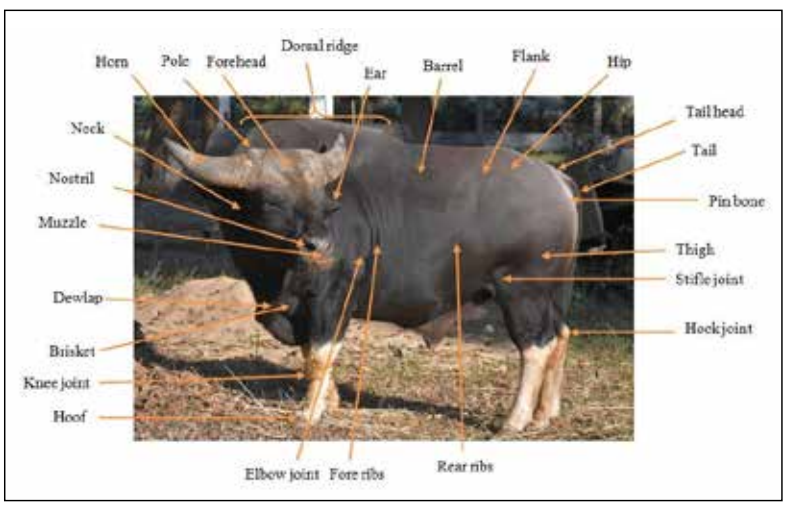

Figure: Body parts of Mithun

7.2 Reasons for Handling of Mithun

Mithun are typically handled or restrained for various purposes, as outlined below:

- Physical examination
- Administration of medicine and vaccines
- Artificial Insemination
- Performing operations like wound dressing and castration, etc.

7.3 Techniques for approaching the farm animals

Understanding the correct approach to animals is crucial for their safe handling. As explained in previous sessions, most large animals have a wide field of vision, but there is a blind spot directly behind their hindquarters. Any movement in this blind spot area can make the animal uneasy and nervous. The following aspects should be taken into consideration when approaching large animals.

- Before approaching an animal, ask the attendant or the owner whether the animal is docile or aggressive.
- Never carry a stick when approaching an animal.
- If possible, call the animal by its name and approach it preferably from the left side.
- Gently pat the animal while using its name or familiar words.
- Most large animals kick in an arch, starting from the front and moving toward the back. Avoid this kicking region while approaching the animal.
- When approaching an animal that appears excited or fearful, they will look in the direction they intend to go and may move toward their point of escape; therefore, the handler should maintain a safe distance.
- Handlers should remain vigilant at all times to avoid injury to themselves and the animals, including:
    - Head butting and arc of swing.
    - Being caught between the animal and a solid structure (e.g. wall, fence, chute etc).
    - Avoiding being kicked or stepped on, including:

- Front foot pawing.
- Hind foot swinging forward and backward to the side (cow kick).
- Direct head butt.

7.4 Restraining of Individual Animal

The following precautions should be observed while restraining animals:

- Always announce your presence when approaching the animal and gently touch it if possible
- If the animal tends to kick, consider using a rope. Do not allow workers to speak loudly, as even gentle animals can become dangerous when defending their territory or young calves
- Special care is needed when handling pregnant animals and breeding bulls. Handlers should never come into direct contact with a breeding bull
- Animals can be challenging to handle if they are forced to behave in ways that are unnatural for them

7.5 Restraining Particular Body Parts of Animals

Various tools and methods are employed to gain control over the necessary body parts of animals. The different techniques for restraining specific parts of an animal are outlined below.

Restraining of the head region

To manually restrain the head region, grasp the lower part of mouth (mandible) by one hand and hold the base of the ear with the other hand and slightly turning the neck of animal. This method will secure the head of young animal.

Figure: Restraining head of a young Mithun

Restraining of the fore leg

The foreleg of the Mithun is raised and held off the ground for examination or treatment. Raising the foreleg also helps control the movement of the animal and hinders its kicking with the hind leg.

Figure: Restraining of fore leg of Mithun

Restraining of tail to divert animal's attention

For this purpose, the animal worker stands on the side or back side of the Mithun keeping a distance of 2-3ft to avoid being kicked. The animal handler holds the end portion of the tail (tail switch) and raises it as much as possible, as shown in the picture below. The grip should be gentle but firm. Restraining the tail is necessary to divert the Mithun's attention from another part of its body, especially during operations.

Figure: Tail restraining in Mithun

Restraining of Mithun using Travis

This restraining device is suitable for bovines having large horn like Mithun due to its adjustable iron rode. This

Figure: Restraining of Mithun using Travis

device will help in easy control of animal for vaccination, health inspection and any other treatment or sample collection.

7.6 Casting of Mithun

Casting a Mithun involves causing the animal to fall to the ground. Animals are cast for various reasons, such as surgical operations, hoof trimming etc. to prevent accidents during handling. In a large farm, a casting pit or casting ground is established to avoid injuries during the animal casting process. The casting pit is typically a circular area with a diameter of about 8 meters, filled with bedding materials like sand, wheat straw, sawdust, etc., or a casting ground can be developed. It is essential to ensure that sharp or piercing objects are never left in the area.

As a precautionary measure, animals are usually fasted for 12 hours before casting to prevent injury to distended digestive organs. Casting pregnant animals should be avoided.

7.6.1 Casting Methods

Figure: Depiction of casting ground and casting pit filled with bedding material for Mithun casting

The following are the two commonly used methods for casting of large animals

7.6.1.1 Reuff's Method

This is the most common and efficient method for casting large animals. To execute this method, you will need approximately 30 feet of rope, and you should follow these steps:

- Create a loop around the animal's neck using a bowline knot, positioning

it as shown in the pictures.

- Throw the rope's end over the animal's back to the opposite side.
- Take the rope from under the animal and wrap it around its body near the bowline, forming a half hitch just behind the shoulder.
- By tossing the end over the animal's back, create another half hitch just in front of the udder or scrotum in the case of males.
- Gently pull the rope to cast the animal.

Figure: Reuff's method of casting down a Mithun

7.6.1.2 Burley Method of Casting

The following steps are involved in this method,

- Divide the rope into two equal parts.
- Place the middle portion of the rope on the upper side of the animal's neck.
- Cross the free ends of the rope under the neck.
- Pass both free ends of the rope between the front legs in a backward direction on either side of the animal.
- Cross the free end of the rope over the back of the animal and subsequently pass it through the area between the udder or scrotum (in case of males) and hind legs.
- When the rope is pulled in the backward direction, the animal is cast to the ground.

Figure: Burley's method of casting down a Mithun

8. FEEDING

Mithun is entirely dependent on pasture land and jungle fodder in the traditional system of rearing. Nutrient requirement of Mithun is mostly fulfilled with available fodders in the jungle with the provision of salt to the animals for licking. For proper growth, feeding the animal with the best quality feeds and fodder is essential. Green fodder should be supplied in ample quantity under the semi-intensive system of Mithun rearing. Voluntary intake of natural pastures with high nutritive value can maintain Mithun with a growth rate of 400-500 gm daily and no supplementary concentrate feeding is required. However, the quantity and quality of natural jungle fodders during dry season are comparatively low. Additional concentrate feeding @ 2 kg/day/adult animal is recommended if animals are maintained solely on grazing. Nutritional requirement is high during the last trimester of pregnancy, peak growth and early lactation. Therefore, suitable concentrate mixture supplemented with mineral and salt should be fed to the animals during these stages.

8.1 Feeding of growing animals (From 6 months onwards)

For calves below one year of age it is always desirable to give sufficient concentrates in addition to good roughage so that they make optimum growth. Feeding concentrate can be considerably reduced in the case of calves over one year of age fed on high quality roughage. A judicious mixture of roughage and concentrate is essential for obtaining optimum growth without undue fat deposition. From six months onwards, calves can be given the same type of concentrate mixture (14-16% Digestible Crude Protein and about 70% Total Digestible Nutrients) as used for adult cattle. Examples of concentrate mixtures are given separately.

Table: Feeding schedule of growing animals from 6 months onwards when fodders are abundantly available

Age (months)	Approximate body weight (kg)	Concentrate mixture (DCP-14%, TDN-70%) (kg)	Green fodder (kg)
6-9	70-100	1.5-1.75	5-10
9-15	100-150	1.75-2.25	10-15
15-20	150-200	2.25-2.50	15-20
Above 20	200-300	2.50-2.75	15-20

Table: Feeding schedule of growing animals from 6 months onwards when fodders are not abundantly available

Age (months)	Approximate body weight (kg)	Concentrate mixture (DCP-16%, TDN-72%) (kg)	Paddy straw (kg)	Green fodder (kg)
6-9	70-100	1.5-1.75	1-1.5	2-3
9-15	100-150	1.75-2.25	1.5-2.0	3-4
15-20	150-200	2.25-2.50	2.0-3.0	4-5
Above 20	200-300	2.50-2.75	3.0-4.0	5-7

- Good quality roughage saves concentrates. Approximately 20 kg of grasses (guinea, Congo signal, napier, etc.) or 6-8 kg legume fodder (cowpea, rice bean, lucerne) can replace 1 kg of concentrate mixture (0.14-0.16 kg of DCP) in terms of protein content.
- 1 kg straw can replace 4-5 kg of grass on dry matter basis. In this case the deficiency of protein and other nutrients should be compensated by a suitable concentrate mixture.

Feeding of heifer

Heifers are growing animals and so the requirements for growth is of higher order than for more maintenance during early stage relatively more protein is required than energy. Most young heifers grow well if excellent hay is given as much as they eat. The amount of growth depends upon the quality of forage in unlimited amounts. Feed ad libitum of green fodder so that the animal gets enough carotene. If leguminous fodders are fed it gives enough calcium, and other minerals. When the heifer is fed with ad libitum of roughages and concentrates, now and then check for its growth. Fat animal should be discouraged and feeding is practice to become non-fat animal.

The heifer with pregnancy should be fed very carefully, because the - animal is still growing and for compensation for the growth of the foetus. An extra amount of 1.215 kg to 1.75 kg concentrate may be provided to allow the growth of the foetus normally. 6 weeks before calving 2-3 kgs of concentrates should be given. Laxative -feeding should be given from two weeks before calving which prevents consumption and difficulty in parturition.

Feeding milch and pregnant animal

A female mithun needs feed for maintenance, for development of foetus and for milk production. Besides in the first lactation a female mithun may be growing and producing simultaneously so that allowances for growth have to be in corporate

over and above requirement. Therefore the first step in feeding a female mithun is to calculate the total requirements as per the standards. A female milking mithun may be fed with 1 kg concentrate mixture for every 2 kg milk produced. Actual feeding may be done on the basis of requirements calculated as per feeding standards. Individual computation for daily feeding of cows in impracticable. Therefore certain thumb rules are widely employed. It is common practice to feed grains at the time of milking, and roughages after milking. This causes changes in digestion. The remedy in concentrates should be mixed with roughages or after the animal has consumed certain amount of forages.

Feeding of bulls: Male calves to be reared as future breeding bulls, should be fed on a higher plane of nutrition than female calves.

Table: Feeding schedule of bull

	When green fodder is plenty		When paddy straw is the major roughage		
Body weight (kg)	**Concentrate mixture (kg)**	**Green grass (kg)**	**Concentrate mixture (kg)**	**Green fodder (kg)**	**Paddy straw**
400-500	2.5-3	20-25	3	5	6

A bull in service should be given good quality roughage with sufficient concentrates. Too much roughage feeding should be avoided as it makes the bull paunchy and slow in service. A large concentrate allowance may make the bull too much fatty and less virile

8. 2 Points to be considered for feeding of Mithun

- Feed the animals with good quality feeds and fodders
- Dry matter requirement is calculated @ 2.5 kg per 100 kg body weight
- This may increase or decrease based on the rate of its body weight gain/ physiological age or production, etc.
- Water should be available round the clock for drinking
- Wherever possible fodder plant should be planted
- In case of non-availability of green fodder, animals must be supplied with dry roughages like straw
- Chaff the roughages into 1-4 cm length before feeding
- If available concentrates should be supplied for improving the body condition of animals

- Vitamins and minerals should be provided for better health, production and reproduction of animals either mixed with feed or as mineral lick in the form of mineral block
- Salt licks should be provided besides vitamins and minerals under the shed constructed either permanently or temporarily
- Abrupt changes in feed should be avoided

Table: Concentrate Mixture composition

Ingredients	Parts (Kg)
Wheat Bran	35
Rice Polish	25
Maize	20
Mustard oil cake	18
Mineral Mixture	1
Salt	1
Total	**100**

Table: Mineral mixture composition

Ingredients	Parts (Kg)
Dicalcium Phosphate	41.516 kg
Common salt	49.58 kg
Manganese Sulphate	4.61 kg
Copper Sulphate	3.987 kg
Cobalt Chloride	23.0 gm
Sodium Selenate	21.68 gm
Total	100 Kg

Mineral Block

In order to prevent any spoilage of mineral mixture due to spreading over the rocks/ boulders while feeding Mithun this technology was developed. This will help in controlled release of minerals during licking and also reduced competition among the animals.

Figure: Mineral Block developed by ICAR – NRC on Mithun

Mineral dispenser

The developed device has several features combined into one

single unit, catering to the need of livestock owners, for supplementation of mineral mixture to animals. This device will prevent the mineral block from rain. This device is portable, durable, and affordable and will be beneficial for different category of animal due to its adjustable height viz. Goat, gazelle apart from Mithun.

Figure: DeSave mineral block dispenser Figure: Adjustable mineral block dispenser

Feed Chopping

The green and dry fodder should be chaffed 1-4 cm length before feeding which will improves its digestibility.

Figure: Feed Chopping

Feed blocks – Paddy straw and brewery waste

There is scarcity of fodder and feed for animals during the winter season in this region, which adversely affected the growth, production and reproduction of animal (Mithun). However, there are plenty of fodders, tree leaves, grasses available in this region during rainy season, which can be preserved by different technologies and can be used during the scarcity period. The feed blocks were made from locally available feed ingredients. Tree leaves, straw and concentrate feed were mixed together and pressed by using feed block making machine. Complete feed block were developed for better growth and production, reduced

Figure: Chopped feed

dustiness, improved palatability as well as digestibility of nutrients, thereby increased the productivity in Mithun for higher income.

Figure: Feed blocks

8.3 Fodder production

- Fodders like napier, congo signal, guinea grass, maize fodder are some of the green forages which grow well in northeastern hilly soil
- Production potential: Napier, Congo signal and Maize – 25, 16 and 5 tons/ha/year on fresh basis which corresponds to dry matter production of 6.24, 4 and 1.24 tons/ha/year, respectively
- However, this forages are available for 6 months only from May to October but it could be harvested and preserved for feeding animals during lean period
- *Ficus hookerii*, *Ficus hirta*, *Bauhinia* sp., bamboo grass, broom grass can be used in winter season
- During the early phase of plantation fruits trees like orange, avocado, guava and lemon can be intercropped with bajra X napier hybrid, golden timothy grass, guinea grass, rice bean, fine stylo and maize

Figure: Depiction of figures for concentrate mix, Ficus hirta, and Hybrid napier grass used for Mithun feeding

Figure: Fodders being grown in fodder museum developed at ICAR – NRC on Mithun

9. BREEDING

Successful livestock farming utilizes animals to convert basic ingredients into marketable commodities that worth more than the total cost of production. All animal products are obtained through the exploitation of reproductive processes; therefore, efficient reproductive management is an integral part of the efficient livestock rearing systems. For economically viable production systems, a practical breeding management system should be developed to maximize reproductive efficiency to the extent that can be justified economically.

Knowledge of estrus behaviour is very important for proper reproductive management. However, the expression of estrus behaviour in Mithun is silent which makes it difficult to detect heat in Mithun through visual observation. The most commonly observed signs out of all behavioural estrus signs are mounting of Mithun bulls over estrus cows followed by standing to be mounted by Mithun bull. Some of the estrus behaviour like bellowing, mounting over herds mate, swelling of vulva and chin resting by the bull were completely absent in Mithun unlike other bovine species.

9.1 For proper breeding management, the following factors should be taken into account:

- Mithun can be bred throughout the year but winter and spring are the favourable seasons for breeding
- The biggest and best bulls should be saved as breeding bull and should not be sold or sacrificed at any cost
- Efforts should be made to replace breeding bulls preferably once in five years to avoid inbreeding in the herd. Alternately, bulls from neighbouring villages/ communities can be exchanged at a regular interval, preferably in a cycle of 1-2 years
- Keep all the records of calving date, onset of heat, duration of heat, conception, etc.

- Observe the animals closely for signs of heat like swollen vulva with congestion of mucus membrane, vulval discharge, mounting other animals and standing to be mounting, showing interest in bull
- Estrus detection can be done with the help of teaser bull (vasectomized bull) through bull parading. Teaser bull will mount the Mithun animal in estrus.
- Artificially inseminate with good quality proven semen or select the superior bull from the herd for breeding
- Breed the animal 12 to 24 hours after the onset of estrus and based on cervical mucus consistency at least 2 times at 12 hours intervals
- Timely breeding will help in achieving conception within 2 to 3 months of calving
- Observe the animals carefully after insemination or mating for occurrence of heat which will indicate failure of conception
- The animal will comes in estrus if not conceived within 19-23 days
- Do not breed animals before 60 days from the date of parturition.
- Adopt nominating bull method. Only one bull will be allowed to roam with the females in the grazing field for a period of 4-5 months and a gap of at least one month before allowing a new bull to ensure that sire of the progenies would be known.

Figure: Mithun bull mounting on Mithun female

- Introduction of new seeds from authentic sources and exchange of bulls among the Mithun rearing villages may be adopted for controlling inbreeding depression.
- Artificial insemination could be a suitable alternative.

9.2 Artificial insemination in Mithun

Artificial insemination (AI) is a technique in which semen is collected from a mature, healthy and fertile male and deposited into the female genital tract at a proper time by using AI instruments. The major advantage of AI over natural mating is that it

allows farmers to use proven sires which help in genetic improvement of his herd and also preventing venereal diseases. As a thumb rule animal coming in heat in the morning should be inseminated in the next morning and those coming in evening should be inseminated in the next evening. Mithun will remain in heat for 36-72 hours and it should be inseminated 24 hours after the onset of heat symptoms at least 2 times at an interval of 12 hour.

Figure: Artificial insemination being practiced in Mithun

10. HEALTH

Management of herd health is a very important aspect of profitable livestock entrepreneurship. Basic knowledge of the disease prevalence of a particular livestock species in a defined geographical area is required for effective prevention and control of diseases. In order to minimize the economic loss due to health-related disorders, such information is an important tool for initiating preventive steps. Mithun animal suffers from various infectious and non-infectious diseases. Foot and mouth disease (FMD) is the most prevalent viral disease among those, and some livestock species are more susceptible to FMD than others. Leech (*Hirudinea spp.*) infestation is also common in Mithun. For the treatment of leech infestation application of common salt solution in nasal cavity or inhalation of ether or ivermectin injection is suggested.

10.1 For proper health management, following points should be taken into account

- Animals should be carefully observed for any signs of illness such as reduced feed intake, fever, abnormal discharges and any unusual behaviour
- Segregate the sick animals from the healthy one during outbreak of a contagious disease
- Consult the nearest veterinary facility for help if any illness is suspected
- Undertake faecal examination regularly. Animals with worm load must be administered with the deworming agent. Generally, animals are dewormed once every six months
- Regular vaccination should be conducted for common diseases like FMD, HS, BQ during pre-and post-monsoon
- Keep records of any mortality in the herd with symptoms

Figure: Treatment and vaccination procedures for FMD disease in Mithun

Table: Vaccination schedule of Mithun

Disease	Vaccine (Trade Name)	Dose & Route	Primary Vaccination (Age at 1st vaccination)	Booster (1st revaccination)	Revacci-nation
Foot and Mouth Disease (FMD)	Raksha Trivalent FMD	3 ml S/C	4 months	2-4 weeks after 1st vaccination	Every 6 month
Haemorrhagic septicaemia (HS) & Black Quarter (BQ)	Raksha HS+BQ	3 ml S/C	6 months and above	-	Annually

10. 2 Pasture management and Ecto-parasitic control.

- Availability of good pasture is important for livestock rearing under free range and semi-intensive systems.
- Farmers are encouraged to practice rotational grazing on their farms during monsoon season (moving livestock to another pasture before over-grazing)
- Practice of pasture rotation with interval of one month for one section of pasture can prevent overgrazing, aid optimal re-growth of plants and allow the same piece of land to be grazed several times.
- Pasture rotation also contributes to control of parasitic infestation like leech, ticks etc.

Health calendar

Mithun health calendar is developed by the institute for vaccination and deworming as per the schedule. FMD has emerged as the single most economically devastating disease among mithuns in the northeastern states. It is commonly observed that mithun is comparatively more susceptible to FMD than other livestock species.

Ectoparasite expeller cum drug applicator

Ectoparasites cause significant losses and severely compromises animal welfare. This device will help to ward off ectoparasites and minimize the economic impact of the farmer. Easy method of topical application of ectoparasicidal drugs like permethrin, cipermethrin, etc. It is applicable in wide range of large and small ruminants including equine and swine.

Figure: Ectoparasite expeller cum drug applicator

11. CARE OF PREGNANT ANIMALS

Pregnant animals that get proper care and management will produce healthy calves and a high milk yield during subsequent lactations. The animal should not be too lean nor too fat for a healthy pregnancy. They should not be allowed to interact with other animals that are aborted or that are suffering from or carriers of diseases like brucellosis. Pregnant animals should not be allowed to fight or to be chased by other animals. In order to take proper care of pregnant animals the expected date of calving should be calculated so that they can be shifted to around two weeks prior to calving date in separate pens. In free range system it is difficult to know the expected date of calving as date of breeding is not available. However, farmers can notice the changes in the size of animal belly as well as its behaviour like isolating itself from other animals. In such conditions, herdsmen can track their animal and visit the grazing area more frequently. In semi-intensive system of rearing pregnant animal approaching parturition may be provided with a separate pen or enclosure with proper bedding materials. Extra concentrate of 1 kg should be provided towards the last 8 weeks of pregnancy as rapid growth of foetus take place during this stage of pregnancy. Clean drinking water should be made available round the clock.

Pregnant animal approaching parturition in 1-2 weeks should not be let loose for grazing. They should be regularly watched for any signs of approaching parturition like swelling of external genitalia, swelling of udder, usually majority of animals will deliver without any help. However, help must be sought from a veterinarian if any assistance is required during the parturition process. After parturition external genitalia, flank should be cleaned with proper care. Placenta will normally leave the animal within 2-4 hours after calving. If not, seek the help of a veterinarian. Also it is advised to prevent the animal from eating the placenta which may lead to digestive issues in recently calved females. Placenta should be properly disposed of from the premises.

12. CALF MANAGEMENT

Survival of neonatal calf is imperative for livestock propagation. The care and management of the calf should start when the dam is conceived. The performance of the calf is a good indicator that reflects the management system adopted by the farmers or the herdsman from conceiving to calving. The morbidity and mortality of calf represent an irrefutable and irrecoverable financial and genetic loss to the dairy industry. The future of any dairy farm depends on the successful raising of calves whether it is orphan or normal calves as they are the future replacement stock.

12.1 Early Management

- Immediately after birth remove any mucous or phlegm, from in and around nose and mouth.
- Normally the dam has the tendency to licks the calf immediately the birth. This helps in drying off the calf and stimulating breathing and circulation. When the dams does not lick the calf or calving occurring during cold climate, rub and dry the calf with a dry cloth or gunny bag. Provide artificial respiration by compression and relaxing the chest with hands if the calf is not breathing.
- The naval cord should be tied about 2-5 cm away from the body of the calf and cut 1 cm below the ligature and apply tincture iodine or boric acid.

12.2 Feeding of calves

- Feed colostrums *i.e.* the first milk of the cow for the first 3 days. The colostrum is thick and viscous. It contains higher proportions of Vitamin A and proteins. The proteins are immune globulin which gives protection against diseases. Colostrum contains anti trypsin which avoids digestion of immunoglobulin in the stomach and is absorbed as it is.
- Calf should be allowed to suckle the milk from its mother twice daily. However, in the event of death of the dam immediately after calving, calf should be bottle fed from milk collected from other female from the herd or other farm.

- Provide calf starter and good quality green fodder after 2 weeks of age as calf usually start to nibble by this time. This will also help in early development of rumen.

Figure: Depiction of suckling of Mithun milk and feed of orphan calf using bottle feeder

Figure: Feeding of grass and calf starter for Mithun calves

12.3 Calf Management Practices

- Identity the calf by ear tagging within seven days of birth
- Deworm the calf regularly to remove worms using deworming drugs
- Fresh water should be given from 2 - 3 weeks onwards
- House the calves in individual calf pens for 3 months. Thereafter it can be shifted to herd. After six months males and females calves should be housed separately

- Weigh the calves at weekly interval up to 6 months subsequently at monthly interval to know the growth rate
- Mortality in calves is more in first month due to pneumonia, diarrhoea (calf scours) and parasitic load
- House them under warm and clean condition to avoid above conditions
- Keep the body clean and dry to avoid fungal infection.
- Mineral blocks should be provided, so that the calves can lick to prevent mineral deficiency
- Wean the calf from the mother after 6 months of age. As longer suckling will delay the onset of estrus in dam

Figure: Ear tagging of Mithun calf

Figure: Body weight measurement of Mithun calf platform balance

Milking of Mithun

Mithun can produce on an average 1.5-2 litres of milk per day. In order to milk the mithun female mithun should be trained for accustoming the touch of milker hand before the calf is born. In order to milk the mithun concentrates or green roughage should be provided to female Mithun to divert their attention toward the feed. Milkers should clean all the equipments used for milking in advance and let it dry. Milkers should wash their hand with soap water before milking. For let-down of milk, calves should be allowed to suckle its dam for a period of 1 minute and thereafter removed and tied nearby. The udder of female mithun should be cleaned by using clean water containing disinfectant solutions like potassium permanganate

and let the udder and teat dry by wiping with a clean and dry towel. Milking can be done by using stripping method (using thumb and index finger) due to smaller size of Mithun teat unlike other bovines where full hand method is practice.

Figure: Suckling of calf for let-down of milk

Figure: Milking of mithun

13. CARE OF BREEDING BULLS

The success of a farm largely depends on the efficient reproductive performance of the herd. The fertility of bull is important across the whole herd as it may affect the reproductive success across several females. The upkeep of breeding bulls in excellent health condition, suitable for breeding is a crucial prerequisite for the breeding program's success. Males that are overweight may be tardy or unreliable in their service, or they may produce poor-quality semen. A breeding bull that gets a lot of exercise will often ejaculate more frequently and with greater activity sperm. A breeding bull should be kept in a separate building, referred to as a "Bull Shed" with enough floor space and appropriate covering. Enough drinking water and a cool environment are good practices for the management of breeding bulls. Feeding should consist of a balanced feed with enough energy, protein, minerals and vitamins. There needs to be good quality green fodder accessible before and during the breeding season. On an average breeding bulls (500 kg) should be given around 15 kg green grass, 7 kg dry roughage and 3 kg concentrates per day.

Males must have regular feeding that does not alternate between being overfed and underfed. The breeding bull should receive moderate activity to maintain an active and non-fatty state. The breeding bull should be regularly groomed. In farmers' field it is always advised to keep the biggest bull and slaughter or cull the smaller bulls. This will help in increasing the chances of mating with the elite bull.

Figure: Breeding bulls maintained in the Medziphema Mithun farm

14. SLAUGHTER OF MITHUN

Mithun is a meat animal and consumed mostly by people of north eastern hilly region. When turning food animals into consumable goods and valuable by products, it is required to slaughter the animal scientifically, hygienically and humanely. Animals selected for slaughter should be healthy and physiologically normal at the time of slaughter. Slaughter animal should be properly rested if they have travelled over long distances. They may be offered water in holding area. Slaughtering of Mithun is usually done by local butchers. For scientific slaughtering of Mithun in Nagaland a local Municipal slaughter house is available in Dimapur.

14.1 Preparing livestock for slaughter

1. The animals must be kept in a lairage and fasted for 12 to 14 hours prior to slaughter. However, adlibitum water must be provided during this period. This will minimize the gastro intestinal tract load and will improve the hydration of the body.
2. Animals should be driven to the stunning area quietly when they are ready to be slaughtered.
3. Before stunning, animals must be taken in a single file into the stunning area where they can be restrained with the proper restraining device

It is crucial that animals intended for slaughter be properly secured prior to stunning or bleeding. In order to perform the stunning procedure precisely and correctly, it is necessary to maintain the stability of the animals. There are different type of restraining methods available however, the most common device for bovines will be stunning box method.

Steps in slaughter of Mithun are as follow:

1. **Rest and fasting:** The animals intended for slaughter are rested for minimum period of 12 to 24 hours. Ample drinking water during rest should be provided as it lowers the bacterial load in intestines, and facilitates dehiding procedure

2. **Ante mortem inspection:** Ante mortem inspection of food animals is carried out by a qualified veterinarian with the object of providing wholesome meat to the consumers by deciding their fitness for slaughter
3. **Stunning:** Stunning is the first step in the slaughter procedure. This must be done in a way that complies with the humane slaughter act. Electrical, mechanical and gaseous stunning are three important methods
4. **Sticking and bleeding:** It is desirable to keep the animal live, but stunned, in order to eliminate the blood. Therefore bleeding can be achieved when the heart and respiratory functions are still working. Bleeding should be complete, and continued to a minimum period of 6 minutes
5. **Dressing of meat animals:** Carcasses are dressed and excess fat, viscera and offal are separated from the bones and the edible tissue
6. **Deheading:** The head as well as front and rear feet are removed after completion of bleeding. Prior to hide removal, care is taken to tie the oesophagus and bung to prevent fecal contamination later in the process
7. **Dehiding:** The hide/skin is removed by down and side pullers and fisting off the pelt.
8. **Evisceration:** Carcasses are sprayed with pressurized water to eliminate external contamination. Evisceration involves opening of pelvic, abdominal and thoracic cavities and removing the internal organs
9. **Post mortem inspection:** The carcass and internal organs should be inspected for safety. The internal organs are removed and inspected for internal parasites and signs of disease. Lymph nodes are examined for signs of systemic disease
10. **Carcass washing and decontamination:** Then the carcass is washed with pressurized potable water to remove the external contamination and also reduce the body temperature
11. **Chilling:** Carcasses of freshly slaughtered animals have surfaces that are warm and wet and thus provide a perfect substrate for the growth of pathogenic and spoilage organisms. Chilling immediately post-slaughter reduces the surface temperature to a value below the minimum growth temperature for many pathogens

15. VALUE ADDITION TO MITHUN MEAT

Meat is a source of concentrated nutrients. It is a fantastic source of premium protein. Lean meat typically has between 20 and 24 % protein, the majority of which has a high biological value due to how closely its composition resembles that of human proteins. All of the amino acids required for human health are present in it. With the inclusion of Mithun as food animal by the Food Safety and Standards Authority of India (FSSAI) in 2023, the acceptability of Mithun has increased which enhanced the scope for Mithun production all over the country.

15.1 Advantages of value addition of Mithun meat

1. Value addition enhances the demand and marketability and meets the life style requirements of healthy meat products
2. Value addition makes advantageous use of various carcasses as well as various by-products.
3. Value addition helps in distribution to broader audiences, transportation and preservation.
4. Value addition facilitates and encourages employment and entrepreneurial endeavours.
5. Value-added products enable the use of by-products, enhance profit and provide variety to consumers.
6. Value addition results in the economical and high-quality use of non-meat items
7. Value addition to processed meat is also necessary to give consumers shelf-stable, nutrient-dense and designer products

15.2 Process involved in development of processed meat products

Processing of meat entails a broad range of physical and chemical treatment techniques, typically combining multiple techniques.

15.2.1 Meat processing technologies include:

- Cutting/chopping/comminution (size reduction)
- Mixing/tumbling
- Salting/curing
- Addition of spices/non-meat additives
- Stuffing/filling into casings or other containers
- Fermentation and drying (if applicable)
- Smoking (if applicable)
- Heat treatment

Steps for preparation of nuggets

a) **Mincing:** Commence the preparation by mincing the Mithun deboned meat using a meat mincer. For aged animals, repeat the mincing process to achieve a finer consistency.

b) **Transfer to Bowl Chopper:** Once minced thoroughly, transfer the meat to a bowl chopper.

c) **Ingredient Addition:** Prepare a chilled water solution containing salt, ice, sodium tri-poly phosphate, sugar, and sodium nitrite. Add this solution to the meat in the bowl chopper.

Figure: Mithun meat nuggets

d) **Blending:** Blend the mixture in the bowl chopper for 6-7 minutes, ensuring that the meat temperature remains below 10°C throughout the process to maintain food safety and prevent spoilage.

e) **Emulsification:** Add eggs, refined oil, onion and garlic paste, wheat flour, and spices including Naga chilli to the blended mixture. Mix thoroughly until complete emulsification is achieved.

Cooking of the product

a) **Container Preparation:** Smear a container with refined oil and transfer the emulsified meat mixture into it.

b) **Autoclaving:** Tie the container securely with rope and place it in an autoclave. Set the autoclave to 10 psi for 10 minutes, followed by 8 psi for 35 minutes.

c) **Cooling:** After the autoclave cycle is complete, turn off the autoclave and allow the steam to gradually dissipate.

d) **Final cutting:** Remove the meat from the container and cut it into small pieces (block shape).

e) **Packaging and storage:** Mithun meat nuggets are now packed inpolyethylenepouches. Store the nuggets in the refrigerator to maintain freshness.

Steps for preparation of meat balls

Mincing: Commence the preparation by mincing the Mithun deboned meat using a meat mincer. For aged animals, repeat the mincing process to achieve a finer consistency.

- **Transfer to bowl chopper:** Once minced thoroughly, transfer the meat to a bowl chopper.
- **Ingredient addition:** Prepare a chilled water solution containing salt, ice, sodium tri-poly phosphate, sugar, and sodium nitrite. Add this solution to the meat in the bowl chopper.

Figure: Meat balls

- **Blending:** Blend the mixture in the bowl chopper for 6-7 minutes, ensuring that the meat temperature remains below 10°C throughout the process to maintain food safety and prevent spoilage.
- **Emulsification:** Add eggs, refined oil, onion and garlic paste, wheat flour, and spices including Naga chilli to the blended mixture. Mix thoroughly until complete emulsification is achieved.

Formation the meatballs: Roll the meat mixture into balls of preferred size.

Cooking of the product:

a) Fill a pot or saucepan with water and add salt (around 5% of the water volume).

b) Heat the water over medium heat until it reaches a temperature between 65-70°C.

c) Gently place the formed meatballs into the heated water.

d) Once the water reaches 80°C, remove the pot from heat and let the meatballs cook in the hot water for 5-7 minutes.

Packaging and storage

e) Using a slotted spoon, remove the cooked meatballs from the water and let them cool down completely.

f) Once cooled, store the meatballs in polyethylene pouches and store in refrigerator to maintain freshness.

Steps for preparation of sausage

a) **Mincing:** Commence the preparation by mincing the Mithun deboned meat using a meat mincer. For aged animals, repeat the mincing process to achieve a finer consistency.

b) **Transfer to bowl Chopper:** Once minced thoroughly, transfer the meat to a bowl chopper.

c) **Ingredient addition:** Prepare a chilled water solution containing salt, ice, sodium tri-poly phosphate, sugar, and sodium nitrite. Add this solution to the meat in the bowl chopper.

Figure: Mithun Sausages

d) **Blending:** Blend the mixture in the bowl chopper for 6-7 minutes, ensuring that the meat temperature remains below 10°C throughout the process to maintain food safety and prevent spoilage.

e) **Emulsification:** Add eggs, refined oil, onion and garlic paste, wheat flour, and spices including Naga chilli to the blended mixture. Mix thoroughly until

complete emulsification is achieved.

Cooking of product

a) **Stuffing:** Once the marinating period is complete, stuff the meat mixture into sausage casings.

b) **Sausage formation:** Twist the stuffed sausage casings at intervals to create individual sausages. This process can be done manually or with a sausage stuffer.

c) **Cooking:** Boil the sausages in a pan until fully cooked through.

d) **Packaging and storage:** Mithun meat sausages are now packed in polyethylene pouches. Store the sausages in the refrigerator to maintain freshness.

Steps for preparation of pickle

a) In a deep pan, heat a minimal amount of mustard oil on medium flame.

b) Add the cooked Mithun meat and fry until it turns slightly brown (10-15 minutes). Remove and set aside.

c) In the same pan, add the ginger and garlic and fry until golden brown. Remove and set aside.

d) Add the dry spice mix and Naga chilli powder to the pan and fry for a few minutes until the oil separates. Remove and set aside.

Figure: Pickle

e) In a fresh pan, add some fresh oil and combine the fried ginger and garlic, spices, salt, and remaining oil.

f) Mix the fried Mithun meat back into the pan.

g) Briefly heat the mixture, stirring occasionally. Ensure all ingredients are well combined.

h) After cooling, add vinegar.

i) Pack the pickle in sterilized polyester/polyethylene laminate pouches or PET bottles.

ICAR–National Research Centre on Mithun has the facility for processing of Mithun meat. Entrepreneurs or farmers interested in getting the training on value addition to Mithun meat can contact the Institute.

16. VALUE ADDED MITHUN MILK PRODUCTS

Value-added products are made by adding or separating liquid whole milk in order to modify or enhance it. Products with additional value include paneer, probiotic drinks, cheese, ghee, and yoghurt. These products are made by combining liquid milk with additives, microbial fermentation, or other methods of alteration and enrichment. When used properly, value addition can help farmers double their income and increase their profit margin on liquid milk. It may be used as a technique to encourage farmers to enter the dairy business. Although Mithun produces on an average 1.5 - 2 litre of milk per day it can be processed into milk products like paneer, lassi, whey drinks, etc.

16.1 Reason for value addition of milk

1. Since fresh milk is more perishable and bulky to keep
2. The shelf life of dairy products is longer than that of fresh milk.
3. There is not much of a market for raw milk.
4. Higher profitability as compared to selling milk directly

Procedure for preparation of whey drink

a) Heat the Mithun milk to 90°C for 2 minutes, or until the first bubbles appear.

b) Cool the milk to 70-75°C to separate the curds from whey.

c) Prepare a solution by dissolving citric acid in boiled water. Add this solution to the cooled milk, stirring continuously to separate the curds and whey completely.

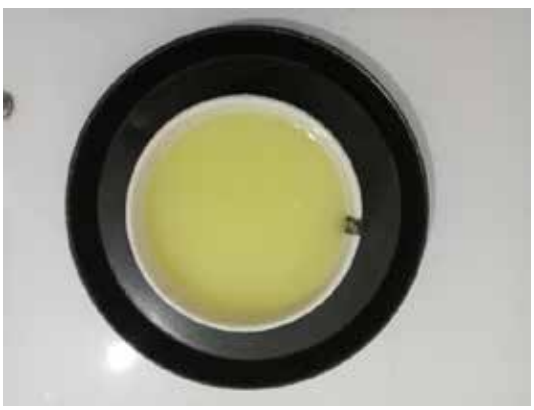

Figure: Mithun whey drink

d) Strain the mixture through a cheesecloth to separate the curds from the whey.

e) Heat the separated whey to 90°C to eliminate harmful bacteria.

f) Place the whey container in a water bath maintained at 70°C (158°F) to preserve its temperature.

g) In a separate beaker, mix the CMC powder with 100 ml of water. Stir until the CMC dissolves completely.

h) Gradually add the CMC solution to the whey, stirring continuously to ensure even distribution and desired consistency.

i) Add the sugar to the whey and stir until it dissolves completely.

j) Mix the flavouring agent with 100 ml of water and stir well. Filter the mixture through a sieve to remove any lumps.

k) Slowly add the filtered flavouring solution to the whey.

i) Pour the prepared whey beverage into polypropylene cups, seal with foil paper, and store at 4°C to maintain freshness and quality.

Procedure for preparation of Paneer

a) Pour the milk into a heavy-bottomed pan and heat it over medium heat. Stir continuously to prevent scorching

b) Once the milk reaches 90°C, maintain this temperature for 2 minutes, or until the first bubble appears on the surface

c) Remove the pan from heat and allow the milk to cool down slightly to 70-75°C

Figure: Mithun paneer

d) Boil water in a separate beaker. Add the citric acid to the boiling water and stir until it dissolves completely

e) Slowly pour the citric acid solution into the warm milk, stirring continuously.

f) Continue stirring gently for a few minutes until the curds become firm and the whey is clear. Stop stirring when the separation is complete

g) Allow the mixture to settle for 5-10 minutes. Then, line a colander with a clean

muslin cloth and carefully pour the mixture into it. The whey will drain through the cloth, leaving the paneer in the muslin

h) Gather the edges of the muslin cloth and gently squeeze out any excess whey. Place the paneer-filled muslin cloth on a flat surface and place a weight (about 1/5 the weight of the paneer) on top

i) Press for 10-15 minutes to remove further whey and give the paneer a firmer texture

j) Unwrap the paneer from the muslin cloth and cut it into desired pieces.

k) Store the paneer in sealed polyethylene pouches at 4°C.

Formulation of Mithun milk lassi:

S. No.	Ingredients	Quantity
1	Mithun milk	1 litre
2	Sugar	8 %
3	Water	2-3 litres
4	Cardamon	0.2-0.3%
5	Almond	2-3%

Procedure for preparation of Mithun milk lassi

a) Prepare curd by adding 1-1.5% starter culture to Mithun milk. Subsequently, incubate it at 38-40°C for a period of 10-12 hours.

b) In a large mixing bowl, combine the Mithun milk curd with 2-3litres of water. Stir thoroughly until the curd dissolves completely and a consistent texture is achieved.

c) Add the sugar gradually, stirring continuously to ensure it dissolves completely.

d) Transfer the lassi mixture to a blender. Blend for a few minutes to achieve smooth and frothy consistency.

e) Add ground cardamom and chopped almonds to the blended lassi. Stir gently to incorporate the flavours.

f) Pour the prepared lassi into clean and sanitized polypropylene cups and tightly seal the cups with foil paper to prevent contamination and preserve freshness.

g) Store the lassi in the refrigerator (4°C) immediately after packing to preserve its quality

Figure: Mithun milk Lassi

17. ABOUT ICAR-NRC ON MITHUN

The ICAR-National Research Centre on Mithun was established in June 1988 at Medziphema, Nagaland under the aegis of the Indian Council of Agricultural Research to provide impetus on the research work on Mithun (*Bos frontalis*). Mithun, a ruminant species belonging to the family Bovidae and assumed to be the domesticated form of wild gaur (*Bos gaurus*) is indigenous to the eastern Himalayas and referred to as the 'sacrificial ox' of the Northeastern Region of India. It plays an important role in the traditions and rituals of the vast tribal population of this region.

ICAR-NRC on Mithun has been playing key roles in the conservation, breeding, and health management of this magnificent species. The scientists of this Institute, in the past 35 years, have generated significant scientific information and developed many farmers' friendly technologies and a package of practices for making Mithun husbandry a sustainable commercial venture.

VISION

To preserve, conserve and propagate superior quality Mithun germplasm for a sustainable production system and subsequent utilization for better nutritional and socioeconomic support to the farmers.

MISSION

Formulation and adoption of scientific management, feeding practices and advanced bio-techniques for reproduction and health with an ultimate objective to develop economically viable and sustainable technologies for the benefit of the farming communities rearing Mithun

MANDATE

- Identification, evaluation and characterization of Mithun germplasm available in the country.
- Conservation and improvement of Mithun for meat and milk.
- To act as repository of information on Mithun.

18. REFERENCES

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