



Vision 2030

National Research Centre on Mithun
Indian Council of Agricultural Research

Jharnapani, Medziphema, Nagaland - 797106
India

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सत्यमेव जयते

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सचिव एवं महानिदेशक

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Foreword

The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, new parasites, slow growth in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural research programmes. The emerging scenario necessitates the institutions of ICAR to have perspective vision which could be translated through proactive, novel and innovative research approach based on cutting edge science. In this endeavour, all of the institutions of ICAR, have revised and prepared respective Vision-2030 documents highlighting the issues and strategies relevant for the next twenty years.

Mithun (*Bos frontalis*), a domesticated form of wild gaur, socio-cultural emblem of North-eastern Hill Region (NEHR), imparts significant imprints of agricultural practices, environment, ecology and overall economy of the tribal people of North-eastern region. It is reared under semi-intensive system. The National Research Centre on Mithun, Jharnapani, Nagaland is established to address challenges faced by Mithun and Mithun rearers in fragile environment and to ensure sustainable development and environmental security. We might be able to harness the opportunity evolving the process through innovation-driven research system benefiting the poorest of the poor stakeholders surviving through Mithun rearing.

It is expected that the analytical approach and forward looking concepts presented in the 'Vision 2030' document will prove useful for the researchers, policymakers, and stakeholders to address the future challenges for growth and development of the agricultural sector and ensure food and income security with a human touch.

9 June, 2011
New Delhi



(S. AYYAPPAN)

Preface

Mithun, a rare bovine species of the North-eastern Hill Region (NEHR) is mainly found in four different States of India viz., Arunachal Pradesh, Nagaland, Manipur and Mizoram. Being a socio-cultural emblem, it plays a vital role in overall economy of the tribal people of this region. According to 2007 census, the population of Mithun in India has been increased from 0.18 million in 1997 to 0.26 million in 2007 (GoI, 1997 & 2007). Forest cover in Mithun rearing states showed declining trend touching 9.3 million hectare in 2009 from 11.9 million hectare of 1997 (FSI, 1997 & 2009). The animal is a unique one with ample avenues for improvement in their productive and reproductive traits, for searching specialty in disease resistance, rumen microbes, meat, milk and hide products. Besides many challenges the animal is facing inbreeding, crossbreeding with cattle and habitat destruction due to faulty agricultural practices (jhum cultivation) and thereby threatened for its existence.

The National Research Centre on Mithun being dedicated to this species envisions that this threatened animal will act as one of the most important driving forces for conserving the agro-ecological balances, economic development and preservation of cultural uniqueness of this hotspot zone.

The first systematic effort to envision the challenges and opportunities was under taken by preparing 'Vision 2020'. The next attempt was by preparing 'Vision 2025 (Perspective Plan)' to address the challenges that has taken place. The present document, 'Vision 2030' articulates the challenges to be faced by Mithun, Mithun rearers and the fragile ecology in their niche and the opportunities thereby comes up for delivering an appropriate strategy and roadmap by National Research Centre on Mithun for sustainable growth and development.

I hope this document will be able to give a desired direction to the scientific community for formulating and implementing various research programmes. I must express my deep sense of gratitude and indebtedness to Dr S. Ayyappan, Honourable Secretary DARE and Director General, ICAR for his constructive suggestions as well as valuable advises for

bringing up this document.

I must also express my deep sense of gratitude to Dr K. M. L. Pathak (DDG, AS, ICAR) and Dr C. S. Prasad (Ex-ADG, AN&P, ICAR) for their constant help and guidance for bringing the vision document to this present shape.

My sincere thanks also go to Dr K. K. Baruah, Dr N. Haque, Dr K. C. Das, Dr (Mrs) Anupama Mukherjee, Dr S. Mukherjee, Dr M. Mondal, Dr N. Prashad, Dr V. Singh and Dr J. Chamuah for their constant help and tireless efforts in bringing up this vision document.

(Chandan Rajkhowa)
Director



01 June, 2011
Medziphema

Preamble

Mithun (*Bos frontalis*) being a socio-cultural emblem of Mithun rearing states, it has got clear link with agricultural practices, environment, ecology and overall economy of this area. Since time immemorial, it has been regarded as an inseparable component during celebration of their social, cultural and religious ceremonies. Presently the existence of this animal is at stake both from social and environmental point of view. The young generations are lured to other easy way of income generation and are less interested in continuing the comparatively more labour intensive Mithun rearing practices. On the other side the forest area in which these valuable animals inhabit is decreasing day by day due to some faulty agricultural practices like *Jhum* with shorter cyclic period. In some areas Mithuns are being crossed with cattle for increasing milk production with high butter fat content. It poses a great threat to the existence of this unique animal before evaluation and full exploitation of its inherent genetic potentials.

However, Mithuns are having sufficient genetic variations in terms of their physical and productive genetic characters. It is also unique in terms of vulnerability / resistance point of view against different diseases compared to that of cattle. This animal is also very much special in their feeding behaviour and maintaining themselves complete independent without material inputs from Mithun rearers except salt in free range system. The above mentioned characters make this animal as a unique one with ample avenues for improvement in their productive characters, searching for speciality in disease resistance, reproductive traits, rumen microbes and meat, milk and hide products.

Being the sole institute in the country as well as in the world dedicated to this species, National Research Centre on Mithun remains vigilant and responsive to changing scenario through development of novel technologies and promoting problem solving innovations.

It envisions challenges the Mithun, Mithun rearers and the fragile ecology in which they inhabit, is facing especially for

ensuring sustainable development, environmental security and also the opportunities it bestow as an avenue for economic development and to be a model ensuring ecological balance as a component of this system.

The first systemic effort was made in this direction by National Research Centre on Mithun with the preparation of 'Vision 2020'; the next attempt was made by refining 'Vision 2020' to prepare 'Vision 2025 (Perspective Plan)' to articulate the changes that has taken place and to address the new challenges that had emerged.

It is now realized that Mithun, Mithun rearers and the fragile ecology of the hot spot zone would have to face several challenges and threats that are emanating from increasing population pressure, climate change, etc and opportunities to mitigate the ecological imbalances, considering sustainable Mithun rearing as an ecologically viable proposition which might be an indicator in its natural habitat.

'Vision 2030' articulates the challenges to be faced by Mithun, Mithun rearers and the fragile ecology in their niche and the opportunities thereby comes up for delivering an appropriate strategy and roadmap by National Research Centre on Mithun for sustainable growth and development.



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Mithun Scenario

Present Scenario

Mithun, a rare bovine species of the North-eastern Hill Region (NEHR) is mainly found in four different States of India viz. Arunachal Pradesh, Nagaland, Manipur and Mizoram and also in neighbouring countries like Myanmar, Bhutan, China and Bangladesh. According to 2007 census, the population of Mithun in India has been increased from 0.18 million in 1997 to 0.26 million in 2007 (GoI, 1997 and 2008). Forest cover in Mithun rearing states showed declining trend touching 9.3 million hectare in 2009 from 11.9 million hectare of 1997 (FSI, 1997 & 2009). Shifting cultivation (locally known as “*jhum*”) is thought to be one of the major contributing factors for reduced available forest area in this region. Broadly, out of the total 25.5 million ha of land in the NEHR, about 3.0 million ha is under settled agriculture and almost 2.7 million ha is under *jhum*. *Jhum* is generally practiced by all tribal population that account 80% in the Mithun rearing States. In this system of cultivation, there is rotation in land use between a long fallow period with forest, followed by a short cropping phase. With the increased population the villagers are reducing the fallow period in order to allot *jhum* land. Reduced fallow period of 1-3 years is not enough for regeneration of the land for further use thereby, resulting in degradation and encroachment of steep slopes with forests. However, *Jhuming* may not survive in long term due to increasing population thereby less availability of forests that bound to shorten the *jhum* cycle, hence, bringing about continuous deterioration in soil fertility and ecological balances. To maintain biodiversity, forest conservation is an important step and Mithun being a component of forest based production system, it needs to be strengthened by incorporating some other component with it to make it a viable and sustainable forest based integrated farming system. For this we need to develop water bodies for fish culture. The forest areas can be explored for orchid and other valuable timber and fodder trees for supporting the poor farmers with sustainable income. This will also help to conserve the forest by discouraging destruction. Therefore, conservation of biodiversity will largely depend on creating conditions to revert to traditional long fallow *jhuming*, through finding suitable alternatives to *jhuming*, or a combination of both. For example, the Government of Nagaland is presently discouraging *jhum* cultivation and has identified the unique economic contribution of Mithun as an alternative to *jhum* cultivation which would also directly or indirectly prevent global warming (Ketarutmakbo, 2011). Mithun also helps to conserve some

rare plant species having medicinal values as has been claimed by the traditional Mithun rearers by giving examples of availability of some specific medicinal plant species only in Mithun rearing areas. For successful livestock farming in free range system carrying capacity of the area is essentially need to be studied. However, similar information is not available for free range Mithun rearing in forests and it is yet to be determined.

Above discussion clearly reflects the need for intensification of Mithun rearing in the region not only for socioeconomic upliftment of Mithun rearers but more importantly to save the biodiversity of the nature for overall benefit of the society.

Mithun is a massive bovine averaging 450 kg and produces milk of around 1.0 to 1.5 litre/d though with 7 to 11% of butter fat. The hide of this animal is presently consumed by the people along with meat though has a great potential to use it as a source for high quality finished leather product. The milk of this animal though not generally used by farmers can be exploited to produce various value added products. Presently, Mithun is used as meat animal and sacrificed occasionally for religious and social ceremonies. Due to humble initiatives taken by the Institute with limited scientific strength (presently 10 numbers), the farmers are being motivated to express their willingness to rear of this rare animal for getting economic benefits from its meat, milk and hide.

Future Scenario

Present trend of increased population of Mithun over last two decades and initiatives of NRC on Mithun to render technical help to the farming community for the scientific rearing of Mithun, it is expected that the growth of Mithun population will further be enhanced over the period of time in near future. The farmers do not practice any breeding strategy for upgradation of Mithun, resulting inbreeding within the species and cross breeding with local cattle thereby dilution of purity of Mithun germplasm. Without optimum technical and scientific intervention it is not possible to control the situation but further aggravate the scenario.

Due to population pressure from human habitation, the area coverage under forest will further be diminishing that will lead to limit the area for Mithun rearing in natural condition. Without any scientific back up towards afforestation programme, using high quality fodder and foliages in denuded areas will further deteriorate this condition. This needs interaction with Village

Council and Forest Department of the Government

Furthermore, Mithun population without proper space and management will be more vulnerable for various diseases and parasites.

The farmers will be able to realize the benefit of scientific Mithun rearing with identification of the organized activities, both research and extension of this Institute and thereby the number of community Mithun farms which are very less in number is expected to increase.

Presently, Mithun meat is of high demand due to its high quality and delicacy but due to its less population the demand from the local market is yet to be fulfilled. When it will be possible to increase the population of Mithun through scientific rearing and community farming, the demand of the market may be fulfilled with more availability of meat and meat products from this animal. This will help the farmers to get more income from high quality hides the Mithun possesses.

Upliftment of socio-economic status of the farmers through Mithun farming might increase the demand for consultancy as well as training for scientific Mithun rearing and the Institute has to fulfil the gap.



National Research Centre on Mithun

The National Research Centre on Mithun was established in June, 1988 with the main objectives of conservation and genetic improvement of Mithun germplasm, development of Mithun nutrition, management, health and products processing technologies related to Mithun. The Centre was to be located in the Nagaland state of NEHR. However, the Centre initially started operating from a rented house at Shillong, the capital city of Meghalaya, which was at a distance of around 600 km from the allocated site at Porba in Nagaland. The office was shifted to Nagaland in the year 1993 and shared accommodation with the ICAR Research Complex for NEH Region centre at Jharnapani. There was not much of a development till late 1990s. This was due to prevailing disturbed socio-political situation in the state of Nagaland that time. But in the later period the Institute could develop itself to a comfortable situation with development of basic physical infrastructure like building, farm and laboratory. In the Xth and in the XIth plan both the campuses located in Jharnapani and Porba could be developed with reasonable physical infrastructure.

Mandate

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

As a preliminary and prerequisite step, original home tracts of Mithuns in four different states of NEHR viz., Arunachal Pradesh, Manipur, Nagaland and Mizoram were identified. The dependency of Mithun on free pasture of the hills/jungles for survival without any supplementation of concentrate feed and shelter was found as a common feature in all these states.

The Institute generated information on growth, productive and reproductive traits in different strains. Studies on identification and characterization of Mithun germplasm revealed four different strains of Mithun in India and these strains are characterized through Randomly Amplified Polymorphic DNA Polymorphism (RAPD) technique. The genetic distances among these strains have also been established. The physical characteristics of these strains have also been studied. Nagaland and Arunachal strains have been identified to be more suitable for meat production, while Mizoram strain for dual purpose i.e. both for meat and milk production. Animals of all four identified strains of are

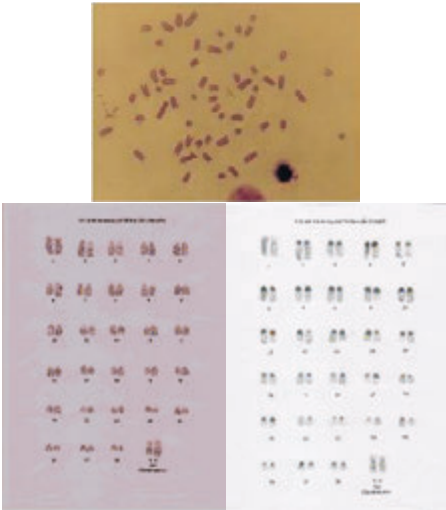


Fig. 1. Chromosomal characterization of Mithun by C & R banding

being maintained in two farms located in Medziphema area of Dimapur district and Porba area of Phek district of Nagaland where scientific breeding programmes are going on for their conservation and propagation. The chromosomal characterization of Mithun was carried out by constructing the cytogenetic profile including chromosome morphology and cytogenetic analysis (Fig. 1). The chromosome is also studied by various banding technique in order to characterize them on the basis of various band patterns. The first ever C - & R - banded Karyotype were

constructed. All the animals present in the farm were cytogenetically screened routinely. The information has been compiled digitally in the form of an 'Album'. The genetic study on Leptin and Kappa casein genes are being carried out to evaluate the genetic polymorphism involved for the better carcass, meat and milk quality traits. The study has been taken up for morphometric and genetic characterization of different strains of Mithun. The scale has been generated to ascertain the age of Mithun on the basis of temporary and permanent teeth eruption (Fig. 2).



Fig. 2. Determination of age by dentition patterns in Mithun

The basic information on physiology and reproduction of this species has been generated (Fig. 3). The sensitive enzyme and immuno-assay procedures for estimating the important reproductive hormones and hormones related to growth and other performances have been standardized and biologically

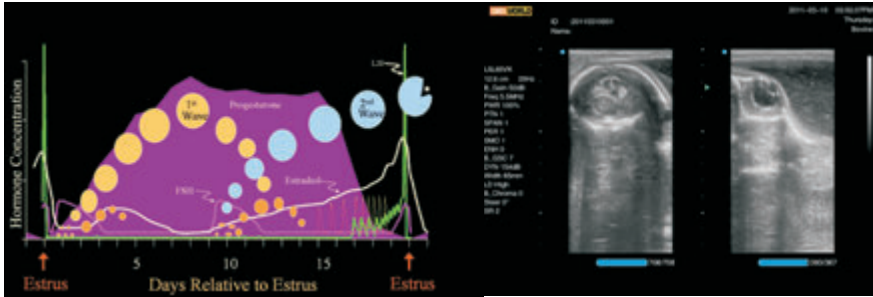


Fig. 3. Follicular dynamics and pregnancy diagnosis in Mithun

validated in Mithun blood plasma. The methodology for collecting semen by artificial vagina method has been standardized with successful preservation at 4°C for 5 days and cryopreservation with LN2 and TAI with suitable diluents. The conception rate from the cryopreserved Mithun semen has also been assessed and results were found to be encouraging. Pregnancies have been established through AI and TAI. Estrus synchronization protocols have been developed for TAI in cyclic and postpartum Mithun cows.

Tree leaves, herbs and shrubs are available in plenty for feeding of Mithun in NEHR. Some of the fodder tree leaves and shrub are found to be excellent in terms of higher crude protein and minerals contents. Digestibility of different nutrients from these sources was also found to be excellent. More than 200 locally available tree leaves/shrubs samples have been collected, identified and some of these tree leaves like Phegwe (*Thysanolina agrostis*), Temichiede (*Ficus birta*), Medzei (*Spondias pinnata*), Thadae (*Trema orientalis*) and Thumero (*Lagerstroemia sp.*) were found to be excellent in nutritive values. The nutritive values of different feed resources (both conventional and non-conventional) available in this area have been determined out. The experiments were conducted on the nutrient utilization and production performances by incorporation of some of these fodders (tree leaves, shrubs, paddy straw, etc in as such or processed form) in the experimental diets and results are quite encouraging (Fig 4a and 4b).

About 50 rumen bacteria have been isolated from rumen liquor of Mithun. Among them *Butyriovibrio fibrisolvans* was observed to be highly fibrolytic, probably play a key role in fibre digestion and has the potential to be used as a microbial feed additive in Mithun (Fig. 5).

The growth and production performance of this animal under semi-intensive

s y s t e m o f management has been assessed. The production (both milk and meat) potentiality of this animal has been evaluated. The milk yield and milk composition has been studied in details throughout



Fig. 4a. Feedblock incorporating locally available feed resources



Fig. 4b. Nutritious fodder tree *Lagerstroemia sp.*

the lactation in Mithun. Economic scientific management practices have been standardized for rearing of Mithun in semi-intensive system of management.

Different value added milk (Paneer, Dahi, Lassi and sweets) and meat products (patties, nuggets, dry meat powder and meat block) from Mithun have successfully been prepared with encouraging organoleptic tests. Mithun hides have also been processed for preparation of different finished leather product like jacket, ladies hand bag, shoes, etc. The quality of finished product was better than those prepared in other bovines. However, the protocols developed for these products need standardization and further improvement.

The major specific (infectious and non-infectious) and non-specific diseases of both semi-intensive as well as free-range Mithuns have been identified. Seasonal and altitudinal variation of parasites have been assessed. Anthelmintic schedules have been prepared for the control parasitic diseases of Mithun and measures for control of ectoparasitic diseases of Mithun have been devised. Different haemoprotozoan diseases that influence the productive status of the animal have been identified. Different sero-diagnostic tests for identification of brucellosis, tuberculosis, IBR and Johne's disease in Mithun have been standardized. The risk factors for important infectious disease of Mithun have been identified and possible remedial measures for the prevention and control of some economically important diseases of Mithun have been formulated. Some of the important causes of Mithun calf mortality have been identified and further studies needed to ameliorate the problems of calf mortality have been suggested.

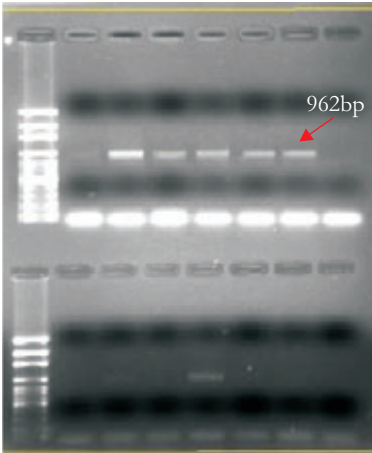


Fig. 5. Band showing PCR amplification of DNA using specific primer (*Butyrivibrio fibrisolvens*)



The National Research Centre on Mithun was established in 1988 with the main objectives of conservation and genetic improvement of Mithun germplasm, development of Mithun nutrition, management, health and products processing technologies related to Mithun. The Centre, which started its functioning from Barapani near Shillong during the initial days, grew considerably over the years in its present location of Nagaland despite some socio-political and logistic difficulties. The Institute has made inroad deep inside the Mithun habitat among the tribal rearers of this unique bovine speice found only in the North Eastern Hilly regions of this country through its commitment of service for overall benefit of tribal populace.

Vision

To preserve, conserve and propagate superior quality Mithun germplasm for 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 an economically viable and sustainable technologies for the benefit of the farming communities rearing Mithun.

Focus

To accomplish the vision and mission, the Institute gives the highest priority to Mithun, Mithun rearers and, the ecology and environment of the niche of Mithuns. It is determined to continuously strive hard to transform the existing Mithun rearing system to more eco-friendly, sustainable and economically viable proposition and transform the Mithun rearers to Mithun farmers. It would concentrate on the following key areas.

- Intensification of research for characterization of the Mithun strain(s) by molecular cytogenetic and genetic approaches. Efforts to identify molecular markers for genetic improvement for meat / milk through Marker Assisted Selection (MAS) and for estimating the genetic diversity among strains of Mithun as well as with other livestock species.
- To study the Mithun genomics by identification Single Nucleotide Polymorphisms (SNPs) for whole genome / genetic analysis using molecular approach.
- Formulation of suitable breeding strategies to accelerate the genetic potential both at farm and field based on available resources.

- Exploring the possibility of using different modern biotechnological techniques like artificial insemination, single evaluation embryo transfer (SOET) and multiple evaluation embryo transfer (MOET), estrus synchronization, in vitro maturation (IVM) / in vitro fertilization (IVF) and stem cell research for propagation of superior germplasm.
- In-house assessment for performance of Mithun under different simulated climatic changes under the present climatic change scenario.
- Evaluation of locally available feeds and fodder in terms of their nutritive value.
- Identification and characterization of rumen microbes of Mithun.
- To establish linkages with other organizations for propagation of locally available quality fodder plants (trees / shrubs) in Mithun inhabited areas.
- Determination of carrying capacity of the forests in terms of Mithun rearing and exploration of possibilities whether Mithun based integrated farming system in the forests can be an alternate livelihood proposition to traditional jhum cultivation.
- Epidemiological survey of Mithun population and preparation of disease map.
- Standardization and validation of immunodiagnostic test for various diseases and preparation of prophylactic and therapeutic measure.
- Standardization of protocols for making value added products of meat, milk and hide.
- Optimization of complete production technologies for the farming community.
- Digitization of data and development of repository on Mithun
- To collaborate with national and international organizations for carrying out in depth studies in this animal.

Harnessing Science

In order to carry out the molecular cytogenetic characterization of Mithun, the techniques of in situ hybridization using fluorescent tags popularly known as Fluorescent in situ hybridization (FISH) will be attempted. For genetic characterization of various strains of Mithun using latest biotechniques will be used. The data generated out of both the above mentioned approaches will be subjected to suitable statistical analysis using latest bioinformatics software. The information generated will be useful as a preliminary step for initiation of the MAS work in mithun for enhancing the genetic potential with them. Whole genome screening and sequencing using latest technique and analysis of SNP's data will also be attempted.

It is felt most essential to record the growth pattern of Mithun to exploit this commodity for meat purpose, hence modern tools of functional genomics will be used in addition to the traditional breeding techniques to study this species towards selection for meat animals using some gene markers.

Estrus synchronisation with TAI, AI, Superovulation, SOET, MOET and IVM/IVF techniques are intended to be used for quality propagation of Mithun germplasm during the period reported upon.

To enhance the reproductive efficiency of Mithun modern tools of biotechnology like functional genomics, microarrays in addition to the established techniques like estrus synchronisation, AI, etc. will be used.

To address the issues related to climate change, different productive and reproductive performance of Mithun will be studied, using in house simulated models where marker (genetic and biological) will be identified, if any, to access the adaptability of this species under different climatic conditions.

As there is dearth of information regarding nutritive value of different feeds and fodders available in this region, it will be evaluated considering available quantity, quality as well as microbial ecosystem of rumen of Mithun. Besides using traditional evaluation techniques, in vitro gas production system will also be used. Atomic absorption spectrophotometry will be used for evaluation of feeds and fodders in terms of their mineral content. For isolation and quantification of active principles present in the feeds and fodders having antinutritional properties and volatile fatty acids and methane gas produced in rumen will be done with the help of Gas Liquid Chromatography (GLC) and High Performance Liquid Chromatography (HPLC). For ecological studies of rumen, isolation and characterization of rumen microbes will be done using

anaerobic culture system and modern molecular techniques

Different molecular techniques will be used for accurate, rapid and economical diagnosis of diseases in Mithun. For diagnosis of different diseases the protocols will be standardized and validated for techniques like Polymerase Chain Reaction (PCR), Immuno-histochemistry (IHC), Fluorescent Antibody Test (FAT), Immuno-peroxidase Test (IPT) and Enzyme linked Immuno-Sorbent Assay (ELISA). Further, advance genomics tools like gene sequencing and phylogenetic analysis will be done to compare the strain/serotypes of virus/bacteria/parasites isolated from Mithuns with those reported from cattle and buffaloes.



Strategy and Framework

The strategic framework has therefore been prepared to address the issues which are expected to aggravate to achieve the demands of both the animal and human being through scientific intervention to bring in the desired development in Mithun for the benefit of human being. The programme designed to cover, among others, the following aspects:-

Strategic framework

SI No	Goal	Approach	Performance measure
1	Identification and molecular characterization of Mithun strains	Morphometric, cytogenetic and molecular characterisation of Mithuns will be studied to identify the genetic variations and unique attributes.	Mithun strains could be specified
2	Molecular genetic study	Systematic study will be designed to characterize the important genes related to different productive and reproductive traits and disease resistance and their mapping to utilize them as genetical markers for further improvement.	Molecular marker(s) will be identified and MAS can be carried out. Whole genetic analysis of Mithun will be done
3	Evaluation of important economic traits in Mithun	The various genetic parameters including heritability for economically important traits in Mithun will be estimated. Further selection and breeding strategies will be formulated as per the suitability of the breeding programme and objectives based on available resources.	Mithun with improved traits with higher heritability will be available
4	Development of Nucleus herd of Mithun for enhancing their genetic worth	Genetically superior and diverse population of Mithun will be maintained as the Nucleus herd in the farmer's field of different Mithun rearing states. Open nucleus breeding scheme will be followed with farmer's participatory approach.	This will help to create the nucleus stock of Mithun and will help in conservation and propagation of superior Mithun germ plasam
5	Conservation of different strains of Mithun	Animals from different strains will be maintained separately in two altitudes (low and mid) for conservation of pure stock of individual strains of Mithun.	A group of Mithun of specified strains will be available for future use

SI No	Goal	Approach	Performance measure
6	Generation of baseline data on Mithun	Detailed hematological and endocrinological studies shall be carried out as per standard procedures. Similar studies on lactation physiology shall also be undertaken. Special emphasis will be given parameters for standardizing hormone assays in relation to growth, lactation and reproduction.	Baseline data on hormonal and haematological aspects will be available especially in relation growth, lactation and reproduction for taking further steps for development of this species.
7	Conservation and propagation Mithun germplasm	Details studies in regard to breeding behaviour, oestrus cycle, gestation parturition, dystokia, involution of uterus shall be taken up. Programmes will also be taken up to augment fertility using modern reproductive, diagnostic and therapeutic tools. Every effort will be made on semen collection, evaluation and preservation including the feasibility of A.I. in domesticated population of confined Mithuns with an emphasis on estrous synchronization and TAI. In order to increase the population of superior Mithun, artificial insemination (AI), embryo transfer, SOET / MOET, IVM / IVF shall be standardized to study the feasibility and economic viability of these programmes for propagation of elite Mithuns.	Conservation and propagation methods of Mithun germplasm will be standardized
8	In - house assessment of performance of Mithun under different climatic conditions	In-house assessment for performance of Mithun under different simulated climatic changes under the present climatic change scen ario will be conducted in cyclometric chamber.	Performance of Mithun under different climatic conditions will be assessed
9	Nutritional evaluation and propagation of locally available feeds and fodders	Nutritive evaluation of locally available feeds and fodders for selecting the best ones for their incorporation in daily ration to make Mithun rearing a viable proposition. Best selected ones will be propagated by standardizing propagation techniques. Efforts will be made to restore the habitat the habitat with high quality nutritive fodder trees.	Feeding strategy for Mithun both in intensive and semi-intensive system will be developed. Maintenance and availability of nutritious fodder plants will beensured, thereby habitat will be restored.

SI No	Goal	Approach	Performance measure
10	Manipulation of rumen microbial ecosystem.	Rumen microbes of Mithun will be isolated and characterized and rumen microbial ecosystem will be manipulated through genetic / non-genetic techniques to improve nutrient utilization and reduce methane production.	Feeding strategy with higher nutrient utilization and lower methane production will be developed
11	Epidemiological survey of diseases	Epidemiological investigation of various viral, bacterial and parasitic diseases prevailing in the Mithun population will be conducted. Various pathogen including bacterial, viral and parasites responsible for different diseases will be Identified and characterized.	Status of disease scenario will be documented in different seasons and altitudes
12	Control of disease and parasites	Efforts will be made to standardize the prevention and control strategies by formulating health calendar and vaccination schedule. Efficacy of various drugs including drugs of herbal origin will be tried for prevention and control of diseases. While doing so efforts will be made to have collaboration with institutes of reputation like IVRI, PDADMAS, ICAR-RC NER, AAU and CAU.	Maintenance of healthy stock and prevention of epidemic
13	Evaluation of meat quality and processing.	Carcass characteristics as well meat quality of Mithun will be assessed. Protocols for making value added products from meat will be standardized.	Value added products from Mithun meat will be developed
14	Evaluation of milk quality and processing.	Quality of Mithun milk will be assessed in relation to human nutrition as wholesome milk as well as preparing certain value added products.	Value added products from Mithun milk will be developed
15	Evaluation of hide and skin quality and processing.	Efforts will be made to study the quality of hide and skin for preparing finished leather products. This will be done in collaboration with the institutions deals with leather technology.	Value added products from Mithun leather will be developed
16	Development of housing system	As there is no specific housing system for Mithun rearing, efforts will be made to standardize proper housing of Mithun with locally available materials.	Housing system for rearing Mithun both in semi-intensive as well as intensive system will be developed
17	Determination of economics of Mithun production	Economics of Mithun rearing system and its impact on socioeconomic condition local people will be studied. This will be done in collaboration with economists of ICAR and SAU	Viability of Mithun production from economical point of view will be apparent

SI No	Goal	Approach	Performance measure
18	Development of sustainable Mithun based Farming system in the fields.	Mithun will be assessed as a component of integrated agro-forestry farming system.	Integrated agro-forestry farming system with Mithun as an important component will be developed for sustainable income to Mithun rearers.
19	Determination of carrying capacity of forests in terms of Mithun rearing	Studies will be conducted to determine carrying capacity of forests in terms of Mithun rearing taking care of ecological balances.	Number of Mithun can be reared per unit area will be determined
20	Evaluation of Mithun rearing as an alternative livelihood proposition to traditional <i>jhumias</i> (shifting cultivators)	Earnings of the farmers and impact on ecology from <i>jhum</i> cultivation as well as Mithun rearing in forests will be compared	Mithun rearing might be recommended as an alternate way of livelihood.
21	Development of repository of information related to Mithun husbandry.	Digitization data bank related to various aspects of Mithun rearing to develop a authentic source of information	Data bank will help scientists, students, farmers and policy makers to have assess to reliable

The NRCM is committed for development of Mithun rearing as an economically viable and ecologically sustainable component of the agro-economic practices of the tribal communities of the NEHR. We envision that this threatened species act as one of the most important driving forces for conserving the agro-ecological balances, economic development and preservation of the cultural uniqueness of this hotspot zone. The NRCM family believes that research on Mithun as well as its ecological environment would augment farmers' income, generate employment opportunities, conserve natural resources and increase value addition for overall socioeconomic development of Mithun rearers. To sustain the benefits of research and development, the NRCM would strive for a continuous effort to disseminate the technologies in the farmers' field with consorted effort with State Government, Private Sectors, NGOs and other Governmental and Non-governmental developmental agencies. Concerted effort would also be made to transform the research, development and extension activities of the Institute to be more target-oriented and need based considering the need of the farming communities and the ecological environment. The Institute will be more focused on research and development issues, always updating the recent development both at national and international levels in the related fields



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