

Vision 2050



Central Institute for Research on Goats

Makhdoom, Farah-281 122, Mathura (UP) India

www.cirg.res.in



Central Institute for Research on Goats

Printed: April, 2013

Publication Committee:

Dr. S.K. Jindal Head, PR&SM	- Chairman
Dr. A.K. Goel Principal Scientist	- Member
Dr. S.V. Singh Head, Goat Health	- Member
Dr. Ashok Kumar Principal Scientist	- Member
Dr. P.K. Rout Principal Scientist	- Member
Dr. V.K. Gupta Principal Scientist	- Member
Dr. A.K. Dixit Senior Scientist	- Member
Dr. V. Raj Kumar Scientist (Senior Scale)	- Member

Published by: **Dr. S. K. Agarwal, Director, CIRG Makhdoom**

All Rights Reserved

2013, Central Institute for Research on Goats, Makhdoom, Farah, Mathura
(UP) India

Printed by:

Foreword

Scientific developments in agriculture have lead the country in achieving self-sufficiency in food production. Livestock sector plays important role in the success story of India's food production. Agriculture, at present is facing diverse challenges and multiple constraints due to fast growing human population, shrinkage of land, depletion of natural resources and impending climate change. In order to sustain food security to feed large human population, continued research efforts and development of technologies are needed for efficient utilization of resources. Growth pattern witnessed in the livestock population, in turn has placed additional stress on already scarce natural resources of the country. To meet out requirements of feed and fodder in view of the rapid degradation of natural resources and climate change have been an another major challenge for improved animal productivity.

India occupies first position in terms of goat population and milk production. *Chevon* (goat meat) is most preferred and widely consumed meat in the country. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and it's all round health promoting traits. Still research is needed to explore and validate medicinal properties of goat milk for projecting it as therapeutic milk for human health. Demand for goat milk and milk products for internal consumption and export is expected to rise in coming years. Goat husbandry provides glimpses of future hope for employment generation, nutritional security and prosperity to the millions of small and marginal farmers in the country. The emerging challenges and opportunities call for technology oriented innovative goat production system and prioritization of researchable issues. The Central Institute for Research on Goats (CIRG)

Central Institute for Research on Goats

has come up with a comprehensive road map to develop goat as ‘future animal’, to meet the growing demand of food for burgeoning human population in the country.

It is expected that the analytical and forward looking approach conceptualized in the ‘Vision 2050’ of the CIRG, Makhdoom will be of immense use to the researchers, academicians, professionals, policymakers and stakeholders to address important issues of research and development for enhancing goat productivity, nutritional security and prosperity in the country. I wish them all success in their endeavor.

Dated: April, 2013

(S. Ayyappan)

*Secretary, Department of Agricultural Research and Education
and
Director General, Indian Council of Agricultural Research
New Delhi - 110001*

Preface

Goat serves as a source of livelihood and nutritional security to large section of society mainly comprising of resource-poor people. In the present scenario of changing agro-climatic conditions, goat has tremendous potential to be projected as the ‘Future Animal’ for prosperity in the country. The traditional goat rearing is steadily turning as the fast growing ‘livestock industry’ in the country. The ‘goat meat’ is one of the choicest edible commodities and carries premium value in the market. The goat milk possesses medicinal and health-promoting properties and needs to be focused as therapeutic milk. Rising affluence will see urban India’s food consumption patterns change from being primarily driven by basic foods to more “high-value foods” with complex proteins.

The Central Institute for Research on Goats (CIRG) is spearheading in goat research, education and extension activities. The comprehensive initiative taken by the institute has led to notable accomplishments in genetic improvement and conservation of native goat breeds, health control, reproductive management, improvement in nutritional efficiency, and economic transformation of farmers through technological advancements and interventions. The present document, CIRG Vision-2050 is focused on the strategies to overcome the challenges and tap the opportunities by harnessing the power of science and undertaking partnership with different stakeholders in food supply chain at national and international level. It also prioritizes the programmes and opportunities for the coming decades ensuring sustainable use of natural resources and to address the surging food demand for over-all socio-economic development in the country.

Central Institute for Research on Goats

I express my sincere gratitude to Dr. S. Ayyappan, Secretary, Department of Agricultural Research and Education (DARE) and Director General, Indian Council of Agricultural Research, Dr. K.M.L. Pathak Deputy Director General (AS) and Dr. B. S. Prakash ADG (AN&P), ICAR, New Delhi for their constant guidance, inspiration and encouragement in developing the present vision document. Chairman and members of the committee deserve appreciation for the hard work and dedicated efforts for on time preparation and publication of this document.

Dated: April, 2013

CIRG, Makhdoom

(S.K.Agarwal)

Director

Contents

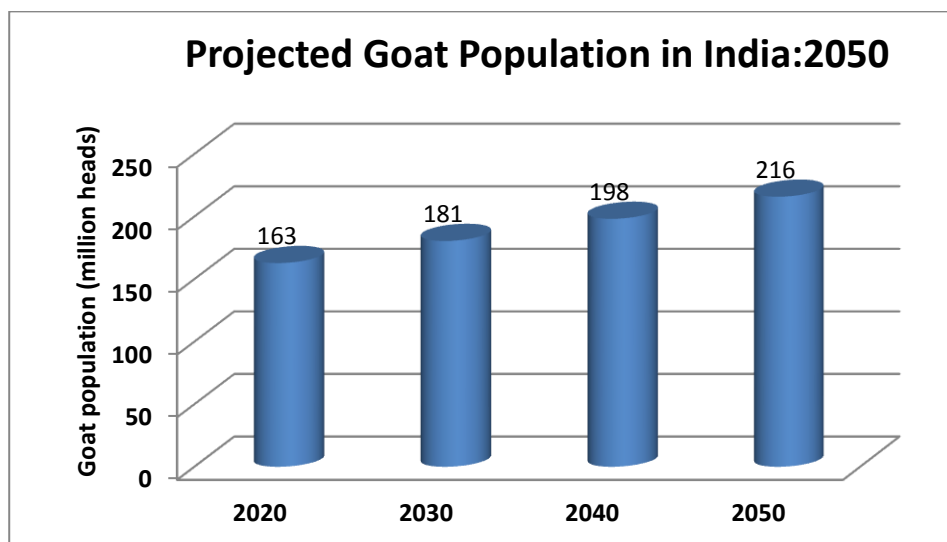
	<i>Foreword</i>	
	<i>Preface</i>	
1.	Context	8
2.	Challenges	17
3.	Operating Environment	22
4.	Opportunities	26
5.	Goals and Targets	28
6.	Way Forward	34
	<i>References</i>	38

Context

The animal production system needs a proper attention as it provides livelihood and nutritional security to larger population in the country. In order to sustain food security and to feed burgeoning population which is likely to be 1.7 billion by 2050, continued research efforts for the development of technologies are needed. Goat plays a significant role in providing supplementary income and livelihood to millions of resource poor farmers and landless laborers of rural India. Small ruminant rearing ensures self-employment and acts as a cushion in distress situations like drought and famine. In last few years, goat production in the country gained momentum in the form of a commercially viable enterprise as evidenced by increasing interest of young energetic youth to develop knowledge and skill in this species. In global scenario, India ranks on top in goat population. The demand for meat, milk and fiber is increasing progressively and expected to further rise in future in view of sizable increase in per capita income and health consciousness of people. Worldwide consumers are preferring products that are “clean, green and ethical”. As such goat producers are shifting to husbandry practices that do not compromise the welfare of animals. Medicinal properties of goat milk increased the interest of society to use it as therapeutic health food nutraceutical; moreover, biotechnologists are focusing on designer milk for human health.

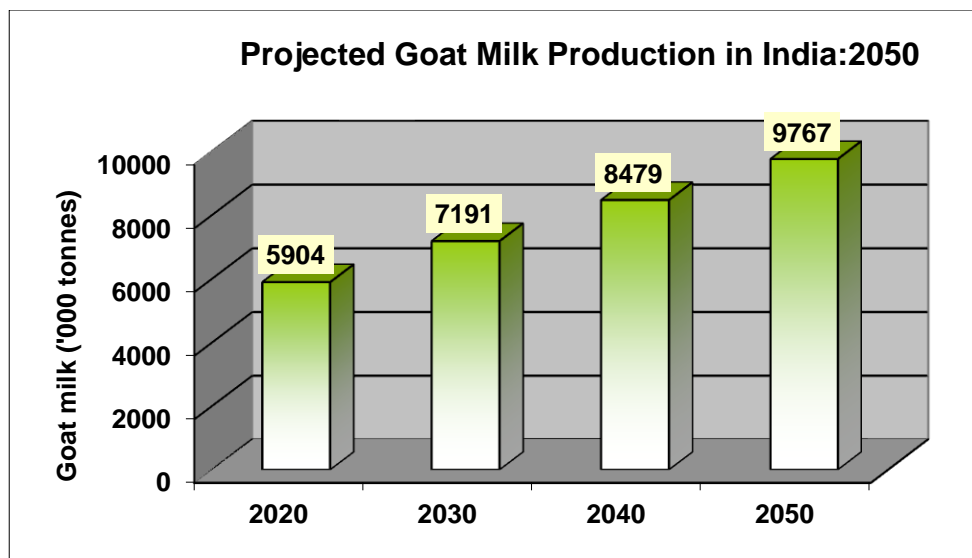
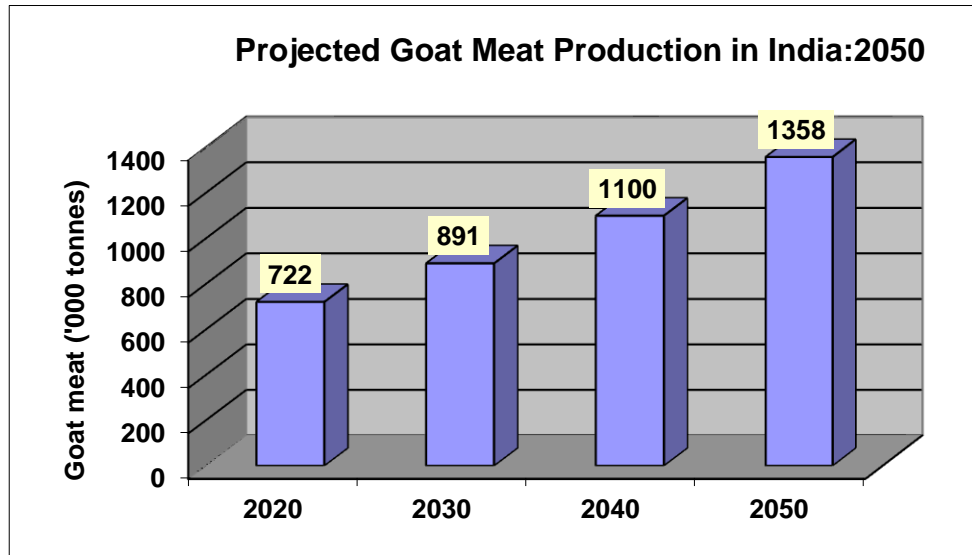
It is to be kept in mind that the country will no longer remain a developing nation by 2050 and malnourishment will be a thing of the past. An increase in per-capita GDP is likely to drive a 4% increase in overall food consumption per annum.

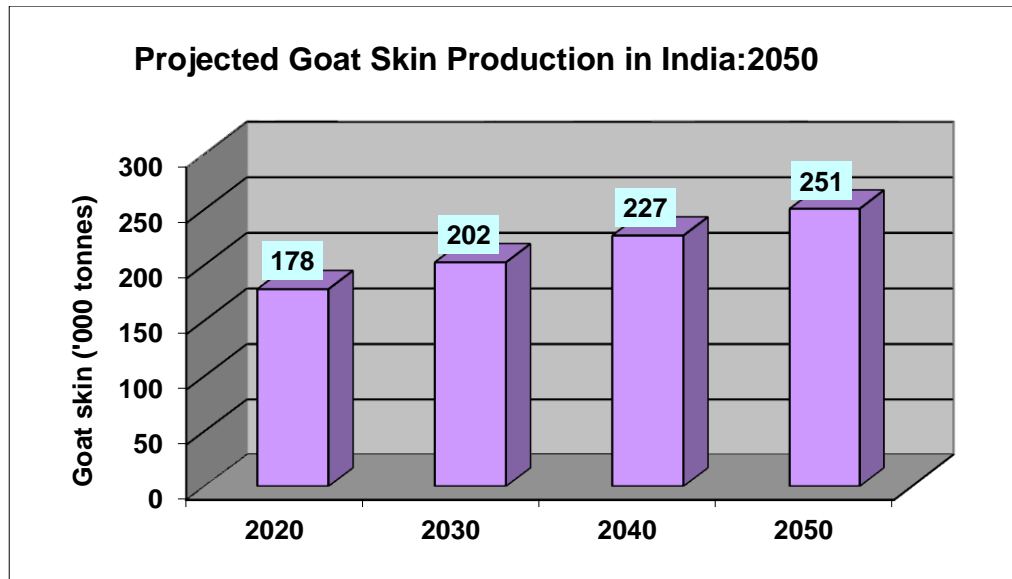
The goat population in the country is expected to reach to 216 million in 2050 with milk and skin production to 9.8 and 0.25 million tonnes, respectively. Urbanization, increased income and strong preference to goat meat will be some of major contributing factors for growth in goat meat production. Considering 14 kg per animal carcass weight and 45% of goats available for slaughter, the goat meat production will increase to 1.36 million tonnes by 2050. As per NSSO reports, per capita per month consumption of goat meat/ mutton has increased from 53 gram to 61 gram during 2003-04 to 2009-10. Considering 3% growth in per capita goat meat/mutton consumption, the demand for goat meat by 2050 would be 2.13 million tonnes.



To meet out increasing demand of animal products by 2050 it would not be possible just only by increasing their numbers alone, but to a large extent enhancing per animal productivity in a sustainable manner. Since, goat is an important source of meat, milk, fiber, skin and manure especially in the subsistent agriculture in arid and semi-arid zones of Asia and Africa;

it can contribute substantially to fulfilling the increasing demand for livestock products in developing and developed countries of the world.





Goats are mainly concentrated in ecologically fragile arid and semiarid areas. Hence, it is imperative to address goat production under the present scenario of climate change, which is adversely affecting health, reproduction and production status of animals. It is, therefore, important to reorient our strategies for goat research and development. The Central Institute for Research on Goats(CIRG) is moving forward to tackle the constraints and challenges in goat production with a view to emerge as a vibrant institution by focused research, visionary approach and road map on goat development for nutritional security and prosperity of the country.

Vision

To develop - the Goat- as a source of livelihood and nutritional security for the prosperity of India

Mission

Central Institute for Research on Goats

Improvement in productivity of goats through research, extension and HRD support.

Mandate

To undertake research, training and extension education for improving milk, meat and fiber production and to develop processing technology of goat products.

Objectives

To accomplish the vision, mission and mandate, the following objectives have been formulated:

- To undertake basic and applied research in all disciplines relating to goat production and product technology.
- To develop update and standardize area specific package of practices on breeding, feeding, management, prophylactic and curative health cover for goats.
- To transfer technologies for improving milk, meat, fiber production, value addition of goat products and capacity building.

Highlights of Achievements

The institute has developed farmers' friendly and commercially viable technologies for goat improvement in the country. So far, 18 patents have been filed; one green drug technology (*Alquit*) for control of ectoparasites has been commercialized to M/S Natural Remedies Pvt. Ltd, Bangaluru. Value added goat meat and milk products, area specific mineral mixture, diagnostics for brucellosis and JD are under process of commercialization. The scientists of the Institute have successfully produced kids from embryo transfer and through IVF. A strain of *Mycobacterium avium* subspecies paratuberculosis genotype 'Indian Bison

type' strain 'S 5' of goat origin has been transferred to M/S Biovet (P) Ltd, Bengaluru for development and commercialization of indigenous vaccine against John's Disease (J.D.). Recently, in recognition of its meritorious scientific achievements and technology innovation, the Institute has been bestowed with the prestigious ICAR's **Sardar Patel Outstanding Institute Award-2010**. Some of the major achievements are as follows.

- Multiplication and conservation of elite germ plasm of Jamunapari, Barbari, Sirohi and Jakhrana breeds of goat for genetic improvement of indigenous goats.
- Improved reproductive performance resulting in higher population growth in Jamunapari (94.65%) and Barbari (183%) goat flocks.
- Positive genetic improvement trend in body weight at birth, at 3, 6, 9, and 12 month of age in Jamunapari goats, (0.12 ± 0.03 , 0.59 ± 0.12 , 1.58 ± 0.19 , 2.66 ± 0.28 and 2.14 ± 0.36 , respectively) and at 9 month (0.999 ± 0.213 kg) in Barbari goats.
- Improvement in milk yield in Jamunapari, Barbari and Jakhrana goats compared to their base population performance.
- Successful freezing of semen of Jamunapari, Barbari, Jakhrana and Sirohi breeds, and production of kids through AI in goats.
- Standardized Embryo Transfer and IVF technology in goats and successfully production of kids through above technologies.
- Characterized heat stress tolerant genes *i.e.* AP-2 binding site in the promoter region of hsp70.1 gene, Melanocortin 1 receptor (MC1R) gene, Tyrosinase (TYR) gene and Signal transducer and activator of transcription 5 A (STAT5 A) gene to facilitate

Central Institute for Research on Goats

further studies on resilience of goat production system under changing climate.

- Established genetic origin of Indian goat breeds and genetic variation in Myf, leptin, Pit I, FecB, SCD gene and HSP genes in Indian goats.
- Developed complete feed pellet for efficient growth (80g/d) in finisher kids. Strategic supplementation of concentrate mixture @ 1.2 % of the body weight for better growth and meat quality of Barbari goats.
- Better dressing percentage and meat quality by supplementation of area specific mineral mixture under intensive goat rearing system.
- Identified anti-methanogenic feed resources for goat production system.
- Developed higher bio-mass producing fodder system (Guar+ Lobia + Sunhamp) for goats under rain fed conditions and *Morus alba* based cost-effective agro-forestry system for sustainable goat husbandry in semi-arid and rain fed areas
- Developed package of practices and dynamic health calendar for goat farmers.
- Determined fatty acids and mineral status of milk of different Indian goat breeds. Standardized process for preparation of herbal functional milk, whey drinks, goat milk and meat based biscuits, and low fat cheese.
- Developed low cost-protein and mineral enriched value added goat meat products using fresh goat spleen and herb supplemented functional goat meat and milk products.

- Created baseline data on commercial goat farming.

Technologies Developed/ Commercialized

- ALQUIT- Ectoparasiticide Drug for animals (commercialized)
- BRUCHEK-Dot ELISA Kit for diagnosis of Brucellosis
- ELISA Kit for diagnosis of Johne's Disease
- Inactivated Johne's disease vaccine
- Intra vaginal pessaries for oestrus synchronization.
- Modern goat appliances to reduce feed and water wastage
- Area specific mineral mixture
- Low cost complete feed palletes
- Cost-effective milk replacers for kids
- Goat meat Murukku: A crispy food product
- Goat meat Nimkee: A snack food
- Goat milk based moisturizer soap (Ajas)

Impact of Research

- Improved productivity and genetic potential of indigenous goats through supply of superior germ plasm from institute to State Animal Husbandry Department, other developmental agencies and goat farmers
- Facilitated in establishment of several small & large commercial goat farms in different parts of the country through different training for capacity building to Veterinary Officers, professionals, farmers and other entrepreneurs on scientific goat rearing and entrepreneurship.

Central Institute for Research on Goats

- Improved body weights of Jamunapari (45.67%) , Barbari (31.96%) goats at 12 month age and kidding rate (1.4 in Jamunapari and 1.48 Barbari)
- Created semen bank for important goat breeds and standardized technique for successful AI in goat.
- Development of goat health calendar leading to over-all reduction in mortality.
- Development of diagnostic kit for JD and Brucellosis.
- Commercialization of ectoparasitical drug- Alquit.
- Development of suitable milk replacer for pre weaning kids.
- Developed complete pelleted feed, feed blocks and designing of low cost pelleting machine that is being adopted by commercial goat farmers for intensive goat rearing

Challenges

Goat production is facing diverse challenge and multiple constraints necessitating continued research efforts and development of cost effective technologies. Resilience of goat production under the changing climatic conditions are posing challenges for the amicable solutions to alleviate the vulnerability of the small and marginal farmers at times when crop production fails particularly where natural resources are limited. Climate change is likely to affect animal health and hence productivity directly and indirectly, by altering the homeostasis and other thermo-regulatory responses to maintain the thermal balance. In the changing scenario of increasing global trade, food demand, manpower requirement, adverse impact of climate change and emergences of newer diseases throw numerous challenges to the livestock sector which need to be addressed. Changes in productivity are also linked with changes in expression of different genes under the changing climatic conditions. Shortage of elite breeding males due to indiscriminate slaughter, lack of national breeding policy for goats and poor initiatives on conservation of indigenous goat breeds, deficiency of feed and fodder with rapid degradation of natural resources, shrinkage of grazing lands and emergence of new pests and pathogens have been major challenges for enhancing goat productivity in the country.

Moreover, adaptability to different stress, water requirement with respect to environmental condition, endurance ability of goats in desert and cold region need be analyzed. Molecular characterization with respect to DNA marker, epigenetic analysis and the role of different RNAs in expression of these traits in different environmental condition need to be carried out. Evaluation of the economic value of goat genetic resources by

Central Institute for Research on Goats

analyzing economics and demographic data (performance, management) with respect to genetic distinctiveness need to be carried out. Our indigenous goat population has not been characterized and evaluated for genetic based disease resistance. Therefore, we must evaluate our stocks for the disease resistance parameters with respect to geographic, climatic and production system. Advances in genomics and proteomics offer an opportunity to look at collective behavior of a large number of genes under a given situation. Discovering novel genes/ regulation mechanism of these genes, hitherto unknown, need to be taken up under the genomics research in goats. The Institute, therefore, envisages undertaking studies to understand how changes in gene expression occur during different patho-physiological conditions and to develop suitable remedies to overcome adverse effects of climatic stress. There is an urgent need to map the goat genome.

There is problem of availability of adequate number elite males to be put for genetic improvement of goats by natural service under field conditions. Artificial insemination technique for breeding and genetic improvement of goat using of frozen semen of elite males need to be thoroughly perfected. Conservation of genetic material through cryo-preservation of semen and embryos have not got momentum in goat. It is necessary to establish a reference semen grid of goats with all types of facilities and certification. Identification of fertility markers needs to be established for early selection of breeding males and to increase the productive and reproductive ability of goats. Other aspects connected to animal productivity i.e. assisted reproductive technologies, understanding of gene regulation through newer technologies, regenerative medicine through stem cells, Biosensor and nanotechnology for diagnostic and drug delivery need to be strengthened. The knowledge on these aspects will be

helpful in harnessing science for sustained goat production. Transgenic research in goat needs to be strengthened through various approaches for production of proteins for therapeutic use. Goats in general may be projected as a model for various types of research including genetic resistance, nutrient metabolism, drug delivery and testing of diseases.

There is a need to integrate meat quality component in to breeding and genetic selection as well as nutrition and management studies. It is necessary to analyze the effect of breed, diet, geographical region on palatability, flavor and tenderness attributes of meat, cheese quality and fatty acid composition of milk to understand better quality goat for meat and milk type. Developing a method to select live animals for increased muscle mass is necessary to form selection indices for faster genetic progress on muscling attributes.

Processing and value addition to goat meat and milk products and by-products with quality assurance is urgently required. Similarly entrepreneurship for processed meat sector development needs to be initiated and encouraged for goat meat. Food with functional benefits such as hypo-cholesterolemic, anti-carcinogenic, anti-ageing effects are being preferred by the consumers & it is possible to deliver these health benefits through functional goat products. In this area of functional goat meat and milk products, research needs to be conducted to either enhance their bioavailability from their natural source or to create novel foods via the addition and/or fortification of isolated or enriched fractions of bioactive peptides. Novel functional products such as antioxidant and omega-3 fatty acids enriched, low cholesterol goat milk products, herbal products, low calorie indigenous goat foods and minerals and vitamins fortified functional products and low cholesterol foods need to be worked out. Newer health promoting and functional ingredients such as fruits, vitamins, bioactive

Central Institute for Research on Goats

peptides & natural antioxidants, and probiotics could be incorporated into product formulation to enhance value and offer consumers a wider range of choice. For commercial exploitation of the value added goat foods, development of shelf stable products assumes greater importance and work need to be carried out in this direction.

Emergence and re-emergence of diseases lead to considerable economic losses, therefore, effective control of such diseases is relevant in present era of bio-security as well as for safe and ethical food production. Control of PPR, Goat pox, ET, helminthoses, JD, brucellosis, FMD, blue tongue and vigil on transboundry emerging diseases are of paramount importance to augment goat production in the country. Emerging diseases lead to heavy mortality in farmers flock and as such are posing major threat to development of goat industry in the country. Cost effective newer diagnostics and prophylactics for important diseases with prompt surveillance, monitoring and forecasting system are lacking. Inadequate veterinary and extension services, lack of awareness in the farmers, credit and access to markets are some of the other important constraints and challenges which need to be addressed.

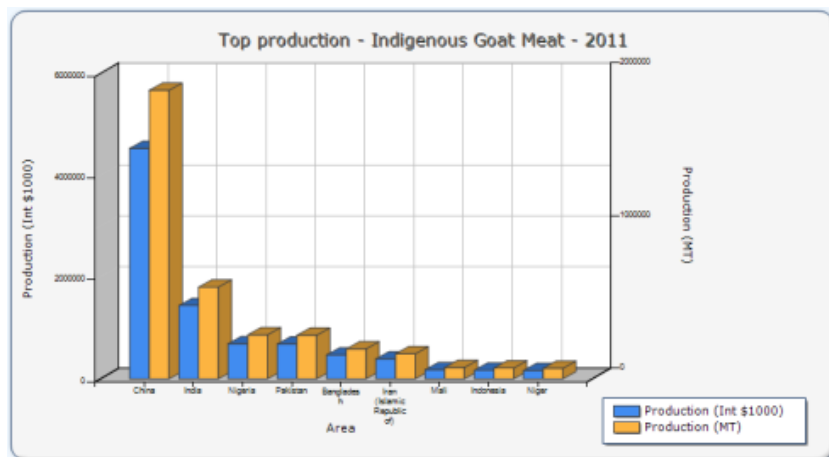
Management of feed and fodder resources is crucial for the future development of goat production in the country. Keeping in view the priority for food grains, pulses and oil seeds the scope for increasing the area under fodder production seems to be meager. Therefore, concerted efforts are required to develop technology for increasing per animal productivity. It is equally important to further enhance productivity of fodder per unit area and utilization of the waste lands and newer non-conventional feed ingredients for goat production. The unorganized market system is another hurdle for goat farmers to fetch remunerative price. In this context, coordination among a wide group of stakeholders is essential.

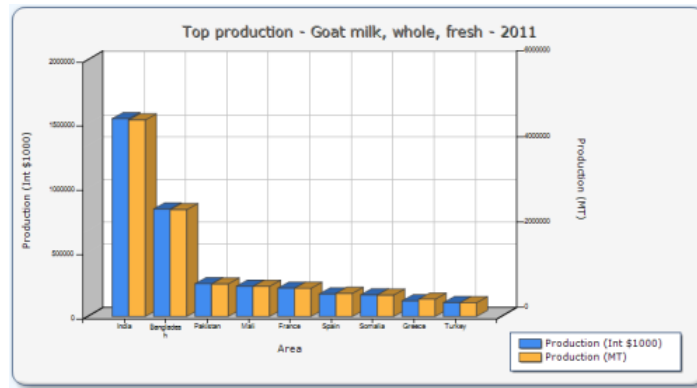
Grazing goats improve soil, plant, animal biodiversity and facilitate dispersion of seeds but importance of this valuable genetic resource is neglected due to many social and environmental biases and misconceptions. Poverty, illiteracy, lack of cooperatives and non-participation in policy making brings the goat farmers at disadvantageous position. There exists poor quality control on germplasm *i.e.* semen & embryo, meat and milk products which need to be improved by development of suitable technologies and logistics. Interdisciplinary and transitional research across disciplines, institutions & agencies need to be encouraged to enhance productivity of goats in the country. Considering the existing and emerging challenges and opportunities, the CIRG has revisited its priority and envisaged future roadmap in the Vision-2050.

Operating Environment

India with 154 million goats is one of the largest goats owning country in the world and playing a significant role in livelihood and nutritional security as well as providing supplementary income to nearly 70 million farmers of over 500,000 remote villages. Goat meat production in the country has increased from 4.7 lakh tons to 5.96 lakh tons during the last decade (2002 to 2011) with an annual growth rate of 2.4%. Similarly, goat milk production in the country has also increased from 36.4 to 45.9 lakh tons during the same period with an annual growth rate of 2.6 %. The country stand first in goat milk production and is the second largest in goat meat in the world by sharing 29% & 12% production, respectively.

The goat sector contributes Rs. 22,138 crores to the country's livestock GDP through meat (Rs. 11,932 crores), milk (Rs. 5,513 crores), skin (Rs. 800 crores) and manures (Rs. 1,594 crores).





Goats contribute nearly 8.5% of the total GDP from livestock sector to Indian agriculture production system. The goat husbandry also generates about 4.2% rural employment to millions of small, marginal farmers and landless laborers. Women are also benefitted by goat rearing being the main custodian in rural areas, especially in Bihar, Jharkhand, West Bengal, Rajasthan, NEH and many tribal regions in the country. In the recent years, some commercial goat farms have emerged in different parts of the country providing substantial income to the progressive farmers. The production efficiency of goat rearing as such seems to be low and needs to be enhanced by a thorough review of its different components. It is, therefore, needed to prioritize research programme and approaches keeping in view the need of meat and milk for ever increasing human population in next 4 decades.

The Central Institute for Research on Goats (CIRG), a premier research Institute of Indian Council of Agricultural Research (ICAR), Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India, New Delhi was established on 12th July, 1979 with a vision to develop poor man's cow-the goat as a source of livelihood security, poverty alleviation and employment generation for the

Central Institute for Research on Goats

small holders. CIRG is contributing to research in the areas of goat production, health, milk and meat products technology through multidisciplinary approach to improve eco-efficient rearing and making goat farming a vibrant and viable enterprise, besides popularizing goat produce by value addition keeping in view of human health and attractive for industrial applications. The basic theme of research has been technological and institutional innovations to enhance the income of goat farmers. CIRG is working for ensuring livelihood security by demonstrating various technologies at the farm and farmers' doorstep. A concerted approach has been adopted by the institute in this direction by creating goat-net ([http:// cirg.res.in](http://cirg.res.in)), helpline (0565-2763320) to address the problems of goat farmers across the country.

The Institute has developed modern laboratory facilities to undertake research on Goat Genetics and Breeding; Physiology, Reproduction & Shelter Management; Diagnosis, Prevention and control of Diseases; Nutrition, Feed Resource Development and Utilization; processing of Milk and Meat Products and Transfer of Technologies. The institute maintains superior germ plasm of Jamunapari, Barbari and Jakhrana goats and Muzaffarnagari sheep for production of elite males for the breed improvement in the farmers flock. . The Coordinating Unit of AICRP on Goat Improvement, one of the important projects of ICAR, New Delhi for enhancing goat production in the country is also located at the Institute. This unit has 14 centers spread all over the country to address different issues on goat health and production across the country. The major emphasis has been on development of superior germplasm of the indigenous goat breeds to serve as improver flocks for different regions of the country.

Impact of research, extension, training and consultancy services of institute is apparent by improvement in health and production efficiency. Adoption of technologies for scientific goat rearing by several farmers has witnessed enhanced productivity of their flocks with better financial returns. The significant impact can also be visualized with increase in number of commercial goat farms and majority of which have been established by the progressive farmers after completing trainings on commercial goat farming organized by the Institute.

Opportunities

Among all farm animal species, goat possesses distinct social and biological advantages and have been poor people's most reliable livelihood resource since their domestication during Neolithic Revolution about 10 millennia ago. Goats can be maintained on a limited area and can sustain on wide variety of vegetation in varied agro-climatic conditions. Goats are easy to manage and their small size makes them suitable for home slaughter. Goat meat (*chevon*) is one of most preferred meat type by the consumers in several countries including India. The goat milk is easily digestible due to smaller size of fat globules and serves as a ready source of family nutrition preferably to infants, old age and sick persons. In India, both demand and production of goat meat during the last decade have shown steady increase. To meet the projected requirement of goat meat for growing human population in the coming decade's there is need to increase the number as well as per animal productivity. However, the increase in livestock number would definitely put stress over the land as well as limited and depleting natural resources. Therefore, special attention of scientists would be needed to develop technologies ensuring availability of food from goat origin.

Goats are hardy, widely adapted, thrive well and reproduce in tropical, cold, humid as well as dry regions. Their small size and expenditure incurred compared to cattle and buffaloes permit them to be maintained on a limited area thus can be used as a model for different experimentation in biological research also. Goat consumes a wide variety of grasses, weeds, forbs, bushes, shrubs, tree leaves and crop residues that would otherwise go waste and cause pollution. Goat is an efficient converter of the sparse vegetation available in wastelands, community

grazing lands of arid, semi-arid and mountainous regions into milk, meat, skin, fiber and manure while utilizing traditional and under employed manpower. They are docile and easy to control. Their small size makes them suitable for backyard slaughter and the meat can be consumed by the family. The goats can be milked any time of the day and are, therefore, named as the moving refrigerators. Goat meat (*chevon*) is preferred over others because it is leaner and there are no religious taboos against its consumption. The vast goat population and large genetic resource are the strengths of the programme.

Goals / Targets

Goal	Approach	Targets with timelines										
1. Genetic Improvement and Conservation of Elite Germplasm of Indigenous Breeds of Goats.	<ul style="list-style-type: none"> ▪ Multiplication and conservation of superior germplasm employing reproductive biotechniques. ▪ Quality semen production and cryobanking as a national grid on semen. ▪ Stem cell, transgenesis and cloning for pharmaceutical farming and to develop goat as experimental model. ▪ Marker assisted selection (MAS) for disease resistance, production and 	<ul style="list-style-type: none"> ▪ Increasing Productivity for Remunerative Goat Production. 										
		<table border="1"> <thead> <tr> <th>Timeframe</th> <th>% increase in milk production per goat</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>50</td> </tr> <tr> <td>2030</td> <td>100</td> </tr> <tr> <td>2040</td> <td>150</td> </tr> <tr> <td>2050</td> <td>200</td> </tr> </tbody> </table>	Timeframe	% increase in milk production per goat	2020	50	2030	100	2040	150	2050	200
		Timeframe	% increase in milk production per goat									
		2020	50									
		2030	100									
		2040	150									
		2050	200									
		<table border="1"> <thead> <tr> <th>Timeframe</th> <th>% increase in meat production per goat</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>30</td> </tr> <tr> <td>2030</td> <td>60</td> </tr> <tr> <td>2040</td> <td>90</td> </tr> <tr> <td>2050</td> <td>120</td> </tr> </tbody> </table>	Timeframe	% increase in meat production per goat	2020	30	2030	60	2040	90	2050	120
		Timeframe	% increase in meat production per goat									
		2020	30									
		2030	60									
		2040	90									
		2050	120									
		<table border="1"> <thead> <tr> <th>Timeframe</th> <th>% of Descript/superior Population</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>30</td> </tr> <tr> <td>2030</td> <td>40</td> </tr> <tr> <td>2040</td> <td>50</td> </tr> <tr> <td>2050</td> <td>60</td> </tr> </tbody> </table>	Timeframe	% of Descript/superior Population	2020	30	2030	40	2040	50	2050	60
		Timeframe	% of Descript/superior Population									
		2020	30									
2030	40											
2040	50											
2050	60											
<table border="1"> <thead> <tr> <th>Timeframe</th> <th>% of Population using AI</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>10</td> </tr> <tr> <td>2030</td> <td>20</td> </tr> <tr> <td>2040</td> <td>30</td> </tr> <tr> <td>2050</td> <td>50</td> </tr> </tbody> </table>	Timeframe	% of Population using AI	2020	10	2030	20	2040	30	2050	50		
Timeframe	% of Population using AI											
2020	10											
2030	20											
2040	30											
2050	50											

	<p>fertility enhancement in view of the impending climatic change.</p> <ul style="list-style-type: none"> National Breeding Policy on goats to further strengthen breed improvement programme. 	<table border="1"> <thead> <tr> <th>Timeframe</th> <th>Marker Assisted Selection</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>10</td> </tr> <tr> <td>2030</td> <td>20</td> </tr> <tr> <td>2040</td> <td>30</td> </tr> <tr> <td>2050</td> <td>40</td> </tr> </tbody> </table>	Timeframe	Marker Assisted Selection	2020	10	2030	20	2040	30	2050	40															
Timeframe	Marker Assisted Selection																										
2020	10																										
2030	20																										
2040	30																										
2050	40																										
<p>2. Management of Important Goat Diseases.</p>	<ul style="list-style-type: none"> Recombinant based diagnostics and vaccines against PPR, Brucellosis, JD, Goat Pox, Blue Tongue Haemonchosis and Cryptosporidiosis etc. Development of DIVA and sensitive Pen side Test for major goat diseases. 	<ul style="list-style-type: none"> Reduction in morbidity, mortality and occurrence of diseases. <table border="1"> <thead> <tr> <th>Timeframe</th> <th>Mortality %</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>15</td> </tr> <tr> <td>2030</td> <td>10</td> </tr> <tr> <td>2040</td> <td>8</td> </tr> <tr> <td>2050</td> <td>5</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Timeframe</th> <th>% of population under Vaccination For PPR,FMD, ET,HS</th> <th>% of population having Diagnostics For PPR,ET,FMD, HS, Brucellosis</th> </tr> </thead> <tbody> <tr> <td>2020</td> <td>30</td> <td>20</td> </tr> <tr> <td>2030</td> <td>50</td> <td>40</td> </tr> <tr> <td>2040</td> <td>70</td> <td>60</td> </tr> <tr> <td>2050</td> <td>100</td> <td>100</td> </tr> </tbody> </table>	Timeframe	Mortality %	2020	15	2030	10	2040	8	2050	5	Timeframe	% of population under Vaccination For PPR,FMD, ET,HS	% of population having Diagnostics For PPR,ET,FMD, HS, Brucellosis	2020	30	20	2030	50	40	2040	70	60	2050	100	100
Timeframe	Mortality %																										
2020	15																										
2030	10																										
2040	8																										
2050	5																										
Timeframe	% of population under Vaccination For PPR,FMD, ET,HS	% of population having Diagnostics For PPR,ET,FMD, HS, Brucellosis																									
2020	30	20																									
2030	50	40																									
2040	70	60																									
2050	100	100																									

	<ul style="list-style-type: none"> ▪ Disease surveillance, monitoring and forecasting system on major goat diseases including caprine zoonoses. ▪ Developing alternative therapies using ethno-veterinary and regenerative medicines for treatment of goat diseases and disorders. ▪ Establishing National Referral Centre on goat health. 	
<p>3. Nutritional Strategies to Improve Nutrient Utilization, Feed and Fodder Availability.</p>	<ul style="list-style-type: none"> ▪ Strategic supplementation for better feed conversion, nutrient utilization and rumen microbial 	<ul style="list-style-type: none"> ▪ Improved growth rate and productivity.

	<p>manipulation.</p> <ul style="list-style-type: none"> ▪ Evaluation of properties of indigenous herbs and approaches to optimize nutrient utilization, methane mitigation and to improve animal productivity under different agro-climatic conditions. ▪ Developing feed and fodder production and goat pasture system. 	<table border="1" data-bbox="847 512 1385 819"> <thead> <tr> <th colspan="2" data-bbox="847 512 1385 589">Timelines for 50 % of Goat Farmers to use useful nutritional interventions</th> </tr> </thead> <tbody> <tr> <td data-bbox="847 589 1114 651">Area Specific Mineral Mixture</td> <td data-bbox="1114 589 1385 651">2020</td> </tr> <tr> <td data-bbox="847 651 1114 687">Complete Feed Block</td> <td data-bbox="1114 651 1385 687">2025</td> </tr> <tr> <td data-bbox="847 687 1114 750">Designer feed from by-products only</td> <td data-bbox="1114 687 1385 750">2030</td> </tr> <tr> <td data-bbox="847 750 1114 819">Doubling of fodder production from CPR</td> <td data-bbox="1114 750 1385 819">2040</td> </tr> </tbody> </table>	Timelines for 50 % of Goat Farmers to use useful nutritional interventions		Area Specific Mineral Mixture	2020	Complete Feed Block	2025	Designer feed from by-products only	2030	Doubling of fodder production from CPR	2040
Timelines for 50 % of Goat Farmers to use useful nutritional interventions												
Area Specific Mineral Mixture	2020											
Complete Feed Block	2025											
Designer feed from by-products only	2030											
Doubling of fodder production from CPR	2040											
<p>4. Value Addition of Goat Products & by-products and Quality Control.</p>	<ul style="list-style-type: none"> ▪ Evaluation of medicinal properties of goat milk and its promotion as neutral-ceutical. ▪ Research on 	<ul style="list-style-type: none"> ▪ Availability of quality milk & meat products of goat origin. ▪ Establishment of a national referral lab, for quality assurance of goat products of public health significance and development of an interactive data base. 										

	<p>processing technologies, value addition, quality assurance (detecting adulterants and contaminants) packaging, storage and marketing.</p> <ul style="list-style-type: none"> ▪ Promotion of public-private partnership, management of intellectual property and effective transfer of technology of value added goat meat and milk products. 	<table border="1"> <tr> <th colspan="2">Availability of goat products in the market</th> </tr> <tr> <td>Cheece</td> <td>2020</td> </tr> <tr> <td>Freeze dried goat milk</td> <td>2025</td> </tr> <tr> <td>Designer goat meat</td> <td>2030</td> </tr> </table>	Availability of goat products in the market		Cheece	2020	Freeze dried goat milk	2025	Designer goat meat	2030		
Availability of goat products in the market												
Cheece	2020											
Freeze dried goat milk	2025											
Designer goat meat	2030											
<p>5. Human Resource and Entrepreneurial Development through Trainings, Consultancy and ICT Support.</p>	<ul style="list-style-type: none"> ▪ Development of human resource to tackle specific problems in goat production, health and product technology. ▪ Capacity building of 	<ul style="list-style-type: none"> ▪ Promotion of goat entrepreneurship for livelihood security of goat farmers. <table border="1"> <tr> <th colspan="2">Increase in income of goat farmers over that in 2010 (%)</th> </tr> <tr> <td>2020</td> <td>50</td> </tr> <tr> <td>2030</td> <td>100</td> </tr> <tr> <td>2040</td> <td>150</td> </tr> <tr> <td>2050</td> <td>200</td> </tr> </table>	Increase in income of goat farmers over that in 2010 (%)		2020	50	2030	100	2040	150	2050	200
Increase in income of goat farmers over that in 2010 (%)												
2020	50											
2030	100											
2040	150											
2050	200											

	<p>different stakeholders for promotion and adoption of goat enterprise</p> <ul style="list-style-type: none">▪ Creating Information System (IS) and database on goat marketing and available practices for farmers.▪ ICT mediated extension approaches to strengthen linkages with large number of farmers to assist transfer of technologies.▪ Establishment of 'National Goat Museum'.	
--	---	--

Way Forward

Improved goat production hold promises to enhance the economy and living standards of millions of farmers in India living in eco-fragile and vulnerable zones of country. We have only 23 recognized goat breeds sharing 20-25% of the total goat population of the country. However, most of the goat population is of the non-descript types with a low production potential thus warrants their up-gradation. The adaptation of goats to tropical climates ensures their place in the future livestock scenario. Resilience of goat production under the changing climatic conditions is posing challenges and offers amicable solutions.

In the changing scenario of increasing global trade, food demand, manpower requirement, adverse impact of climate change on productivity and emergences of newer pests, pathogens and diseases, livestock sector is going to face numerous challenges which need to be addressed for its composite development. Climate change is likely to affect animal health and hence productivity directly and indirectly, by altering the homeostasis and other thermo-regulatory responses to maintain the thermal balance. Productivity is also linked with changes in expression of different genes under the changing climatic conditions. Molecular characterization of candidate genes for growth, production, reproduction, health and adaptability traits in goats under the prevailing climatic conditions needs to be carried out. Management of feed and fodder resources is crucial for the future development of goat production in the country. Biotechnological interventions, modulating rumen fermentation for better nutrient utilization as well as reducing methane production of feeds need to be harnessed for combating the adverse effects of climate on goat production.

Majority of the goat population is nondescript having lower production potential. With shrinking resources and increasing demand of goat meat and milk, there is urgent need to genetically improve and manage these animals through modern reproductive tools. Breed improvement programmes need to be undertaken more intensively using Artificial Insemination Technique (both Fresh and frozen semen), MOET, IVM/IVF and stem cell. For widespread dissemination and conservation of superior germplasm cryopreservation and banking of semen, embryo, embryo transfer and cloning will be the thrust area. It will also not be far-fetched to anticipate that the application of stem cell for meat production in the laboratory from skeletal muscles would be the reality by 2050.

Control of animal diseases assumes prime importance in the crucial time of shifting of animal agriculture from extensive to intensive and commercial system of management. Development of new generation diagnostics and vaccines along with appropriate adjuvant and improved delivery system for the endemic, emerging and exotic diseases of goats will be the major thrust area in the coming decades. Research on developing technologies for early and accurate diagnosis of diseases and DIVA kits will be a priority programme. Health related research activities will be focused to assist programmes for control and eradication of important notifiable, zoonotically important and trans-boundary diseases. Application of micro array for detection and characterization of various pathogens need to be employed for better disease diagnosis over large population of goats. Efforts are also needed for development of sensitive sero-diagnostic, molecular, chip- and biosensor-based diagnostics for important bacterial, viral, mycoplasmal, fungal and parasitic diseases. Host pathogen interactions, functional genomics and immuno-modulations of pathogens, molecular pathology, stem cell and cytokine therapy of different diseases

Central Institute for Research on Goats

need to be emphasized. Another important thrust area would be development of formulations from herbal/synthetic sources against economically important goat diseases. Use of stem cells as an alternative medicine would be needed for the therapeutic management of diseases, injuries to vital organs and especially expediting the recovery in certain chronic diseases. Nano-biotechnological approach needs to be developed for efficient drug delivery system, diagnostics and vaccines for better health care of animals.

The value addition of the goat foods through the development of newer biotechnological and nanotechnological approaches would bring in a new era of foods that would address the future needs of the society. There is an urgent need for developing rapid and reliable techniques for monitoring quality and safety management of ready-to-eat convenient goat meat products . The institute would endeavor to harness the emerging tools, techniques and research methods, to provide directions for designing policies, mechanisms and facilitating decision-making process of the stake holders. Development of strong liaison amongst research institutes and public private partnership would be required for collaborative research and development of programmes in coming decades for the efficient goat production in the country.

THRUST AREAS AND STRATEGIES

1. Genetic improvement & conservation of elite germplasm of indigenous breeds of goats, cutting edge and frontier technologies to improve goat productivity

- Establishment of seed stock production centers for important breeds of

goats in their breeding tracts.

- Multiplication and conservation of superior germplasm employing reproductive biotechniques.
- Quality semen production and cryo-banking as a national grid on semen.
- Stem cell, transgenesis and cloning for pharmaceutical farming and to develop goat as experimental model.
- Molecular basis of adaptation and functional genomics
- Marker assisted selection (MAS) for disease resistance, production and fertility enhancement in view of the impending climatic change
- National Breeding Policy on goats to further strengthen breed improvement programme.
- Automation in management systems for improving goat farm management practices.
- Shelter management practices, development and standardization of modern shelters and appliances in view of climate change.

2. Development of newer generation diagnostics, vaccines and alternative therapies for important diseases of goats

- Recombinant based diagnostics and vaccines against PPR, Brucellosis, JD, Goat Pox, Blue Tongue, Haemonchosis and Cryptosporidiosis etc.
- Development of DIVA and sensitive Pen side Test for major goat diseases.
- Disease surveillance, monitoring and forecasting system on major goat diseases including zoonosis.
- Developing alternative therapies using ethno-veterinary and regenerative medicines for treatment of goat diseases and disorders.
- Establishing National Referral Centre on goat health.

3. Nutritional strategies to improve nutrient utilization, feed and fodder availability

- Strategic supplementation for better feed conversion, nutrient utilization and rumen microbial manipulation.
- Evaluation of properties of indigenous herbs and approaches to optimize nutrient utilization, methane mitigation and to improve animal productivity under different agro-climatic conditions.
- Developing feed and fodder production and pasture system for eco-friendly goat production under changing climatic conditions.

4. Value addition of goat milk and meat products and quality control

- Evaluation of medicinal properties of goat milk and its promotion as nutraceutical.
- Development of designer and nutrient fortified goat milk and meat products.
- Research on processing technologies, value addition, quality assurance (detecting adulterants and contaminants) packaging, storage and marketing.
- Promotion of public-private partnership, management of intellectual property and effective transfer of technology of value added goat meat and milk products.

5. Human resource and entrepreneurial development through trainings, consultancy and ICT support

- Development of human resource to tackle specific problems in goat production and health.
- Capacity building of different stakeholders for promotion and adoption of goat enterprise.
- Creating Information System (IS) and database on goat marketing and available practices for farmers.
- ICT mediated extension approaches to strengthen linkages with large number of farmers to assist transfer of technologies and address goat farmers' problems.
- Establishment of 'Goat Museum' of National importance.

References

- GOI (2009). *Basic Animal Husbandry Statistic 2008*. Department of Animal Husbandry & Fisheries, Ministry of Agriculture, Government of India, New Delhi.
- GOI (2007). *Report of the Working Group on Animal Husbandry for the Eleventh Five Year Plan (2007-2012)*. Planning Commission, Government of India.
- FAOSTAT (2013) <http://faostat.fao.org/default.aspx>