

Joint FAO/IAEA Programme in Food and Agriculture



Atoms for Food



Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Joint FAO/IAEA Programme in Food and Agriculture Corporate Mission



Atomic energy for peace,
health and prosperity



Sustainable agricultural
development, improved
nutrition and food security

to contribute to sustainable food security
and safety by use of nuclear techniques
and biotechnology



IAEA

Joint FAO/IAEA Programme Organizational Chart

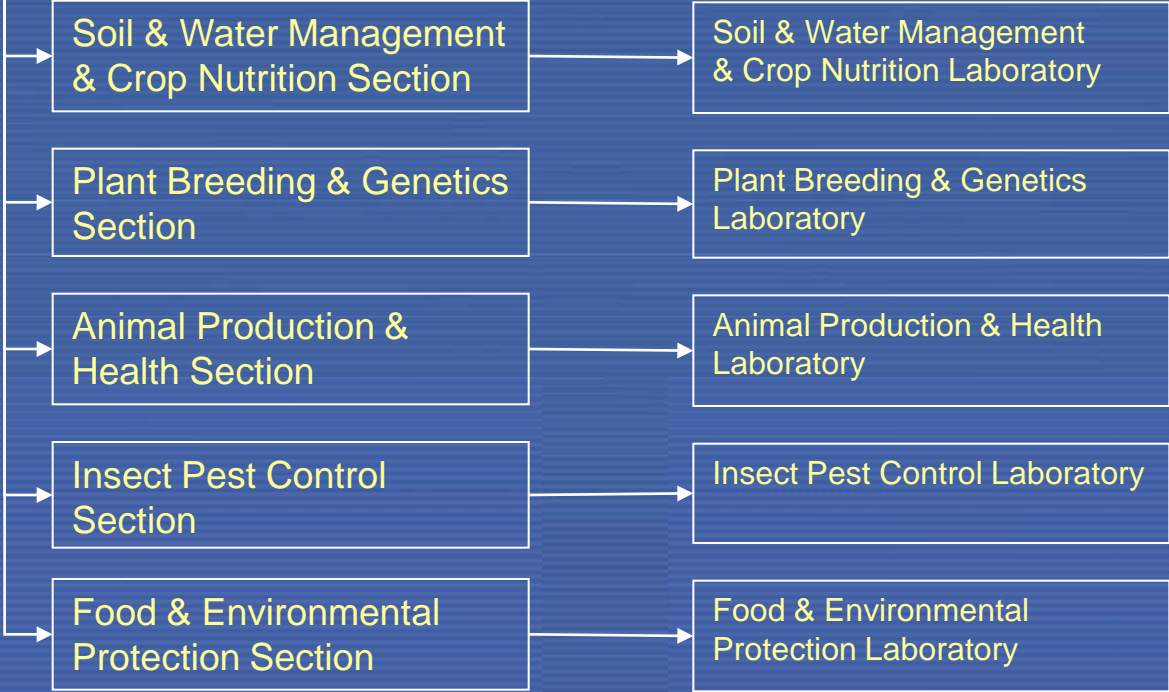


FAO
Agriculture and Consumer
Protection Department

IAEA
Department of Nuclear
Sciences and Applications



Joint FAO/IAEA
Division of Nuclear Techniques
in Food and Agriculture



Our Goals

- Food Security



- Food Safety



- Sustainable Agriculture



Working in Partnership

- ❖ FAO Animal Production and Health Division (AGA)
- ❖ International Livestock Research Institute (ILRI)
- ❖ World Animal Health Organisation (OIE)
- ❖ Africa Union's Inter-African Bureau of Animal Resources (IBAR)
- ❖ World Health Organization (WHO)
- ❖ Pan American Health Organization (PAHO)
- ❖ EU Commission

plus FAO & IAEA Member States

168 IAEA Member States
191 FAO Member States



Animal Production and Health Sub-programme



Animal Production and Health Section

- Vienna Headquarters
- Seibersdorf Laboratory



Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Our Mandate



Assist MS to improve livestock productivity through:

- ✓ **Efficient** use of locally available feed and animal genetic resources,
- ✓ Adequate management practices and efficient reproductive / breeding programmes,
- ✓ Development of proactive disease prevention and control measures

using nuclear and nuclear-related technologies



Sub-programme Activity Areas

Animal Production

- ❑ Support member states on gene-based technologies in livestock breeding
- ❑ Strengthen and improve artificial insemination system in member states to enable genetic improvement of livestock
- ❑ Efficient use of locally available and unconventional feed resources for livestock



Sub-programme Activity Areas

Animal Health

Disease Diagnosis and Control

- Early and Rapid Diagnosis of zoonotic and transboundary Animal Diseases
- Application of radio isotope technologies for development of vaccines against zoonotic and transboundary animal diseases



Modalities of Cooperation with Member States

- ✓ Coordinated Research Projects (CRPs)
- ✓ Technical Cooperation Projects (TCPs)
 - National TC Projects
 - Regional TC Projects
- ✓ Extra budgetary Projects
 - Peaceful Uses Initiative (PUI) Projects



Coordinated Research Project

- Research is done within an operational framework and well defined global or regional thematic or problem focus
- Bring together research institutes in both developing and developed countries to network on a specific research topic
- CRPs are composed by 6 - 15 Research Contract holders, 2 - 5 Agreement holders, and 1 - 2 Technical Contract holders
- CRPs last for 3 - 5 years
- 3 - 4 Research Coordination Meetings (RCM) are held to evaluate and harmonize activities
- The results are freely available through IAEA's publications and relevant international journals
- The knowledge is also used to enhance the quality of TC projects



Technical Cooperation Projects

The IAEA Technical Cooperation Department (TC) facilitates the transfer of nuclear and related technologies

- TC works in full partnership with the IAEA Technical Departments.
- Over US\$ 70 million per year in nearly 100 developing countries.
- Project proposals are approved in a 2-year cycle.
- Submitted by local institutions through national atomic energy authorities
- Provides supports for expert missions, fellowships, and equipment.
- Projects last for 2-4 years and amount for US\$ 50,000 to 200,000 per year



Capacity Building under TC Projects

National and Regional training course

- Held at Seibersdorf Laboratory or hosted by academic or research institutions in Member States
- Focus on modern and specific nuclear and nuclear-related technologies for improving livestock productivity

Fellowship trainings

- Usually 1-3 month training for both scientists and technicians
- IAEA covers the trainee and host institute expenses; Seibersdorf labs or advanced labs

Scientific visits

- Targeted to senior staff of TC projects; 1-2 weeks visit to state of the art laboratory

Field Support Missions

Animal Production and Health
Sub-programme



TC or CRP – What is the difference?

CRP

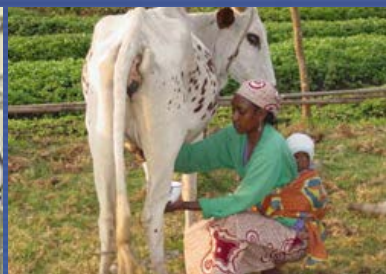
- ✓ Research based project
- ✓ Single activity
- ✓ Interest of contracting institute
- ✓ Seed money for research
- ✓ Not for capacity building
- ✓ Call for specific CRPs
- ✓ Direct submission to the IAEA
- ✓ Approval based on technical merits
- ✓ 5 years
- ✓ Emphasis on technical results

TC

- ✓ Transfer and adoption of proven technology
- ✓ Variety of activities
- ✓ Involves an array of stakeholders
- ✓ Large amount of funds
- ✓ Strong capacity building component
- ✓ Applications on a 2-year cycle
- ✓ Submission through the NLO
- ✓ Approval based on country priorities
- ✓ 2 – 3 years
- ✓ Emphasis on implementation



Application of Nuclear and Molecular Techniques to Improve Livestock Productivity ANIMAL GENETICS



Animal Production and Health Laboratory



Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Animal Production and Health Sub-Programme

IAEA Headquarters

Implementation of

- ✓ Coordinated Research Programs (CRPs)
- ✓ National Technical Cooperation Projects (TCPs)
- ✓ Regional TCPs

Seibersdorf Laboratory

Technical Support to CRPs and TCPs

- ✓ Development and transfer of tools/methods
- ✓ Capacity building – Conduct training courses/workshops
- ✓ IAEA Fellowship trainings and Internships



Animal Genetics: Major Focus



- Support MSs to implement Global Plan of Action on ANGRs
- Development and transfer of tools to improve genetic disease resistance
- Tools for animal identification, recording and selection to improve animal productivity

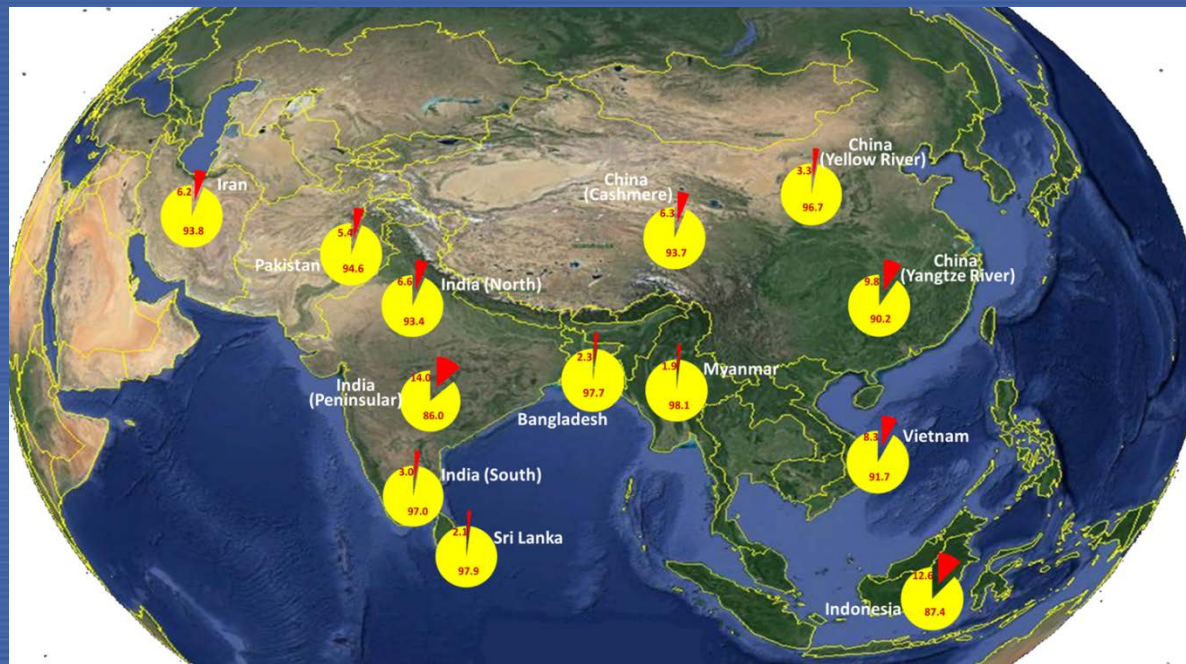
Coordinated Research Projects on Animal Genetics and Breeding

- ✓ **CRP D3.10.25 (2005-2010): Gene based technologies for livestock breeding: Characterization of small ruminant genetic resources of Asia**
- ✓ **CRP D3.10.26 (2011-2015): Gene based technologies for livestock breeding: Genetic variation for the control of parasite resistance in sheep and goats**
- ✓ **CRP D3.10.28 (2016-2020): Application of Nuclear and Genomic Tools to Enable for the Selection of Animals with Enhanced Productivity Traits**



CRP D3.10.25 : Characterization of small ruminant genetic resources of Asia

- ✓ Seven Asian countries were supported by the CRP
- ✓ ~57 indigenous goat breeds and 41 sheep breeds were characterized using MS and mtDNA markers



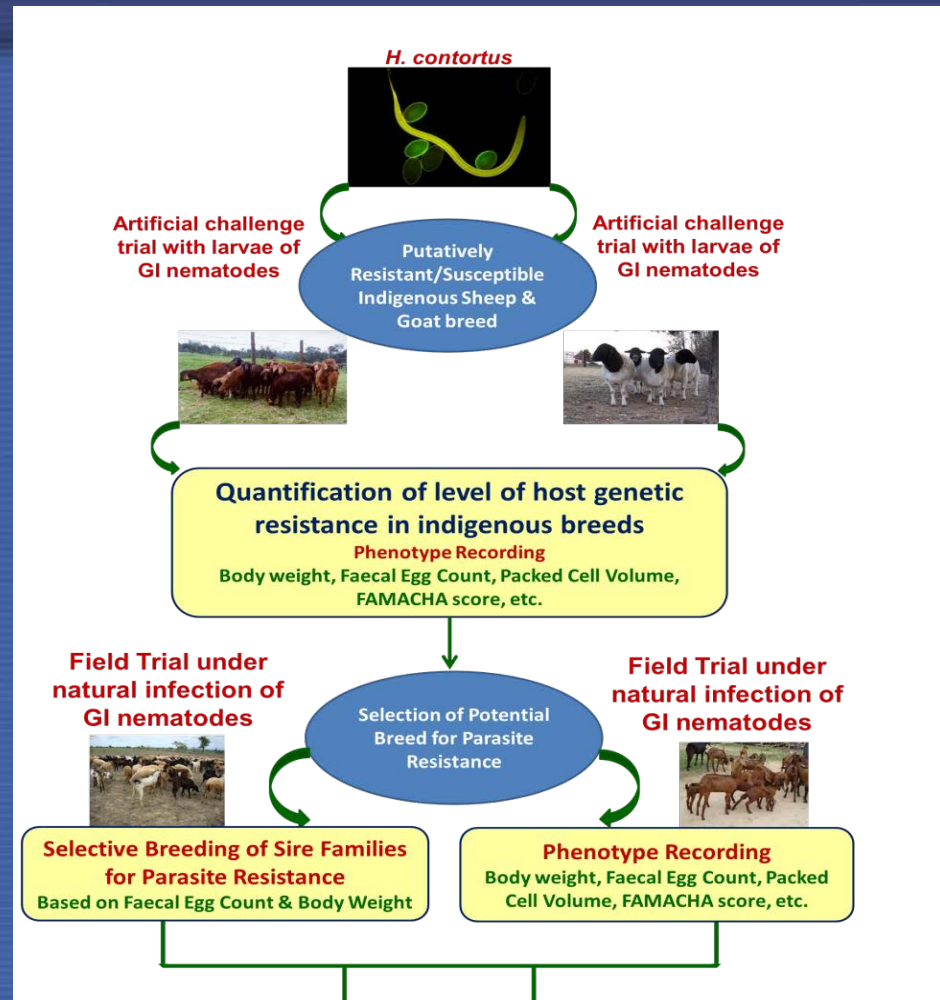
CRP D3.10.26 : Genetic variation for the control of parasite resistance in sheep and goats

- ✓ **Gastrointestinal nematodes impose severe constraints on sheep and goat production (>\$10 billion loss annually)**
- ✓ **Increasing drug resistance among GI nematodes**
- ✓ **12 countries across Asia, Africa and Latin America were supported**
- ✓ **Argentina, Brazil, Ethiopia, Burkina Faso, Nigeria, Pakistan, China, Sri Lanka, Bangladesh, Indonesia, Iran and Saudi Arabia**

CRP D3.10.26: Breeding local sheep/goat breeds for parasite resistance

- Quantification of innate resistance of indigenous sheep/ goat breeds against parasite infections
- Identification of DNA markers for parasite resistance in sheep/goat

Breeding programs with the goal of enhancing host resistance to parasites



OPEN ACCESS Freely available online

PLOS ONE

Candidate Gene Approach for Parasite Resistance in Sheep – Variation in Immune Pathway Genes and Association with Fecal Egg Count

Kathiravan Periasamy^{1*}, Rudolf Pichler¹, Mario Poli², Silvina Cristel³, Bibiana Cetrá⁴, Daniel Medus⁵, Muladno Basar⁶, Thiruvankadan A. K.⁷, Saravanan Ramasamy⁷, Masroor Babbar Ellahi⁸, Faruque Mohammed⁹, Atanaska Teneva¹⁰, Mohammed Shamsuddin¹, Mario Garcia Podesta¹, Adama Diallo¹

1 Animal Production and Health Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, International Atomic Energy Agency, Vienna, Austria, 2 Instituto de Genética "Ewald A. Favre", Instituto Nacional de Tecnología Agropecuaria, Buenos Aires, Argentina, 3 Anguill Experimental Station, Instituto Nacional de Tecnología Agropecuaria Santa Rosa, La Pampa, Argentina, 4 Mercedes Experimental Station, Instituto Nacional de Tecnología Agropecuaria Mercedes, Corrientes, Argentina, 5 Concepción del Uruguay Experimental Station, Instituto Nacional de Tecnología Agropecuaria Concepción del Uruguay, Entre Ríos, Argentina, 6 Department of Animal Sciences, Bogor Agricultural University, Bogor, Indonesia, 7 Veterinary College and Research Institute-Namakal, Tamil Nadu Veterinary and Animal Sciences University, Chennai, India, 8 Department of Animal Genetics and Breeding, University of Veterinary and Animal Sciences, Lahore, Pakistan, 9 Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh, 10 University of Forestry, Sofia, Bulgaria

Genome Wide Association Study (GWAS)

- Genotyping field samples with 50K SNP chip to assess whole genome variation
- Detection of Selection Signature within sheep & goat genome for parasite resistance
- Whole genome association with phenotype

Candidate Gene Study

- Targeted re-sequencing of candidate genes involved in immune pathways, pathogen recognition receptors, adaptive immune response, etc.
- Detection of functional allelic variants
- Association of allelic variants with phenotype

CRP D3.10.28: Application of Nuclear and Genomic Tools to Enable for the Selection of Animals with Enhanced Productivity Traits

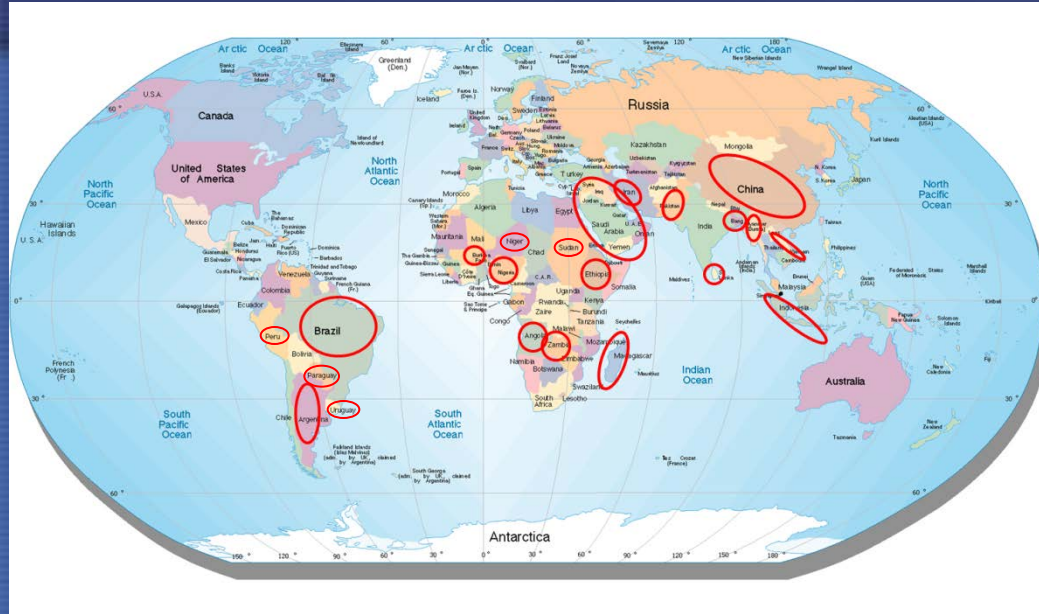
Countries implementing pure breeding program

Argentina China
Peru Serbia

Countries implementing cross breeding program

Bangladesh India
Sri Lanka Kenya
Tunisia South Africa

Support to Technical Cooperation Projects



- ☐ >30 countries are currently supported on AnGR, animal genetic improvement and DNA Barcoding
- ☐ National TCPs: Burkina Faso, Madagascar, Sudan, Papua New Guinea, Bangladesh, Cambodia, Zambia, Peru, Myanmar, Sri Lanka, Malaysia

ARASIA: Regional cooperation in Arab Asia
Genetic characterization of small ruminants

ARCAL: Regional Cooperation in Latin America
Implementing breeding programs to decrease parasite infestation in sheep

Animal Production and Health
Sub-programme



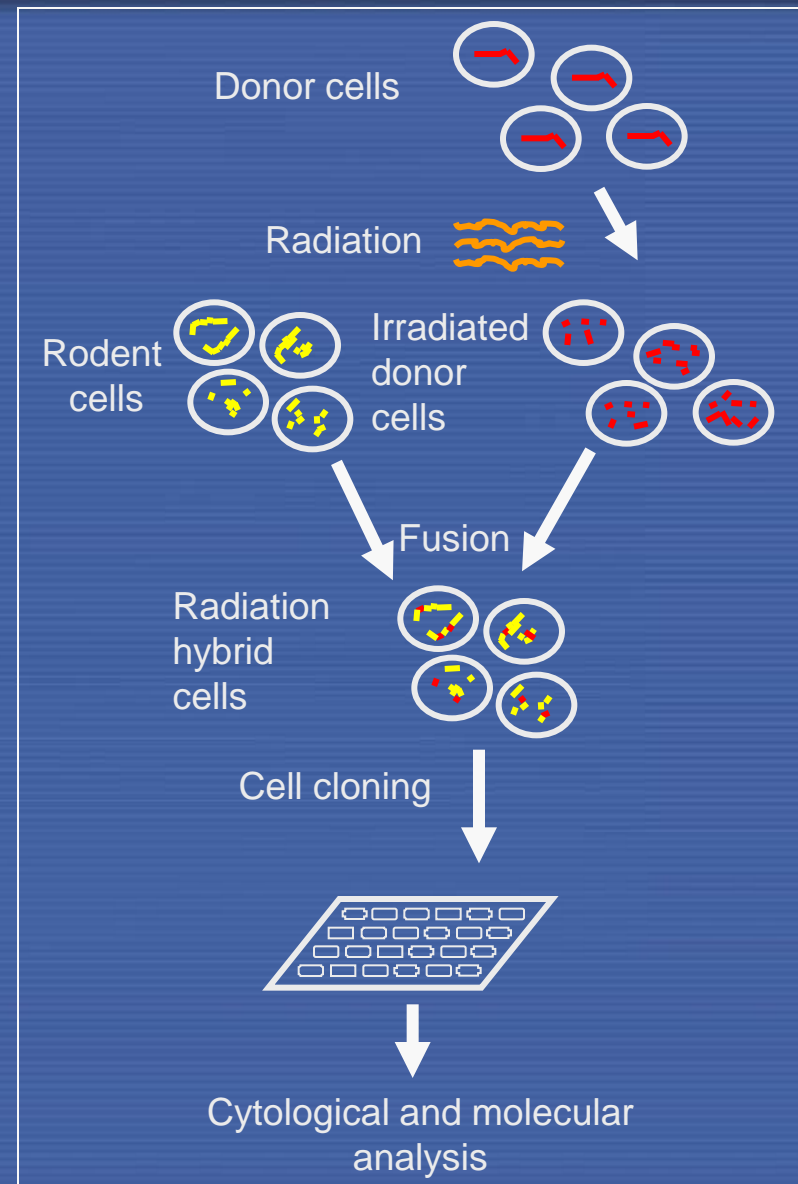
Other Research and Development Activities

- Construction of radiation hybrid panels for mapping livestock genomes
- Development and transfer of Genetics Laboratory Information and Data Management System (GLIDMaS)
- Maintenance of a Global Genetic Repository to promote collaborative animal genetic research
- Support to member states to establish national Gene Banks of performance recorded animals
- Development and transfer of SNP panel for estimation of breed admixture in cattle



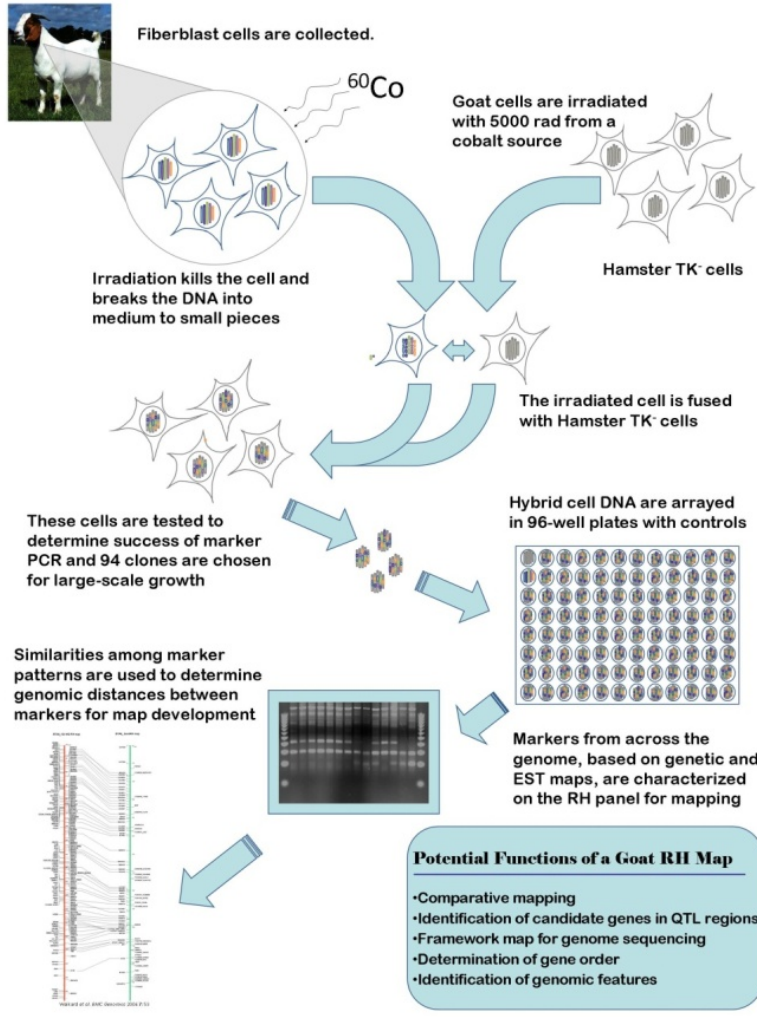
Development of Tools: Radiation Hybrid Panels for Mapping Livestock Genomes (RHMap)

- A method for ordering markers along a chromosome
- Irradiated donor cells are fused with recipient rodent cells
- Hybrid cell lines are grouped in panels of clones
- Each panel contains a set of chromosome fragments produced by radiation-induced breakage
- Clones are screened by PCR amplification to establish the presence of a given marker
- The distances between markers are calculated by statistical models



Tools Development: Radiation hybrid mapping for goats

Goat Radiation Hybrid Map Development



Contents lists available at SciVerse ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres



A whole-genome radiation hybrid panel for goat

X.Y. Du^a, J.E. Womack^b, K.E. Owens^b, J.S. Elliott^b, B. Sayre^c, P.J. Bottcher^d, D. Milan^e, M. Garcia Podesta^f, S.H. Zhao^{a,*}, M. Malek^{f,**}

^a Department of Animal Science and Technology, Huazhong Agricultural University, Wuhan 430070, PR China

^b Department of Veterinary Pathobiology, College of Veterinary Medicine, Texas A&M University, College Station, TX 77843, USA

^c Department of Biology, Virginia State University, Petersburg, VA 23830, USA

^d Animal Production and Health Division, Food and Agriculture Organization of the United Nations, 00153 Rome, Italy

^e Toulouse, INRA, FR (INRA), Laboratoire de Génétique Cellulaire et Biométrie et Intelligence Artificielle, Castanet-Tolosan, France

^f FAO/IAEA Agriculture and Biotechnology Laboratory, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, Wagramer Strasse 5, P.O. Box 100, A-1400, Austria

ARTICLES

nature
biotechnology

OPEN

Sequencing and automated whole-genome optical mapping of the genome of a domestic goat (*Capra hircus*)

Yang Dong^{1,2,12}, Min Xie^{3,12}, Yu Jiang^{1,5,12}, Nianqing Xiao^{10,12}, Xiaoyong Du^{4,12}, Wenguang Zhang^{1,6,12}, Gwenola Tosser-Klopp⁷, Jinhuan Wang¹, Shuang Yang¹, Jie Liang¹, Wenbin Chen¹, Jing Chen¹, Peng Zeng¹, Yong Hou¹, Chao Bian¹, Shengkai Pan¹, Yuxiang Li¹, Xin Liu¹, Wenliang Wang¹, Bertrand Servin⁷, Brian Sayre¹¹, Bin Zhu¹⁰, Deacon Sweeney¹⁰, Rich Moore¹⁰, Wenhui Nie¹, Yongyi Shen^{1,2}, Ruoping Zhao¹, Guojie Zhang¹, Jinquan Li⁶, Thomas Faraut⁷, James Womack⁹, Yaping Zhang¹, James Kijas², Noelle Cockett⁸, Xun Xu¹⁻³, Shuhong Zhao¹, Jun Wang¹ & Wen Wang¹

Du et al. *BMC Genomics* 2014, **15**:625
<http://www.biomedcentral.com/1471-2164/15/625>



RESEARCH ARTICLE

Open Access

An update of the goat genome assembly using dense radiation hybrid maps allows detailed analysis of evolutionary rearrangements in *Bovidae*

Xiaoyong Du^{1,6†}, Bertrand Servin^{2†}, James E Womack³, Jianhua Cao¹, Mei Yu¹, Yang Dong^{4,5}, Wen Wang^{4*} and Shuhong Zhao^{1*}

Tools Development: Construction of Radiation Hybrid Panels for Camels

- ✓ Two RH panels for camels are currently under construction
 - 15000 rad (Male dromedary)
 - 5000 rad (Female dromedary whose genome is sequenced)
- ✓ Screening of clones for retention of donor genome is underway
- ✓ 5000 rad panel will be used for genotyping/sequencing to assemble the genome at chromosome level

Global DNA Bank to promote collaborative animal genetic research

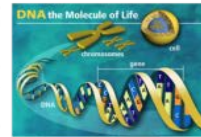


GLOBAL DNA BANK FOR LIVESTOCK BREEDS -AN ARCHIVE OF DOMESTIC ANIMAL GERMLASM

Animal Production and Health Laboratory, Joint FAO-IAEA Division, International Atomic Energy Agency, Seibersdorf Laboratories, Vienna, Austria

INTRODUCTION

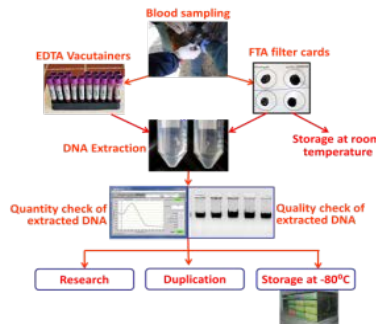
- Livestock breeds/populations have been evolved over centuries due to sustained natural and artificial selection with adaptation to local agricultural production systems and agro-ecological environments
- The domestic animal genetic resource (AnGR) represents a unique source to respond to the present and future needs of livestock production
- With the rapid erosion of animal genetic resources, it is essential to conserve their genetic material either *in situ* or *ex situ*



OUR MISSION

- To collect, preserve and maintain genomic DNA from distinct breeds of various livestock species
- To promote collaborative animal genetic research on indigenous livestock breeds across different countries

THE PROCESS OF DNA ARCHIVING



"Our ultimate aim is to preserve representative genetic variation from all livestock populations around the world"

Expected Benefits

- A global core collection of genetic material from different breeds of various livestock species with easy access and established standards
- Historical archive of livestock biodiversity and *ex situ* conservation of rare and endangered domestic animal germplasm
- Source of genetic material for a wide range of animal researchers to benefit the farmers worldwide



Genetics Laboratory Information and Data Management System



Animal Production
and Health

GLIDMaS

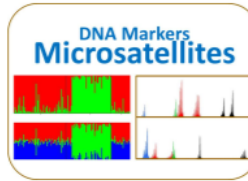
GENETICS LABORATORY INFORMATION
AND DATA MANAGEMENT SYSTEM



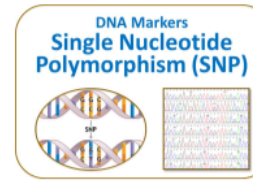
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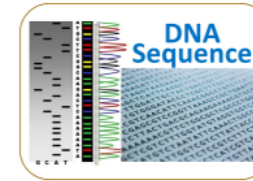
Genetic
Repository



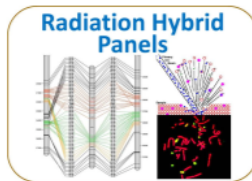
DNA Markers
Microsatellites



DNA Markers
Single Nucleotide
Polymorphism (SNP)



DNA
Sequence



Radiation Hybrid
Panels



Oligos



SOPs.....
Protocols..
Manuals....
References



Archive Data
Retrieve Data

Wednesday, October 05, 2016

User Name:

User Type: #Name?

Administrator



GLIDMaS – Genetic Repository

Samples

View, Edit & Enter Data Manually



Import multiple records



Search and Export



Find:

New Edit Back Home

Sample Information

Sample Provider

Country: Peru
Project Leader: Mario GP
Lab personnel: John

Sample ID PER-BT-SFV-585

Operator: Garcia Podesta, Mario
Autonumber: 585

Date of entry: 07-Sep-16

Sample Information

Place of origin: Lima Sex: Male
Species: Taurine cattle Date of collection:
Breed/Population: Simmental Sample label:
Animal/Specimen ID: Sample type: Blood
Birth date: Collection method: EDTA vacutainer
Estimated age (year/month):

Remarks:




Nucleic Acid Details New Edit

Nucleic acid type:
Concentration (ng/µl):
260/280:
260/230:
Volume (µl):
Yield (ng):
Extraction kit:
Solvent:
Isolation date:

Date of Entry	Room	Freezer	Rack	PER-BT-SFV	Box	Plate	Well	Stock	Edit
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Samples **Import Sample Data** Back Home




Enter your Sample data in the Excel Template sheet

First step: Enter sample information   

Second step: Enter sample NA Details

Third step: Enter sample location

Save the filled template in your computer or an external drive

First step: Upload sample information   

Second step: Upload sample NA Details

Third step: Upload sample location

Warning! An error message may appear if

- One or more records already exist
- If duplicate records have been entered in the template sheet
- If basic information (e.g. The Source, The Animal and The Storage) was not entered before preparing template sheet
- If existing basic information is not matching with data in the template sheet
- Incorrect type of data entered for different variables in the template sheet

Back Home

Search for Samples

Sample Provider

By Country:
By Project Leader:
By Personnel:

Sample Information

By Origin: By Blood Type:
By Species: By Tissue Type:
By Breed / Population: By Collection Method:
By Animal / Specimen ID: By Extraction kit:
By Sex: By Solvent:
By Sample Label: By Nucleic acid:
By Sample Type:

Data Entry

By Sample ID:
By Operator:
By Date of entry: From: 30-Oct-1916 To: 03-Oct-16

Sample Details

By Conc (ng/µl): From: 0.00 To: 3,000.00
By Yield: From: 0 To: 999,000
By Volume (µl): From: 0 To: 3,000

Sample Location

By Rooms:
By Freezer:
By Rack:
By Box:

Search

Reset

Animal Production and Health Laboratory

Capacity building

Individual Training



Training Courses



Field Support Missions



Capacity Building –Group Trainings at Seibersdorf Animal Genetics



Livestock Biodiversity

*DNA based animal breed
characterization*



Capacity Building –Fellowship Trainings, Seibersdorf (Animal Genetics)



Madagascar



Zambia



Burkina Faso



Angola



Pakistan



Myanmar

Field Support Missions

Animal Genetics

Madagascar



*Implementing
Animal Identification
Systems*



*Demonstration/Training
of work flow*

*Establishing Genetics
Laboratories*



Myanmar

12/03/2013 15:08



*Animal Recording
under Field
Conditions to
improve Genetics*



Animal Production and Health Subprogramme



✓ Thanks