
IMAGE

Innovative Management of Animal Genetic Resources

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Deliverable title: Technical workshop in third countries n^o2

Abstract:

A total of three post-graduate training courses were organized in third countries, in addition to those already described in D7.7. The first course was organized in Egypt, by one of the IMAGE partners, the Animal Production Research Institute (APRI), in November 2019. The course was entitled "Management of Livestock and Poultry Genetic Resources within the scope of climate change" and it was attended by 27 trainees, coming from different Egyptian Universities and Research Institutes and other stakeholder entities. The second course was organized by another IMAGE partner, AGROSAVIA in Colombia, in January 2020. The course was entitled "Genomics and its application to conservation and characterization of animal genetic resources", and it was attended by 40 trainees coming from different Universities and Research Institutions in Colombia and Argentina. This course was also offered in live streaming mode and allowed the additional attendance of 6 trainees from Argentina, Cuba and Spain. The third course was organized by partner INRA Morocco in Morocco, in January 2020. The course was entitled "Biobanking for a sustainable management of farm animal genetic resources (FAnGR): novel approaches in genomics, reproductive technologies and economics". The course was attended by 20 trainees, 13 from Morocco, 4 from Tunisia, 2 from Nigeria and 1 from Soudan.

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Organisation name of lead contractor: AGROSAVIA, APRI, INRA Morocco

Contributors: WR, WU, BOKU, INRAE, ULisboa, UCM

Dissemination level: PU

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Executive Summary

| | |
|-----------------------------------|---|
| Background | <p>T7.6 Third countries capacity building</p> <p>T7.5 According to IMAGE training plan, it is important to reinforce the training in third countries in subjects related to the conservation of animal genetic resources, namely using new genomic tools.</p> |
| Objectives | <p>Organization of three post-graduate training courses mainly intended for PhD candidates, researchers and stakeholders to:</p> <ul style="list-style-type: none"> a) disseminate the use of genomic approaches for characterization, management and exploitation of genomic diversity in animals. b) promote stakeholder discussions for the conservation of local animal genetic resources. |
| Methods | <p>The courses had the participation of IMAGE partners and invited experts who provided lectures and practical sessions. During the first course organized in Egypt, the training included lectures, field visits to the National Gene Bank and some AnGR related lab facilities, and stakeholder brainstorming on the major issues of AnGR management to develop a road map for the Innovative Management of Animal Genetic Resources in Egypt. During the second course organized in Colombia the lectures and practicals focused on: a) the assessment of genetic diversity and structure using genomic information; b) detection of selection; c) genotype x phenotype association. At the end of the course, students worked in groups and developed projects using their own data or data available in public databases, in which they have applied in practice the acquired knowledge during the course. Importantly the course was broadcasted in streaming allowing participants from other countries to follow the classes.</p> <p>During the third course which was organized in Morocco, the program included the following themes: a) assessment of genomic diversity; b) progress in genotyping; c) adaptive/productive introgression; d) functional genomics; e) economic assessment of conservation; f) conservation strategies; g) conception and use of animal genebanks; h) sustainable Management of livestock populations; i) legal issues. The training included a field trip and group works. There was also a workshop with stakeholders at the headquarters of INRA Morocco.</p> |
| Results & implications | <p>The three courses achieved high levels of attendance, as a result of an effort of dissemination by IMAGE, in conjunction with local organizers. Although most of the attendants were coming from the country in which the course was organized, nevertheless participants were selected taking into account that they were coming from different Institutions within the country, which implies the course allowed to achieve a broad dissemination within these countries.</p> <p>Group works were very successful. Case studies presented at the training in Morocco provided material for a future cooperation project in PRIMA.</p> |

Management of livestock and poultry genetic resources within the scope of climate change - EGYPT

Aim: To promote an efficient discussion forum including several stakeholders from the community in Egypt in order to make an assessment of the current status on conservation of Egyptian indigenous AnGR and develop a road map for innovative management of AnGR in Egypt.

Scope of the course:

With the aim of assessing the AnGR-related resources in Egypt, the following specific topics were addressed:

- Analysis of policies and legislations dealing with management of AnGR;
- Status of inventory and characterization (phenotypic and molecular), and applicable characterization approaches including adaptation traits;
- Assessment of the current status on conservation of Egyptian indigenous AnGR including community-based utilization programs;
- Assessment of the National Gene Bank (NGB) role in the management of AnGR;
- Building a road map for innovative management of AnGR in Egypt.

Target: A total number of twenty-seven (27) Egyptian trainees participated. The trainees were selected taking into account that their host institutions were from different regions of the country, assuring a wide distribution and thus disseminating to a wide range of Universities and Research centres and targeting researchers working in different scientific disciplines within the scope of AnGR management. This resulted in the selection of trainees from five (5) universities and four (4) research centres across the country. All trainees were scientists in their early to mid-career stages (post-graduate university and research centres students, university staff, and young researchers) in different fields of AnGR management.

Results: The Main Achievements of this course training can be summarized as: 1) Building capacity (awareness and knowledge dissemination; brain storming and group discussion) on different AnGR management themes i.e., policies, inventory and monitoring, characterization and conservation of adapted indigenous AnGR. Workshop sessions covered the current status, gaps, opportunities, and the way-forward for the innovative management of AnGR in Egypt; 2) Development of a framework for innovative management (characterization, utilization and conservation) of prioritized indigenous AnGR resources (Egyptian buffalo and goats, and Fayoumi chicken) was formed, following community-based utilization approach.

Dates: 3-7 November 2019

Venue: Animal Production Research Institute – Agricultural Research Center. Nadi El Said,
Dokki, Giza , Egypt

Instructors:

Institut National de la Recherche Agronomique de Maroc (INRA-Morocco), Morocco

- Badr Benjelloun

Wageningen Research (WR), The Netherlands

- Sipke-Joost Hiemstra

University of Natural Resources and Life Sciences (BOKU), Austria

- Hans Sölkner

Food and Agricultural Organization of the United Nations (FAO), Italy

- Paul Boettcher

| Day 1: Sunday 3rd November 2019 | | |
|---------------------------------|--|--|
| Time | Event | Trainer / Moderator |
| 08:30-09:00 | Arrival and registration | A. Elomda, S. Ahmed |
| | <i>Session 1: Welcome ceremony</i> | |
| 09:00-10:00 | Opening remarks by Deputy Minister of Agriculture, for animal, poultry and fishery production Opening remarks by the ARC President Opening remarks by the ARC Vice President Opening remarks of NC-AnGR Introduction of Participants | HE, Prof. Mona Mehrez Prof. Mohamed Soliman Prof. Sami Darwish Prof. Mostafa Khalil All Participants |
| 10:00-10:30 | Coffee break and Group Photo | |
| 10:30-11:00 | Introduction to IMAGE project, and training workshop. | IMAGE |
| | <i>Session 2: Egyptian AnGR- An Overview</i> | Chairman: Prof. Dr. Momtaz Shahein |
| 11:00-11:30 | Current Status on implementation of GPA for AnGR. | Prof. Mostafa Khalil |
| 11:30-12:00 | The Egyptian Association for Genetic Resources, NGO approach in the Management of local AnGR | Prof. Alaa Eltahan |
| 12:00-12:30 | Egyptian National Strategy and Action Plan for AnGR | Dr. Ahmed Abdelkhalek |
| 12:30 – 13:00 | Plenary Discussion (NSAP-AnGR-EG) | All Participants |
| 13:00-14:00 | Lunch break | |
| | <i>Session 3: Policies and Institutional Capacities</i> | Chairman: Prof Dr. Samir Alsheikh |
| 14:00 – 14:30 | Status on implementation of policies in management of AnGR in Egypt (including Nagoya Protocol) | Dr. Ahmed Imam |
| 14:30-15:30 | Group work: Analysis of AnGR policy(ies) for AnGR utilization, conservation and IPR in Egypt | All attendants. Chairman: Dr. Amin Said Rapporteur: Dr. Ahmed Imam |
| 15:30-16:30 | Group Presentation and Plenary Discussion: AnGR Policies in Egypt. | All attendants. Chairman: Prof. Ahmed Imam Rapporteur: Dr. Amin said |

| Day 2: Monday 4 th November 2019 | | |
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| | <i>Session 4: Characterization and Inventory of AnGR</i> | Chairman: Prof. Ahmed Abdelkhalek Rapporteur: Dr. Amin Said |
| 09:00-09:30 | Phenotypic characterization of adaptation to desert hot dry conditions in small ruminant. | Prof. Mohamed Elshafei |
| 09:30 – 10:00 | Poultry Genetic Resources in Egypt | Prof. Ahmed Galal |
| 10:00-10:30 | Inventory and characterization of AnGR approaches in the African Union, Inter-African Bureau for Animal Resources (AU-IBAR). | Dr. Ayman Rezk Habib |
| 10:30-11:00 | Coffee break | |
| 11:00-11:30 | Utilization of livestock Production System data for supporting inventory and characterization of AnGR | Dr. Reda Elsayed Hammada |
| 11:30-12:00 | Characterization of local buffalo populations | Prof. Islam Faidullah |
| 12:00 - 12:30 | Camel's genetic resources in Egypt: Potential research opportunities. | Dr. Ahmed Sallam |
| 12:30 – 13:00 | Utilization of Natural Genetic Variation to Improve Economically Important Traits in Egyptian Barki Sheep | Prof. Adel Elhoseiny |
| 13:00-14:00 | Lunch break | |
| 14:00-14:30 | Phenotypic characterization; different approaches and purposes (FAO, AGIN and IMAGE) | Dr. Paul Boettcher |
| 14:30-15:00 | Introduction to DAD-IS | Dr. Paul Boettcher |
| 15:00-15:30 | DAD-IS practical exercise | Dr. Paul Boettcher |
| 15:30-16:00 | Genome Screening and Sequencing for some Growth Performance Major Genes in Yangzhou Geese | Dr. Sherief Melak |
| 16:00 – 17:00 | Plenary Discussion: Characterization in Egyptian AnGR, approaches, gaps and opportunities. | All attendants. Chairman: Prof. Islam Faidullah Rapporteur: Dr. Ahmed Sallam |

| Day 3: Tuesday 5 th November 2019 | | |
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| | <i>Continue Session 4: Characterization and Inventory</i> | Chairman : Prof. Dr. Mostafa Khalil |
| 9:00-9:30 | Application of Candidate Genes Approach in genetic improvement programs in livestock | Prof. Maher Khalil |
| 9:30-10:00 | Overview of NextGen and AdaptMap | Prof. Badr Benjelloun |
| 9:30-10:30 | Computer practical exercise on SNP analysis approaches/tools | Prof. Badr Benjelloun |
| 10:30-11:00 | Coffee break | |
| | <i>Session 5: Conservation</i> | |
| 11:00-11:30 | Introduction to AnGR Conservation; approaches, priorities and challenges. | Prof. Hans Sölkner |
| 11:30 – 12:00 | Practice of in situ conservation of endangered livestock breeds – “The case of Austria” | Prof. Hans Sölkner |
| 12:00 - 12:30 | Development of GeneBank Collection | Prof. Sipke-Joost Hiemstra |
| 12:30 – 13:00 | Conservation strategies | Prof. Sipke-Joost Hiemstra |
| 13:00-14:00 | Lunch break | |
| 14:00 – 14:30 | National Gene bank | Prof. Khaled Roshdy |
| 14:30 – 15:00 | Characterization and cryopreservation of AnGR in the National Gene Bank | Prof. Mohamed El-Sayed |
| 15:00-16:00 | Work groups: Analysis of AnGR conservation in Egypt; approaches, priority, gaps and opportunities. | All participants Chairman: Prof. Hans Sölkner. Rapporteur: Prof. Sipke-Joost Hiemstra |
| 16:00 – 17:00 | Plenary Discussion: The road map in Characterization, inventory and conservation of AnGR in Egypt. | Chair: Prof. Samir Alsheikh Rapporteur: Dr. Amin Said |

| Day 4: Wednesday 6 th November 2019 | | |
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| | <i>Session 6:Community-based Conservation</i> | Chairman: Prof Dr. Esam Shehata |
| 09:00-9:30 | Theory of community-based conservation | Prof. Hans Sölkner |
| 09:30-10:00 | Case study on community-based conservation | Prof. Hans Sölkner |
| 10:00 – 10:30 | Utilization of improved local AnGR for food security and improvement livelihood of poor communities in Southern Egypt. | Dr. Othman Elsheikh |
| 10:30-11:00 | Coffee break | |
| 11:00 – 11:30 | Gained experience from trials for genetic improvement of sheep and goats in Egypt and suggested plan for the future | Prof. Essam Shehata |
| 11:30 – 12:00 | Local Genetic Resources of Rabbits in Egypt, A case Study | Dr. Galal Sobhy Aboukhadiga |
| 12:30 – 12:30 | AnGR Association and community-based conservation. A case study: The Egyptian Association for Improving Egyptian Buffalo. | Prof. Layla Nasser |
| 12:30 – 13:00 | Conservation of desert AnGR | Prof. Samir Alsheikh |
| 13:00-14:00 | Lunch break | |
| 14:00 – 14:30 | Recent approaches in in-vitro conservation of Egyptian AnGR applicable in Egypt | Prof. Ayman Mustafa |
| 14:30 – 15:00 | Conservation of Endangered Egyptian geese | Prof. Sayed Mahfouze |
| 15:00 – 15:30 | Cryo-preservation effects on cytogenetic profile | Dr. Mohamed Fahmy |
| 15:00-16:30 | <i>The way forward</i> | All Participants Dr. Ahmed Elbeltagy |

| Day 5: Thursday 7 th November 2019 | | |
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| | <i>Session 7: Initiative to Networking</i> | Chairman: Prof. Dr. Alaa EITahan |
| 09:00-09:40 | Genotyping of Growth Performance Genes in Some Local Sheep Breeds | Eng. Sherief Melak |
| 09:40-10:00 | Molecular characterization in Egyptian cattle | M. Hamada (PhD., APRI) |
| 10:00- 10:20 | Gene expression for reproductive performance in rabbits | Ahmed Elomda (M.Sc., APRI) |
| 10:20-10:40 | Genotyping of Growth Performance Genes in Some Local Sheep Breeds | Eng. Sherief Melak |
| 10:40-11:00 | Coffee break | |
| 11:00 – 12:30 | Initiative: Implementation of the “Egyptian AnGR Network, EAN-Net” “Objectives, and selection of task force”. | IMAGE |
| 12:30-13:00 | <i>Closing ceremony</i> Closing remarks by the NC-AnGR Closing remarks by ARC Vice-President Closing remarks by participants/students (represent.) | Prof. Mostafa Khalil. Prof. Sami Darwish M. Hamada & A. Elomda |
| 13:00-14:00 | Lunch break | |
| 14:00-16:00 | Visit to the National GeneBank, ARC. | All participants |

Genomics and its application to conservation and characterization of animal genetic resources - COLOMBIA

Aim: To provide advanced training on the use of genomic data for the characterization of genetic diversity and develop an understanding of the association between genome diversity and phenotype. A team of international lecturers involved in the IMAGE project, developed a challenging program that included various relevant topics needed to understand and make the best use of genetic diversity.

Scope: With the aim of providing advanced training regarding the characterization of animal genetic diversity using genomic information, the following topics were approached during the course:

- a) measures of genetic diversity
- b) population structure and admixture
- c) analysis of within-breed population genetic diversity and
- d) analysis of between-breed genetic differentiation and admixture
- e) detecting selection signatures using different estimators and strategies
- f) linking genome and phenotype through association analysis
- g) functional impact at the level of biological processes and metabolic pathways
- h) genomic selection

Target: The course was attended by an enthusiastic group of 40 participants coming from a wide range of Universities and Research Institutions from Colombia. Also, the course was attended by streaming by participants in Argentina (5), in Cuba (1) and in Spain (1). Participants were young researchers and University professors, as well as PhD candidates.

Results: With this course, IMAGE has provided capacity building for the use of the most up-to-date genomic tools for the conservation and management of animal populations. For that, participants acquired knowledge regarding the topics described above through lectures and practical classes. In practical modules, the participants were organized into 11 groups (that included some of the participants following the course in streaming mode) and developed projects applying the acquired knowledge to actual genomic data (in conjunction with phenotype data as well as in some cases) of populations of local breeds. These were either their own data, or data obtained from public databases. The results of these projects were presented in the final session by each group.

Dates: 13-17 January, 2020

Venue: AGROSAVIA station, Bogotá, Colombia

Instructors:

University of Lisbon (ULisboa)

- Luís Telo da Gama (LTG)
- Andreia J. Amaral (AJA)

Universidade Complutense of Madrid (UCM), Spain

- Oscar Cortés (OC)

| Day 1: Monday 13 th January 2020 | | |
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| 8:00-9:00 | Welcome | Director of the AGROSAVIA Research station in Tibaitata u Carlos Lucero |
| 9:00-10:00 | Introduction | LTG & OC |
| 10:00-10:15 | Coffee break | |
| 10:15-12:00 | Review of concepts related with the measure of genetic diversity; AnGRs of Argentina | LTG, OC and Maria Antonia Revidatti |
| 12:00-13:00 | Lunch | |
| 13:00-14:00 | Genomic tools and their use in conservation genetics and management of populations | OC |
| 14:00-15:00 | SNP chip panels: conception and usage. Conventional data formats for genotype data. Public databases for genomic data | AJA |
| 15:00-15:15 | Coffee break | |
| 15:15-16:15 | Analysis software: introduction on basic functions | OC & AJA |
| Day 2: Tuesday 14 th January 2020 | | |
| 08:00-09:00 | Analysis software: conclusion | OC & AJA |
| 09:00-10:00 | Principles of genetic characterization and estimation parameters | LTG |
| 10:00-10:15 | Coffee break | |
| 10:15-12:00 | Using runs of homozygosity (ROH) and estimation of linkage disequilibrium (LD) decay. Estimating ancestral effective population size (Ne). | OC |
| 12:00-13:00 | Lunch | |
| 13:00-15:00 | Practical: estimating ROH and LD using PLINK. Estimating ancestral Ne using SNeP | OC & AJA |
| 15:00-15:15 | Coffee break | |
| 15:15-16:15 | Organization of working groups. Kick-off of group projects | AJA, LTG & OC |

| Day 3: Wednesday 15 th January 2020 | | |
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| 8:00-9:00 | Detecting selection signatures across genomes | AJA |
| 9:00-10:00 | Practicals: Introduction to linux; How to access to a remote server and perform basic operations using BASH | AJA |
| 10:00-10:15 | Coffee break | |
| 10:15-12:00 | Practical: Introduction to R and data manipulation in R environment | AJA |
| 12:00-13:00 | Lunch | |
| 13:00-14:00 | Practical: Introduction to principal component analysis (PCA). Using it to identify signatures of selection and genetic markers associated with adaptation (pcadapt R package) | AJA |
| 14:00-15:00 | Practical: Detection of signatures of selection by identifying FST outliers with an inferred neutral distribution (The OutFLANK R package) | AJA |
| 15:00-15:15 | Coffee break | |
| 15:15-16:15 | Relationships between breeds and Principal component analysis | OC |
| Day 4: Thursday 16 th January 2020 | | |
| 08:00-09:00 | Practical: admixture analysis | LTG |
| 09:00-10:00 | Linking phenotype and genotype: principles of genome-wide association analysis | LTG |
| 10:00-10:15 | Coffee break | |
| 10:15-12:00 | Practical: performing GWAS using PLINK Functional impact of selection: biological processes and pathways | AJA |
| 12:00-13:00 | Lunch | |
| 13:00-14:00 | Principles of genomic selection | LTG |
| 14:00-16:15 | Working in groups | AJA & OC & LTG |
| Day 5: Friday 17 th January 2020 | | |
| 08:00-12:00 | Working in groups | AJA, OC ,LTG |
| 12:00-13:00 | Lunch | |
| 13:00-15:45 | Presentation of groups' projects | AJA, OC ,LTG |
| 15:45-16:30 | Plenary discussion: The way forward for the preservation of AnGR in latin America | AJA, OC ,LTG & Maria António Revidatti |

Biobanking for a sustainable management of farm animal genetic resources (FAnGR): Novel approaches in genomics, reproductive technologies and economics - MOROCCO

Aim: To give an update on the role of biobanking for a sustainable management of farm animal genetic resources (FAnGR) with a focus on the use of novel methods in genomics, reproduction, economics and the possibility to carry out practical cases of interest to participants.

Scope: About one third of domestic breeds are considered to be at risk of extinction, as reported by the FAO (DAD-IS, 2019). The Global Plan of Action for Animal Genetic Resources identified conservation as a Strategic Priority Area to be addressed. In order to preserve the genetic diversity of livestock, as a complementary approach to *in-vivo* conservation, the *ex-situ in-vitro* cryoconservation of animal reproductive material represents an excellent and cost-effective alternative. New progress in structural and functional genomics and novel methods in reproductive technology allow for an unprecedented characterization of animal genetic resources and for an effective use of cryo-preserved material. Therefore the course focused on the following themes: a) assessment of genomic diversity; b) progress in genotyping; c) adaptive/productive introgression; d) functional genomics; f) economic assessment of conservation; e) conservation strategies; g) conception and use of animal genebanks; h) sustainable Management of livestock populations; i) legal issues.

Target: Target audience of the course were PhD candidates, post-docs and researchers interested in conservation of animal genetic resources and in genomic characterization of neutral and adaptive diversity. A prerequisite for participants of the course was a strong interest in the conservation of animal genetic resources and a basic knowledge in genetics of farm animals and in currently available genomic tools, i.e. SNP or sequence data. The applicants were therefore asked to provide a short CV (not more than 2 pages) and to hand in a paragraph describing their motivation for the course. The course was attended by 20 PhD candidates or young researchers, 13 from Morocco, 4 from Tunisia, 2 from Nigeria and 1 from Sudan.

Results: With this course, the IMAGE project has successfully provided capacity building for the use of the most up-to-date genomic tools for the conservation and management of domestic animal populations. Using a similar methodology as in previous IMAGE courses, participants acquired knowledge regarding the topics described above through lectures and practical classes.

Students developed projects in which they had the opportunity to apply the recently acquired knowledge and discuss the results with lecturers. Five groups were made, mixing countries and experience. As a first step to develop practical projects, participants shared information within each group regarding the status of animal genetic resources in their countries (all species). Then they were invited to select the case for which they wanted to make a proposal for improving/implementing biobanking. At the end, participants had the

opportunity to present their proposal in a plenary session. They prepared slides and illustrated a range of situation for cattle, sheep, goat, camel.

Dates: 21-24 January, 2020 ; Venue: INRA Morocco, Beni Mellal city, Morocco

Instructors:

Wageningen Research, The Netherlands

- Sipke Joost Hiemstra

French National Institute for Agricultural Research, France

- Michèle Tixier-Boichard
- Gwendal Restoux
- Philippe Monget
- Julie Demars

Moroccan National Institute for Agricultural Research, Morocco

- Badr Benjelloun
- Bouchra ElAmiri

University of Edinburgh, United Kingdom

- Dominic Moran, Rafael Silva

The training was preceded by a seminar for stakeholders, organised in French at the headquarters of INRA Morocco in Rabat.

The programme was introduced by the director of INRA Morocco, Dr Faouzi Bekkaoui and by Dr Michèle Tixier-Boichard, coordinator of IMAGE, it featured the following presentations

- Impact des changements climatiques sur les systèmes d'élevage et les systèmes d'élevage ;
Dr Abdelmajid Bechchari (INRA-Maroc), et al
- Diversité et valorisation des ressources génétiques locales au sein des animaux d'élevage au Maroc. Cas des petits ruminants.
Dr Badr Benjelloun (INRA-Maroc), et al
- Conservation des animaux d'élevage au Maroc.
Dr Mouad Chentouf et Dr Mustapha Ibbelbachyr (INRA-Maroc)
- Stratégies mondiales de conservation des ressources génétiques animales
Dr Gregoire Leroy (FAO)
- Réseau européen ERFIP Dr Sipke-Joost Hiemstra, (WR)
- Analyse économique de la diversité génétique chez les animaux d'élevage
Dr Dominic Moran (U. Edinburgh, UK)
- Implémentation, gestion et utilisation des banques de gènes animales.
Dr Michèle Tixier Boichard (INRAE-France) et Dr Coralie Danchin (IDELE)
- Success stories:

(i) La banque de gènes des plantes de l'INRA-Maroc. Dr Ali Sahri (INRA-Maroc),

(ii) Les banques de gènes des animaux en France. Dr Michèle Tixier-Boichard

| Day 1: Tuesday 21 st January 2020 | | instructors |
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| 09:00 - 10:30 | Lecture 1: Introduction to genetic diversity in Livestock species. Domestication, local adaptation, diversification of livestock species. | Badr Benjelloun & Michèle Tixier Boichard |
| 10:30-11:00 | Coffee break | |
| 11:00 - 12:30 | Lecture 2: Conservation strategies (in situ, ex situ). | Sipke-Joost Hiemstra |
| 12:30-13:30 | Lunch | |
| 13:30 - 15:00 | Lecture 3: Building genebank collections and using stored material. | Sipke-Joost Hiemstra |
| 15:00-15:30 | Coffee break | |
| 15:30 - 17:00 | Lecture 4: Advances in cryoconservation technologies. | Philippe Monget (skype) & Bouchra El Amiri |
| 17:00-19:00 | Forming groups | |
| 19:30 | Dinner | |
| Day 2: Wednesday 22 nd January 2020 | | |
| 09:00 - 10:30 | Lecture 5: Genome neutral and adaptive diversity. | Gwendal Restoux & Badr Benjelloun |
| 10:30-11:00 | Coffee break | |
| 11:00 - 12:30 | Exercise: Introduction to Linux and Measures of genomic diversity from SNP data | Badr Benjelloun & Gwendal Restoux |
| 12:30-13:30 | Lunch | |
| 13:30 - 15:00 | Lecture 6: Functional genomics. | Julie Demars |
| 15:30 - 17:00 | Exercise: Neutral/Adaptive diversity and decisions for balancing conservation/production. | Gwendal Restoux, Badr Benjelloun. |
| 17:00-19:00 | Group work | |
| 19:30 | Dinner | |

| Day 3: Thursday 23rd January 2020 | | |
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| 09:00 - 10:30 | Lecture 7: Equipment and infrastructure and quality management. | Michèle Tixier Boichard & Bouchra El Amiri |
| 10:30-11:00 | Coffee break | |
| 11:00 - 12:30 | Lecture 8: Economic assessment of diversity and gene banking policies. | Dominic Moran & Rafael Silva |
| 12:30-13:30 | Lunch | |
| 13:30 – 16:30 | Field trip: visit of Sardi herds in Tadla area. Discussion with the association of sheep breeders. | Whole group |
| 16:30-17:00 | Coffee break | |
| 17:00-19:00 | Group work: Decision on conservation in a given situation: Moroccan goats | |
| 19:30 | Dinner | |
| Day 4: Friday 24th January 2020 | | |
| 09:00 - 10:00 | Lecture 9: Current solutions on genotyping/sequencing and advances - Potential of nanopore technologies for genotyping for instance – IMAGE multispecies DNA chip. | Michèle Tixier Boichard & Badr Benjelloun |
| 10:00- 11:15 | Lecture 10: Adaptive/productive introgression - genome editing e.g. Introgression of blue egg in poultry. | Michèle Tixier Boichard in the name of Claudia Dierks (UGOE) |
| 11:15-11:30 | Coffee-break | |
| 11:30 - 12:30 | Lecture 11: Legal issues, property of the cryopreserved material, Nagoya Protocol. | Michèle Tixier Boichard |
| 12:30-13:30 | Lunch and group picture | |
| 14:30 - 18:00 | Presentation of group works | Gwendal Restoux, Badr Benjelloun, Michèle Tixier Boichard, Bouchra El Amiri |
| 19:30 | Dinner | |
| Day 5: Saturday 25th January, 2020: Pleasure trip in the Atlas area (optional) | | |