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COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 3.1 of the Provisional Agenda

INTERGOVERNMENTAL TECHNICAL WORKING GROUP ON ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Tenth Session

Rome, 27 - 29 June 2018

DETAILED FAO PROGRESS REPORT ON THE IMPLEMENTATION OF THE GLOBAL PLAN OF ACTION FOR ANIMAL GENETIC RESOURCES

TABLE OF CONTENTS

I. INTRODUCTION

The Commission on Genetic Resources for Food and Agriculture (Commission), at its Sixteenth Regular Session,[1] requested FAO to continue supporting countries in their efforts to implement the Global Plan of Action for Animal Genetic Resources[2] (Global Plan of Action). The document *Status of Implementation of the Global Plan of Action for Animal Genetic Resources*[3] provides an overview of activities undertaken between the Fifteenth and Sixteenth Regular Sessions of the Commission. This document provides a more detailed report on FAO activities since the Ninth Session of the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture (Working Group). The activities are grouped according to their relevance to the four strategic priority areas of the Global Plan of Action.

II. *THE SECOND REPORT ON THE STATE OF THE WORLD'S ANIMAL GENETIC RESOURCES FOR FOOD AND AGRICULTURE*

The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture[4] (Second Report) was launched in January 2016 at a ceremony held at FAO headquarters. Since the launch, FAO has continued to disseminate the Second Report widely, including its in-brief[5] and brochure[6] versions, which are available in all official languages of the United Nations. With the support of the Government of China, a Chinese version of the Second Report has been prepared and distributed. Translations of the "in brief" version of the Second Report into other languages have been undertaken by stakeholders on a voluntary basis.

Four articles have been published in scientific journals on the basis of in-depth analyses of the country-report data provided for preparation of the Second Report (see Annex 4 for details).

III. REPORTING AND AWARENESS-RAISING ON THE GLOBAL PLAN OF ACTION

As invited by the Commission at its Sixteenth Regular Session,[7] in July 2017 the Director-General of FAO brought the draft resolution *Reaffirming the World's Commitment to the Global Plan of Action for Animal Genetic Resources*[8] to the attention of the Fortieth FAO Conference. The resolution was endorsed.[9]

The Global Focal Point for Animal Genetic Resources (Global Focal Point) has continued to distribute printed versions of the Global Plan of Action and related products and guidelines and prepare articles for the scientific press. Annex 4 provides a list of documents published since the Ninth Session of the Working Group. The website "Implementing the Global Plan of Action for Animal Genetic Resources"[10] (available in English, French and Spanish) continues to provide information under the following headings: information resources; intergovernmental process; national implementation; regional collaboration; activities of international organizations; support to countries; funding strategy; call for support; reporting system; and global assessments. The website is currently undergoing a complete redesign and the new version will be launched during the second half of 2018.

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[1] CGRFA-16/17/Report/Rev.1, paragraph 45.
[2] www.fao.org/docrep/010/a1404e/a1404e00.htm
[3] CGRFA-16/17/13.
[4] CGRFA-15/15/Inf.17.1,2 and 3.
[5] http://www.fao.org/3/a-i5077a.pdf, http://www.fao.org/3/a-i5077c.pdf http://www.fao.org/3/a-i5077e.pdf http://www.fao.org/3/a-i5077f.pdf http://www.fao.org/3/a-i5077r.pdf http://www.fao.org/3/a-i5077s.pdf
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[7] CGRFA-16/17/Report/Rev.1, paragraph 50.
[8] C 2017/25, Appendix B.
[9] C 2017/REP, paragraph 54.
[10] http://www.fao.org/ag/angr.html

With regard to raising awareness within FAO on the importance of animal genetic resources, in January 2017 the Global Focal Point, including colleagues in Rome and at the FAO/International Atomic Energy Agency (IAEA) Joint Division on Nuclear Techniques in Food and Agriculture (AGE) in Vienna, were conferred an Outstanding Teamwork Achievement Award by FAO's Agriculture and Consumer Protection Department. The award recognized the Global Focal Point for its activities and superior accomplishments in supporting the Global Plan of Action.

IV. CAPACITY-BUILDING AND TECHNICAL SUPPORT TO THE IMPLEMENTATION OF THE GLOBAL PLAN OF ACTION AT NATIONAL LEVEL

The Global Plan of Action[11] refers to the essential role of FAO in supporting country-driven implementation efforts, in particular in the following areas: facilitating global and regional collaboration and networks; supporting the convening of intergovernmental meetings; maintaining and further developing the Domestic Animal Diversity Information System (DAD-IS);[12] developing communication products; providing technical guidelines and assistance, and coordinated training programmes; promoting the transfer of technologies related to the sustainable use, development and conservation of animal genetic resources; and coordinating preparation of global status and trends reports on animal genetic resources.[13] The following paragraphs provide a detailed description of FAO activities in each strategic priority area of the Global Plan of Action.

A. Strategic Priority Area 1. Characterization, inventory and monitoring of trends and risks

Institutional and technical support

FAO continued to contribute to the 2010 Biodiversity Indicators Partnership (BIP),[14] and finalized work on proposals for indicators related to the Sustainable Development Goals (SDGs),[15] specifically under Target 2.5: "By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed". Goal 2: "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".[16]

Two indicators were proposed:

- SDG Indicator 2.5.1: Number of plant and animal genetic resources for food and agriculture secured in either medium or long term conservation facilities.
- SDG Indicator 2.5.2: Proportion of local breeds classified as being at risk, not-at-risk or at unknown level of risk of extinction.

During the approval process, indicators are assigned to "tiers" on the basis of their level of methodological development and the availability of data at global level, with Tier 1 being the highest level. Both indicators were upgraded to Tier 1, indicating international approval, at the sixth meeting of Inter-Agency and Expert Group on Sustainable Development Goal Indicators, in November 2017. DAD-IS is recognized by the United Nations Statistical Commission as the source of information on animal genetic resources for the calculation of SDG Indicators 2.5.1 and 2.5.2.[17]

[11] Global Plan of Action for Animal Genetic Resources, paragraph 58–61.
[12] http://www.fao.org/dad-is
[13] Global Plan of Action for Animal Genetic Resources, paragraph 22–23, Strategic Priority 14.
[14] http://www.bipindicators.net/about
[15] http://www.un.org/sustainabledevelopment/sustainable-development-goals
[16] http://www.un.org/sustainabledevelopment/hunger
[17] https://unstats.un.org/sdgs/metadata

With funds from the FAO Regular Programme budget and extrabudgetary support from the Government of Germany, the Global Focal Point has continued to maintain and further develop and update DAD-IS. The Commission, at its Sixteenth Regular Session,[18] stressed the importance DAD-IS as the international clearing-house mechanism for animal genetic resources and welcomed the development of the updated version.

The new version of DAD-IS was launched at FAO headquarters in November 2017. The launch event was followed by a training workshop attended by 68 National Coordinators for the Management of Animal Genetic Resources (National Coordinators) and government statisticians from a total of 46 countries. More detailed information on the development of DAD-IS is presented in the documents *Report on the status of the development of the Domestic Animal Diversity Information System*[19] and *Detailed analysis of the Domestic Animal Diversity Information System with focus on population data*.[20]

In 2009, the Commission requested FAO to make status and trends reports on animal genetic resources available to the Commission at each of its regular sessions.[21] FAO has prepared a report of this kind for each subsequent session. The document *Status and trends of animal genetic resources – 2018*,[22] has been prepared for review by the Working Group. The status report is based on information entered into DAD-IS by National Coordinators. Currently, 179 countries have a nominated National Coordinator.

Since 2016, the proportions of avian and mammalian national breed populations for which population data are available have improved slightly, from 57 to 58 percent and from 61 to 62 percent, respectively. The new version of DAD-IS has, for the first time, allowed risk status to be classified according to the system described in the guidelines In vivo *conservation of animal genetic resources*,[23] which was approved with the endorsement of the guidelines by the Commission at its Fourteenth Regular Session.[24,25] Among the 8 803 breeds recorded in DAD-IS, 24 percent are currently classified as being at risk, 10 percent are classified as not at risk, 59 percent have unknown risk status and 7 percent are reported to be extinct.[26]

FAO has in the last two biennia supported characterization of local populations through two Technical Cooperation Projects (TCP), "Élaboration d'un plan d'action national pour la gestion et l'amélioration des ressources génétiques animales au Burundi" (TCP/BDI/3402) and "Survey and characterization of livestock breeds and their production systems in Liberia for the development of a national strategy and action plan for animal genetic resources" (TCP/LIB/3502). Since the last session of the Working Group three scientific publications have been produced through the analysis of breed-related data collected through these projects (see Annex 4).

AGE has provided technical support to 28 countries[27] on phenotypic and molecular characterization of locally adapted breeds. AGE has continued to maintain and enrich the Global Genetic Repository of Livestock at its Animal Production and Health Laboratory (AGE-APHL) in Seibersdorf, Austria, to

[18] CGRFA-16/17/Report/Rev.1, paragraph 46.
[19] CGRFA/WG-AnGR-10/18/3.
[20] CGRFA/WG-AnGR-10/18/ Inf.6.
[21] CGRFA-12/09/Report, paragraph 39.
[22] CGRFA/WG-AnGR-10/18/Inf.3.
[23] http://www.fao.org/docrep/018/i3327e/i3327e00.htm
[24] CGRFA-14/13/Report, paragraph 60.
[25] CGRFA-14/13/12, paragraph 12.
[26] CGRFA/WG-AnGR-10/18/Inf.3.
[27] Argentina, Bangladesh, Bolivia (Plurinational State of), Brazil, Burkina Faso, Cambodia, Costa Rica, Cuba, Dominican Republic, El Salvador, India, Iraq, Kenya, Malaysia, Mali, Mexico, Niger, Nigeria, Paraguay, Peru, Serbia, South Africa, Sri Lanka, Sudan, Tunisia, Uruguay, Venezuela (Bolivarian Republic of), Zambia.

help preserve genomic DNA from global animal genetic resources and to promote collaborative research in developing countries. At present, the repository maintains about 8 500 DNA samples belonging to more than 130 breeds of various livestock species including cattle, sheep, goat, buffalo, pig, alpaca, chicken and guinea fowl.

Research and capacity-building

To facilitate global analysis of breed diversity through molecular genetic characterization, FAO has continued its partnership with the International Society for Animal Genetics (ISAG),[28] through the ISAG/FAO Advisory Group on Animal Genetic Diversity. FAO attended the 36th (2016) and 37th (2017) ISAG Conferences, in the United States of America and Ireland, respectively, and gave presentations on the Second Report (2016) and on SDG Indicators 2.5.1 and 2.5.2 (2017). FAO continues to promote the international use of standard marker sets for the various species of livestock. Technical assistance was provided to Jordan in the genetic characterization of local Awassi sheep to draw inference on the genetic basis of the earless trait in this breed.

In June 2017, FAO presented guest lectures at the Training Workshop on Molecular Genetic Characterization of Domesticated Animals, which was sponsored and organized by the Asian Food and Agriculture Cooperation Initiative (AFACI) and held in at the headquarters of the Rural Development Administration of the Republic of Korea. Ten young scientists from nine countries[29] participated.

Since the Ninth Session of the Working Group, AGE has supported in-country research on the characterization of 41 breeds or populations of cattle, sheep, goat and guinea fowl across five countries through various national and regional TCP. From 2016 to 2018, six IAEA National Technical Cooperation Projects (TCP) and one Regional TCP in Latin America (ARCAL) with an active component on animal genetic resource characterization were implemented by AGE: 1) "Genetically Characterising and Improving Productivity of Cattle by Enhanced Reproduction and Better Feeding" in Papua New Guinea (TCP/PAP5002); 2) "Conducting Genetic Characterization of Alpacas for Resistance to Diseases" in Peru (TCP/PER5032); 3) "Improving Livestock Production for Enhanced Food Security through Genetic Improvement of Indigenous Animal Breeds Using Artificial Insemination, Improved Nutrition and Adequate Animal Disease Control Measures" in Sudan (TCP/SUD5036); 4) "Using Modern Animal Breeding Methods, Nuclear and Genomic Tools to Improve Dairy Production in Smallholder Production Systems" in Burkina Faso (TCP/BKF5017); 5) "Supporting Sustainable Livestock Production" in Cambodia (TCP/KAM5003); 6) "Building Capacity to Improve Dairy Cows Using Molecular and Nuclear Techniques" in Bangladesh (TCP/BGD5030); and 7) "Decreasing the Parasite Infestation Rate of Sheep" in the Latin American region (TCP/RLA5071).

AGE also organized two expert meetings to develop guidelines and support phenotypic characterization for enhanced genetic resistance among locally adapted sheep breeds in Latin America. The meetings were held in 2016 in Paraguay and in 2017 in Bolivia (Plurinational State of). Further information on these meetings is provided in Annex 1. To help address the issue of the lack of availability of genomic tools and resources for less common livestock species, AGE-APHL developed radiation-hybrid panels for camels. AGE transferred the panels to members of International Camel Genome Consortium in early 2018. To assist animal genetic laboratories in developing countries to manage their genetic repositories and molecular genetic data on indigenous livestock breeds, AGE developed a database application called Genetics Laboratory Information and Data Management System and transferred the system to four countries.[30] An online training event to demonstrate the

[28] http://www.isag.us.
[29] Bhutan, Cambodia, Indonesia, Kyrgyzstan, Lao People's Democratic Republic, Nepal, Sri Lanka, Thailand, Viet Nam.
[30] Bangladesh, Burkina Faso, India, Pakistan, Sri Lanka.

system was organized for seven participants from the respective countries. Between 2016 and 2018, AGE trained 13 fellows from nine countries[31] in DNA marker based genetic characterization of animal breeds. The fellowships were held at AGE-APHL and ranged from one to three months in duration. AGE also implemented three regional training courses and one national training course on the characterization of animal genetic resources. Details can be found in Annex 3.

B. Strategic Priority Area 2. Sustainable use and development

Institutional and technical support

In response to the need for technical assistance to ensure the better use and development of animal genetic resources, FAO has further invested in providing assistance in these fields, both directly and through cooperation with other organizations.

Small-scale livestock keepers may be reluctant to invest in development of animal genetic resources if a reliable market for livestock products is not available. The specific characteristics of small-scale livestock production systems (i.e. multi-functionality, input and output provision, etc.) underline the need to analyse value chains in a holistic manner, considering not only the supply chain itself but also its broad environment, its dynamics and its connections to other systems. To assist small-scale livestock producers and other stakeholders in this regard, FAO has prepared the document *Draft guidelines on developing sustainable value chains for small-scale livestock producers*,[32] which is available for review by the Working Group. The draft guidelines are a practical tool, providing guidance in development-thinking and intervention design, considering livestock value chains and targeting particularly small-scale livestock producers.

With the support of the Bill and Melinda Gates Foundation, FAO undertook an evaluation of small-ruminant value chains in Burkina Faso and Ethiopia. This project (MTF/GLO/686/BMG) was an initial phase of a cooperative agreement that is expected to continue in the form of a new project that will develop these value chains, including the establishment of community-based breeding programmes (CBBP). In September 2016, FAO provided technical support to Kuwait for the development of two projects to develop and modernize breeding programmes for locally adapted dairy cattle and small ruminants.

Various countries have requested FAO's technical and financial assistance to develop their animal identification and traceability systems. In the Latin America and the Caribbean region, FAO is supporting Suriname (TCP/SUR/3501) in the development of its animal establishment registration system and an animal identification and traceability system. In June 2017, FAO formally launched a project in Georgia (GCP/GEO/009/SWI) that will establish a national animal identification and traceability system. This project, which is primarily supported by the Governments of Austria and Switzerland, with additional support from the Government of Georgia and FAO, will run for six years.

FAO is supporting several countries with technical or financial assistance to improve the management of local livestock populations. The Lao People's Democratic Republic has launched a project (TCP/LAO/3607) to improve the capacity of government staff to support livestock keepers and other stakeholders involved in the management of local breeds. Saudi Arabia (UTF/SAU/044/SAU) and Mauritania (TCP/MAU/3501 and UTF/MAU/026/MAU) have set up unilateral trust funds (UTF) to finance projects involving technical support from FAO for the establishment and operation of research centres for local camel populations. Azerbaijan (TCP/AZE/3502) has sought to improve cattle breeding by strengthening artificial insemination services. Tonga (TCP/TON/3602) has a project involving both cattle and sheep production.

[31] Argentina, Austria, Burkina Faso, India, Iraq, Malaysia, Nigeria, Papua New Guinea, Sudan.
[32] CGRFA/WG-AnGR-10/18/ Inf.4.

Other countries are receiving FAO support through projects that emphasize the application of genetics to the broad goal of increasing food security. Among these countries, the Democratic People's Republic of Korea has a project (TCP/DRK/3604) on improving pig breeding. Nepal (UTF/NEP/073/NEP) is benefiting from FAO technical assistance in the management of local and exotic goat and chicken genetic resources. Myanmar has included distribution of improved local breeds of livestock in a project (UNJP/MYA/702/WFP) aimed at increasing the access of vulnerable communities to more stable sources of food.

Throughout the reporting period, FAO has continued to provide technical support to Mongolia in the sustainable development of animal genetic resources in conjunction with the World Bank-sponsored Livestock and Agricultural Project (LAMP), including by backstopping a unilateral trust fund project (UTF/MON/009/MON). In particular, LAMP has supported the adoption of improved breeding practices for small ruminants. LAMP was operationally closed in December 2017 and is serving as the model for a larger-scale World Bank project on livestock production. FAO has provided technical support to the design of the larger project. FAO is serving a similar role for World Bank projects in Bangladesh, Ethiopia and Pakistan.

FAO has continued its work in support of small-scale livestock keepers and pastoralists. Specifically, with extrabudgetary support from Germany (GCP/GLO/536/GER; GCP/GLO/311/GER), FAO has continued to operate the Pastoralist Knowledge Hub[33] to improve the capacity of pastoralist livestock keepers and facilitate communication among them. The Hub brings together pastoralist networks and organizations working with them in order to promote collaboration and enhance pastoral development and pastoralist-friendly policy interventions. The Hub aims to give pastoralists a voice by strengthening their capacities and by linking their representatives to policy dialogue.

AGE has continued to provide FAO and IAEA member states with much-required technical support on sustainable management, utilization and improvement of animal genetic resources through various IAEA national and regional TCP. In particular, emphasis has been given to improving animal identification, performance recording and artificial insemination networks in Asia, Africa and Latin America. Animal identification toolkits were provided to member countries following the standards and guidelines of ICAR. Each toolkit consisted of electronic readers, ear tag or bolus applicators and radio frequency identification (RFID) based ear tags or boluses for the identification of 500 animals. Between 2016 and 2018, more than 10 000 RFID ear tags or boluses were supplied to 15 countries[34] to enable identification of at least 500 animals per breed for phenotypic recording. Madagascar is using the toolkit for animal identification and for recording the growth and dairy performance of local Malagasy Zebu cattle, while Burkina Faso is using the toolkit in a CBBP for the improvement of native Zebu Peuhl cattle. Countries in Latin America are utilizing the toolkits to enable phenotype recording of parasite resistance traits in their local sheep.

Artificial insemination using frozen semen technology is an important means of multiplying superior germplasm for sustainable improvement of livestock productivity. To assist eight countries[35] in Africa and Asia that have little or no local production of cattle semen, AGE provided support with the equipment and supplies required for functional semen-cryopreservation laboratories. Technical support was also provided by AGE to Bangladesh and Sri Lanka to enhance the scale of frozen semen and embryo production. This support was crucial to the respective national artificial insemination programmes, as it helped these countries achieve significant gains not only in improving the scale of semen production, but also in conserving germplasm from locally adapted breeds. An international workshop on "Community-based livestock breeding programmes (CBBP) in tropical environment countries", organized by AGE in collaboration with University of Natural Resources (BOKU)

[33] http://www.fao.org/pastoralist-knowledge-hub/en

[34] Argentina, Bangladesh, Bolivia (Plurinational State of), Burkina Faso, Costa Rica, Cuba, Dominican Republic, Madagascar, Mauritania, Mexico, Paraguay, Peru, Sierra Leone, Togo, Uruguay, Venezuela (Bolivarian Republic of).

[35] Benin, Burkina Faso, Cambodia, Cameroon, Eritrea, Madagascar, Mauritania, Togo.

(Vienna), the International Livestock Research Institute (ILRI) and the International Centre for Agricultural Research in the Dry Areas (ICARDA), was held in September 2016 in Vienna, Austria. The workshop, which focused on the application of CBBP to strategize animal breeding in low-input production systems, was attended by 41 participants.

Research and capacity-building

FAO has continued to collaborate with the Animal Genomics and Improvement Laboratory of the United States Department of Agriculture (USDA) as part of the African Goat Improvement Network (AGIN) project,[36] sponsored by the United States Agency for International Development (USAID), which has undertaken characterization of African goat breeds and established CBBP. FAO cooperated with the USDA and the Agricultural Research Council (ARC) of South Africa to organize the Fifth AGIN Workshop, which was hosted by ARC in October 2017. The workshop was attended by 50 persons from 21 countries,[37] including several National Coordinators. FAO supported the participation of scientists from seven countries[38] that are either operating their own CBBP or have planned such programmes through FAO projects.

FAO continued to contribute to the European Union-sponsored COST (European Cooperation in Science and Technology) Action METHAGENE,[39] on "Large-scale methane measurements on individual ruminants for genetic evaluations". The objectives of METHAGENE are to discuss and identify the best approaches to measuring methane emission from dairy cattle and incorporating methane emissions into national breeding strategies. Staff from FAO attended the third METHAGENE meeting, which was held in Padua, Italy in October 2016. The meeting was preceded by an international symposium on "Livestock production efficiency", where the attending FAO staff member gave an invited presentation entitled "Improving the efficiency of dairy production: a holistic perspective". More than 50 people attended the meeting.

AGE is currently implementing a Coordinated Research Project (CRP) on "Application of nuclear and genomic tools to enable the selection of animals with enhanced productivity traits".[40] The CRP targets the development and application of molecular genetic tools to evaluate, select and breed dairy cattle for rapid but sustainable improvement of milk productivity in member states. Research contracts have been awarded to institutes in ten countries.[41] The first research coordination meeting was conducted Vienna in October, 2016 with participation of all ten research contract holders and experts from Austria, Kenya, Italy and the United States of America. In 2017, AGE organized an expert meeting on "Nuclear and nuclear-derived techniques for early pregnancy diagnosis in cattle". Between mid-2016 and mid-2018, AGE implemented seven national[42] training courses on a range of topics including artificial insemination, techniques for reproductive hormone estimation, animal identification, and recording phenotype and performance data in cattle and small ruminants. A total of 111 professionals from the respective countries were successfully trained. AGE also implemented a regional course on "Assisted reproductive techniques to enhance small ruminant productivity", attended by 16 professionals from nine countries.[43] Additional information about these courses is provided in Annex 3.

[36] http://www.ars.usda.gov/Research/docs.htm?docid=23010
[37] Austria, Azerbaijan, Brazil, Egypt, Ethiopia, France, Italy, Kenya, Liberia, Madagascar, Malawi, Mongolia, Mozambique, Nigeria, Republic of Korea, South Africa, Uganda, United Kingdom, United Republic of Tanzania, United States of America, Zimbabwe.
[38] Azerbaijan, Kenya, Liberia, Madagascar, Mongolia, Mozambique, United Republic of Tanzania.
[39] http://www.methagene.eu
[40] https://www.iaea.org/projects/crp/d31028
[41] Argentina, Bangladesh, China, India, Kenya, Peru, Serbia, South Africa, Sri Lanka, Tunisia.
[42] Bangladesh, Benin, El Salvador, Madagascar, Mauritania, United Republic of Tanzania.
[43] Argentina, Bolivia (Plurinational State of), Brazil, Costa Rica, El Salvador, Mexico, Paraguay, Peru, Uruguay.

Awareness-raising and information

Many local breeds provide ecosystem services beyond the production of food and other marketable products. These services are often underappreciated or entirely unrecognized. To help increase awareness of these services, the Global Focal Point, through its contribution to FAO's Major Area of Work on Ecosystem Services and Biodiversity (MAW-ESB) prepared the brochure: *The contributions of livestock species and breeds to ecosystem services*[44] and has made it available to the Working Group.

Livestock farmer field schools allow groups of small-scale livestock producers to test, validate and adapt good practices that help them increase their production sustainably and improve their livelihoods and those of their families. The practices in question may include those directly related to animal breeding and those that complement genetic improvement, such as feeding, health care and marketing. FAO has prepared guidelines on *Farmer field schools for small-scale livestock producers*,[45] which have been made available to the Working Group. The Global Focal Point has also produced several scientific publications related to the sustainable use of animal genetic resources, which are listed in Annex 4.

C. Strategic Priority Area 3. Conservation

Institutional and technical support

FAO is supporting a regional TCP (TCP/RER/3604) in Eastern Europe (Armenia, Georgia and Ukraine) that addresses the conservation and development of dual-purpose cattle breeds. Above-mentioned projects in Saudi Arabia (UTF/SAU/044) and the Lao People's Democratic Republic (TCP/LAO/3607) include components on the conservation of animal genetic resources.

FAO serves on the international advisory board of the Centres de Ressources Biologiques pour les Animaux Domestiques (CRB-Anim) project in France, which aims to improve the infrastructure and management of France's *ex situ* conservation programmes, and participated in its biennial international seminar in May 2017.

Research and capacity-building

FAO is a member of the research consortium implementing the project IMAGE – Innovative Management of Animal Genetic Resources, which is funded through the Horizon 2020 programme of the European Union.[46] The project has 28 partners from 17 countries[47] and emphasizes the improvement of *ex situ* conservation programmes, including their integration with breeding programmes and other *in situ* activities. FAO is responsible in particular for benchmarking best practices and standards for gene banking and for dissemination of results to non-European countries. The project, coordinated by the French National Institute for Agricultural Research (INRA), was launched in May 2016 and will last for four years.

FAO organized a workshop on "Quality management systems of genebanks for animal genetic resources", which was held in February 2017 in Rome in conjunction with the Sixteenth Regular Session of the Commission. FAO also contributed to the organization of, and presented lectures at, a national training course on conservation that was sponsored by the IMAGE project and held in Argentina in March 2017. The training course, hosted by the Instituto Nacional de Tecnología

[44] http://www.fao.org/3/a-i6482e.pdf
[45] http://www.fao.org/3/I8655EN/i8655en.pdf
[46] http://ec.europa.eu/programmes/horizon2020
[47] Argentina, Austria, Belgium, Colombia, Egypt, France, Germany, Hungary, Italy, Morocco, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Agropecuaria, was attended by approximately 40 students from Argentina, Bolivia (Plurinational State of), Colombia, Peru and Uruguay.

FAO has continued to participate in the Conservation Genetics Specialist Group (CGSG) of the International Union for Conservation of Nature (IUCN). The CGSG serves as a focal point for the conservation genetics community and provides advice on genetic policy and management to the IUCN and expert knowledge and assistance to other IUCN specialist groups. Participation in the group allows the sharing of experiences in the conservation genetics of livestock and wildlife. In November 2016, FAO participated in the Next Generation Genetic Monitoring Investigative Workshop, organized in conjunction with the CGSG, which was held in the United States of America. The objective of the workshop was to evaluate improved statistical approaches for genetic resources monitoring, particularly in the light of greater availability of genomic data. Several scientific papers were produced as a result of the workshop (see Annex 4).

Awareness-raising and information

Since 2010, FAO has collaborated with an international learning programme of Iowa State University in the United States of America to work with students on projects related to animal genetic resources and to publish the results in a variety of formats. In 2016, four students prepared a Wikipedia page on cryoconservation of animal genetic resources,[48] using FAO guidelines[49] as the primary resource material.

FAO attended and contributed to the XVI and XVII *Simposio Iberoamericano de Conservación y Utilización de Recursos Zoogenéticos*, in Argentina in October 2016 and in Guatemala in October 2017, respectively.

D. Strategic Priority Area 4. Policies, institutions and capacity-building

Institutional and technical support

Strategic Priority 17 of the Global Plan of Action is to "Establish Regional Focal Points and strengthen international networks". FAO supported the National Coordinator of Thailand in the organization of a meeting of National Coordinators in Asia, which was held in Thailand in October 2017. At the meeting, the participants established an interim steering committee for a provisional Regional Focal Point and agreed on priorities for the region and on a road map for future cooperation.

FAO has been a regular participant in meetings and other activities organized by the European Regional Focal Point for Animal Genetic Resources (ERFP), where it has reported on activities related to the management of animal genetic resources. These events have included the annual General Assemblies of the ERFP and meetings of permanent working groups on information and documentation and *ex situ* conservation and an ad hoc action on honeybees.

With regard to support at national level, the Republic of Moldova received support through a TCP (TCP/MOL/3503) in the preparation of a National Strategy and Action Plan (NSAP) for the management of animal genetic resources. The above-mentioned TCP in Liberia (TCP/LIR/3502) also supported the preparation of NSAPs. The FAO country office in Myanmar supported the inclusion of a NSAP in the country's Agriculture Development Strategy and Investment Plan for 2018 to 2023. Under the umbrella of the above-mentioned LAMP project, FAO provided technical assistance to Mongolia in the drafting of its national law on animal genetic resources. The law was adopted by the Mongolian Parliament in December 2017.

[48] https://en.wikipedia.org/wiki/Cryoconservation_of_animal_genetic_resources
[49] www.fao.org/docrep/016/i3017e/i3017e00.htm

In 2017, FAO organized regional meetings on "Agricultural biotechnologies in sustainable food systems and nutrition". The events were held in Asia (Malaysia) and Africa (Ethiopia) in September and November, respectively. The meetings involved all agriculture sectors and addressed, *inter alia*, the use of biotechnologies for the conservation, sustainable use and characterization of animal genetic resources.

AGE has continued its efforts to improve the laboratory capacity of member states for the management of animal genetic resources. Institutional and technical support with the establishment or strengthening of molecular genetic laboratories have been provided to seven countries[50] through the provision of equipment and laboratory supplies under the framework of national TCP. AGE experts also undertook field support missions to install equipment and provide on-site training to laboratory personnel in many of these countries, thus supporting the establishment of fully equipped and functional facilities for breed characterization that also create opportunities for international cooperation. For example, the new molecular genetic laboratory in Burkina Faso not only allowed the country to complete characterization of its native cattle and sheep breeds, but also provided the opportunity to train researchers from neighbouring Niger and Mali on breed characterization.

Awareness-raising and information

At the 67th Annual Meeting of the European Federation of Animal Science (EAAP) held in Belfast, United Kingdom, in August 2016, FAO, ERFP and EAAP's Working Group on Animal Genetic Resources organized a special session entitled "New legal landscape guiding access and benefit sharing of animal genetic resources". The session included six invited presentations, including one by FAO. The three organizations also organized a special session at the 68th Annual EAAP Meeting, which took place in Tallinn, Estonia, in August 2017. The session was on use of "Effective population size as a tool for the management of animal genetic resources" and was well attended (more than 50 participants, including 8 National Coordinators). FAO also contributed a paper to this session.

FAO collaborated with the organizers of the 11th World Congress on Genetics Applied to Livestock Production, which was held in New Zealand in February 2018. FAO organized and co-chaired a scientific session on genetic improvement of local breeds and offered travel support to young scientists from nine developing countries.[51] The Global Focal Point also presented an invited lecture on "Livestock, animal genetic resources and the SDG".

In the autumn of 2016, FAO hosted an intern from the University of British Columbia in Canada. The intern prepared Wikipedia pages on animal genetic resources for food and agriculture[52] and *The State of the World's Animal Genetic Resources for Food and Agriculture*[53] and revised more than 20 existing pages on topics related to animal genetic resources.

FAO continues to maintain DAD-Net as an informal forum for the discussion of issues relevant to the management of animal genetic resources. In addition, several and regional subgroups are monitored by collaborators. The number of subscribers continues to increase steadily and the network remains active, with hundreds of messages exchanged annually. As of April 2018, approximately 3 190 people from more than 150 countries were subscribed to the network. In 2017, nearly 500 messages were exchanged. DAD-Net continues to be a unique and effective means of sharing experiences, disseminating information and facilitating informal discussions among individuals involved in the management of animal genetic resources.

[50] Bangladesh, Burkina Faso, Cambodia, Nigeria, Papua New Guinea, Peru, Sudan.
[51] Bangladesh, Brazil, India, Iran (Islamic Republic of), Mexico, Peru, Pakistan, Uganda, Zimbabwe.
[52] https://en.wikipedia.org/wiki/Animal_genetic_resources_for_food_and_agriculture
[53] https://en.wikipedia.org/wiki/The_State_of_the_World%27s_Animal_Genetic_Resources_for_Food_and_Agriculture

The Global Focal Point made the decision to discontinue the publication of the journal *Animal Genetic Resources*. The final issues, volumes 58[54] and 59,[55] were published during the reporting period. Despite the decision to cease production, all previously published issues of the journal will remain available online[56,57] indefinitely.

Global Focal Point officers have participated as invited speakers at a number of international conferences and meetings of organizations or projects with programmes related to the management of animal genetic resources. These meetings were held in locations spread throughout the world, including Argentina, Austria, Italy, Estonia, Ethiopia, France, Georgia, Germany, Guatemala, Ireland, South Africa, Turkey and the United States of America.

V. UPDATE ON PROJECTS FUNDED BY THE FAO TRUST ACCOUNT UNDER THE FUNDING STRATEGY FOR THE IMPLMENTATION OF THE GLOBAL PLAN OF ACTION FOR ANIMAL GENETIC RESOURCES

Under the first call for proposals funded by the FAO Trust Account under the Funding Strategy, 13 project proposals, involving 30 countries, were approved by the Bureau of the Commission in October 2012. Subsequently, 17 Letters of Agreement (LoAs), for the implementation of the 13 projects, were prepared by the Secretariat, negotiated and signed. The number of LoAs prepared exceeded the number of projects because, for budgetary and operational reasons, some multicountry projects required the development of a separate LoA for each participating country.

Eight projects had already been closed prior to the last session of the Working Group and the remaining five projects were in the final stages of implementation. These active projects were closed during the course of 2016. The overall project on the first call for proposals funded through the FAO Trust Account was operationally closed in December 2016 and financially closed in December 2017. Total expenditures were USD943 723.

The Commission, at its Sixteenth Regular Session,[58] requested FAO to compile reports and achievements of projects under the Funding Strategy and publicize them on the website of FAO. All reports have been made available on the web pages of the Animal Production and Genetics Unit.[59] An overview of project objectives, achievement of outputs and state of completion is provided in Table 1.

At its Sixteenth Regular Session, the Commission agreed,[60] with regard to future calls for proposals under the Funding Strategy and projects to be funded, to amended modalities[61] for the operation and effectiveness of the FAO Trust Account. The Commission invited donors to contribute to the Funding Strategy and to allocate sufficient funding for monitoring, backstopping and technical assistance of projects. [62] At present, no funds are available for a second call for proposals under the FAO Trust Account.

[54] http://www.fao.org/3/a-i4063t.pdf
[55] http://www.fao.org/3/a-i5198t.pdf
[56] http://www.fao.org/ag/againfo/programmes/en/genetics/journal.html
[57] http://journals.cambridge.org/action/displayJournal?jid=AGR
[58] CGRFA-16/17/Report/Rev.1, paragraph 49.
[59] http://www.fao.org/AG/AGAInfo/programmes/en/genetics/first_call.html
[60] CGRFA-16/17/Report/Rev.1, paragraph 49.
[61] CGRFA-16/17/13, paragraph 49 xvi, xviii–xxi.
[62] CGRFA-16/17/Report/Rev.1, paragraph 49.

Table 1: Overview of project objectives, achievement of outputs and state of completion of projects funded by FAO's Trust Account

Project name	Countries involved	Species and number of breeds[a]	Main objectives	Comments	Project status
Regional projects					
BushaLive	Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, Serbia, The former Yugoslav Republic of Macedonia	Cattle 1 (7)	Strengthening multicountry collaboration Breed characterization Basic recording scheme	Planned outputs only partly achieved	Closed
Preservation of the Béni Guil sheep breed by the exchange of experiences between countries	Algeria, Morocco	Sheep 1 (2)	Improving selection scheme Training and awareness-raising	Planned outputs achieved	Closed
Enhancement of farmers' communities through goat utilization and genetic improvement	Argentina, Brazil, Costa Rica	Goat 11 (11)	Breed characterization Establishment of participatory breeding schemes Cryoconservation Common goat DNA bank	Argentina and Costa Rica delivered the outputs as planned; Brazil withdrew due to difficulties related to fund transfers	Closed
Capacity development supporting the implementation of breeding strategies for llamas	Bolivia (Plurinational State of), Peru	Llama 2 (2)	Training and capacity development	Planned outputs achieved	Closed
Conservation of indigenous pig and chicken breeds	Cook Islands, Fiji, Niue	Chicken, pig 3 (3)	Establishment of collection, breeding and conservation centres	Planned outputs achieved	Closed
Promotion of indigenous chicken for improved livelihood and income generation	Ethiopia, Kenya, Uganda	Chicken 3 (3)	Breed characterization Establishment of breeding schemes	Planned outputs achieved	Closed

Project name	Countries involved	Species and number of breeds[a]	Main objectives	Comments	Project status
Assessment of the impact of transhumance on the sustainable management of animal genetic resources	Gambia, Guinea, Mali, Senegal	Cattle, goat, sheep 3 (12)	Assessment of transhumant system	Planned outputs achieved	Closed
National Projects					
In situ conservation strategy for goats and cattle	Chile	Cattle, goat 2	Development of conservation strategy Breed characterization	Planned outputs achieved	Closed
Documenting and supporting community-based conservation of four local breeds	India	Cattle, camel, goat 4	Development of biocultural protocols Capacity development	Planned outputs achieved	Closed
Conservation of native cattle breeds, for their present and future use	Mozambique	Cattle 3	Breed characterization	Planned outputs achieved, after adjustments to work plan due to social conflict in one target area	Closed
Conserving Muturu cattle in the South Rain Forest Zone	Nigeria	Cattle 1	Establishment of conservation strategy	Planned outputs not achieved; beneficiaries ceased communication	Closed
Phenotypic and molecular characterization of local chicken	Togo	Chicken 1	Breed characterization	Planned outputs achieved	Closed
Conservation and characterization of Criollo sheep	Uruguay	Sheep 1	Breed characterization Development of a conservation plan Creation of a database Training and capacity development	Planned outputs achieved	Closed

[a]Numbers of national breed populations are indicated in brackets for regional projects.

Annex 1

Expert meetings contributing to the development of guidelines, manuals and projects

Meeting	SPA	Date	Location	Countries of participating experts
AGE Experts Meeting on "Development of guidelines for recording phenotypes in breeding sheep to enhance resistance to gastro-intestinal parasites (Latin America)"	1,2	August, 2016	Asuncion, Paraguay	Argentina, Brazil, Costa Rica, Italy, Uruguay,
AGE Research Coordination Meeting on "Application of nuclear and genomic tools to enable for the selection of animals with enhanced productivity traits"	1,2	October, 2016	Vienna, Austria	Argentina, Austria, Bangladesh, China, India, Italy, Kenya, Peru, Serbia, South Africa, Sri Lanka, Tunisia
Writing workshop to prepare the *Draft guidelines on developing sustainable value chains for small-scale livestock producers*	2	May, 2017	Rabat, Morocco	Denmark, France, Germany, Italy, Morocco, United States of America
AGE Expert Consultants Meeting on "Nuclear and nuclear-derived techniques for early pregnancy diagnosis in cattle"	2	August, 2017	Vienna, Austria	Austria, Belgium, Mexico, United Kingdom, United States of America
Fifth Workshop of the African Goat Improvement Network (co-sponsored by the United States of America and South Africa)	2	November 2017	Pretoria, South Africa	Austria, Azerbaijan, Brazil, Egypt, Ethiopia, France, Italy, Kenya, Liberia, Madagascar, Malawi , Mongolia, Mozambique, Nigeria, Republic of Korea, South Africa, Uganda, United Kingdom, United Republic of Tanzania, United States of America,

Meeting	SPA	Date	Location	Countries of participating experts
AGE Experts Meeting on "Preparation of a manual for genetic evaluation and selection of small ruminants for breeding to enhance resistance to gastrointestinal parasites"	1,2	November, 2017	Cochabamba, Bolivia (Plurinational State of)	Argentina, Brazil, Costa Rica, Italy, Uruguay

Annex 2

Global and regional workshops for National Coordinators for the Management of Animal Genetic Resources

Title of workshop	SPA	Dates	Location	List of countries participating
22nd General Assembly of the European Regional Focal Point for Animal Genetic Resources (ERFP) (organized by ERFP)	4	August 2016	Belfast, United Kingdom	Austria, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Montenegro, Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, Switzerland, United Kingdom
Workshop on Quality Management Systems for Animal Genebanks	3	February 2017	Rome, Italy	Burkina Faso, Canada, Eritrea, France, Germany, Guatemala, Kenya, Namibia, Netherlands, Nigeria, Norway, Paraguay, Peru, Poland, Republic of Korea, Slovenia, United States of America,
Meeting of the ERFP working groups on "information and documentation" and "*ex situ* conservation" (organized by ERFP)	1,3	May 2017	Belgrade, Serbia	Austria, Bulgaria, Croatia, France, Germany, Hungary, Italy, Latvia, Lithuania, Montenegro, Netherlands, Norway, Poland, Serbia, Slovakia, Slovenia, Spain, Turkey, Ukraine, United Kingdom
23rd General Assembly of the ERFP (organized by ERFP)	4	August 2017	Tallinn, Estonia	Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom

Title of workshop	SPA	Dates	Location	List of countries participating
Meeting of Asian National Coordinators for the Management of Animal Genetic Resources	4	October 2017	Chiang Mai, Thailand	Bangladesh, Bhutan, India, Indonesia, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Slovakia, Sri Lanka, Thailand, Viet Nam
DAD-IS launch and workshop on "Reasons for the high proportion of breeds with unknown risk status"	1,4	November 2017	Rome, Italy	46 countries
Meeting of the ERFP ad hoc working groups on pollinator genetic resources (organized by ERFP)	1	April 2018	Thessaloniki, Greece	Bulgaria, France, Greece, Italy, Poland

Annex 3

Technical training

Training	Date	Location	List of participating countries (number of participants)
AGE regional training course on "Genotyping workflow and analysis of molecular genetic data"	May 2016	Ouagadougou, Burkina Faso	Burkina Faso, Mali, Niger (13 participants)
International workshop on "Community-based livestock breeding programmes in tropical environment countries"	September 2016	Vienna, Austria	41 participants from a variety of countries
AGE national training course on "Artificial insemination and delivery of reproduction enhancement services on farm"	October 2016	Kpinnou, Benin.	Benin (19 participants)
FAO/OIE subregional workshop on "Animal identification and traceability: tools for the management of animal genetic resources, traceability and disease control"	December 2016	Tunis, Tunisia	Algeria, France, Italy, Libya, Mauritania, Morocco, Tunisia (37 participants)
AGE regional training course on "Genetics of parasite resistance in sheep and goats: sampling, data collection, management and analyses"	December 2016	Montevideo, Uruguay	Argentina, Bolivia (Plurinational State of), Brazil, Costa Rica, Cuba, Dominican Republic, Mexico, Paraguay, Peru, Uruguay, Venezuela (Bolivarian Republic of) (29 participants)
AGE national training course on "Delivering of dairy cattle reproduction enhancement services on-farm"	January 2017	San Salvador, El Salvador	El Salvador (16 participants)
AGE national training course on "Animal identification, recording phenotypes and performance data to enhance cattle breeding in Madagascar"	February 2017	Antananarivo, Madagascar	Madagascar (18 participants)

Training	Date	Location	List of countries participating (Number of participants)
AGE national training course on "Enhancing the proficiency of the semen lab for routine freezing of bull semen"	May 2017	Nouakchot, Mauritania	Mauritania (7 participants)
AGE national training course on "Improving skills on the use of hormone radioimmunoassay at artificial insemination in cattle"	May 2017	Tanga, United Republic of Tanzania.	United Republic of Tanzania (20 participants)
AFACI Training Workshop on "Molecular Genetic Characterization of Domesticated Animals"	June 2017	Jeonju, Republic of Korea	Bhutan, Cambodia, Indonesia, Kyrgyzstan, Lao People's Democratic Republic, Nepal, Sri Lanka, Thailand, Viet Nam (10 participants)
AGE regional training course on "Genetics of parasite resistance in sheep and goats: animal breeding and selection practices"	June 2017	San Carlos de Bariloche, Argentina	Argentina, Bolivia (Plurinational State of), Brazil, Costa Rica, Cuba, Dominican Republic, Mexico, Paraguay, Peru, Uruguay, Venezuela (Bolivarian Republic of) (22 participants)
National training workshop on "Development of teaching modules on delivering herd health services at smallholder dairy production"	August 2017	Bangladesh	Bangladesh (15 participants)
AGE national training course on "Tools for genetic evaluation and selection for breeding alpacas"	September 2017	Puno, Peru	Peru (44 participants)
Regional DAD-IS training for Asian National Coordinators for the Management of Animal Genetic Resources	October 2017	Chiang Mai, Thailand	Bangladesh, Bhutan, India, Indonesia, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Slovakia, Sri Lanka, Thailand, Viet Nam
Global DAD-IS training for National Coordinators for the Management of Animal Genetic Resources	November 2017	Rome, Italy	46 countries

Training	Date	Location	List of countries participating (Number of participants)
AGE regional training course on "Assisted reproductive techniques to enhance small ruminant productivity"	December 2017	Balcarce, Argentina	Argentina, Bolivia (Plurinational State of), Brazil, Costa Rica, El Salvador, Mexico, Paraguay, Peru, Uruguay (14 participants)
AGE National training course on "Improving skills on artificial insemination"	December 2017	United Republic of Tanzania	United Republic of Tanzania (16 participants)
IMAGE postgraduate training course on "Conservación de recursos zoogenéticos".	March 2018	Balcarce, Argentina	Argentina, Bolivia (Plurinational State of), Colombia, Peru, Uruguay (40 participants)

Annex 4

Publications since the Ninth Session of the Working Group

FAO documents[63]

FAO. 2016. *The contributions of livestock species and breeds to ecosystem services* (brochure). Rome. (available at http://www.fao.org/3/a-i6482e.pdf).

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Boettcher, P. 2016. *Overview of* Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture. 35th ISAG Conference. 25 July, Salt Lake City.

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Vahidi, S.M.F., Faruque, O. Falahati Anbaran, F., Afraz, F., Mousavi, S.M., Boettcher, P., Joost, S., Han, J.L., Colli, L., Periasamy, K., Negrini, R. & Ajmone-Marsan, P. 2016. Multilocus

[63] http://www.fao.org/ag/againfo/resources/en/pubs_gen.html

genotypic data reveal high genetic diversity and low population genetic structure of Iranian indigenous sheep. *Animal Genetics*, 47: 463–470.

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Baumung, R., Halvorson, K. & Boettcher, P. 2017**.** *FAO global survey on diversity and data availability for monitoring honey bees and other pollinators*. 45th Apimondia International Apicultural Congress. 30 September, Istanbul.

Boettcher, P. 2017. *Animal genetic resources and the UN Sustainable Development Goals*. 36th ISAG Conference. 18 July, Dublin.

Grema, M., Traoré, A., Issa, M., Hamani, M., Abdou, M., Soudré, A., Sanou, M., Pichler, R., Tamboura, H.H., Alhassane, Y. & Periasamy, K. 2017. Short tandem repeat (STR) based genetic diversity and relationship of indigenous Niger cattle. *Archives Animal Breeding*, 60: 399–408.

Hussain, T., Pichler, R., Babar, M.E., Khan, W.A., Ullah, Z., Shehzad, S. & Periasamy, K. 2017. Mitochondrial DNA D-Loop diversity and evolutionary relationship of wild Punjab Urial sheep (*Ovis vignei punjabiensis*) with closely related taxa. *Small Ruminant Research*, 148: 22–32.

Leroy, G., Boettcher, P., Hoffmann, I., Mottet, A., Teillard, F. & Baumung, R. 2017. Diversité des races animales domestiques dans le monde. *Viandes & Produits Carnés*, 14: 59.

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