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Diversity of animal genetic resources for resilient farming systems

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Abstract. The diversity of animal genetic resources is an important factor in all efforts to ensure resilience of farming systems at different scales, especially if combined with differentiated farming practices. This article provides an overview of the aspects and conclusions presented during session 47 of the Annual Meeting of the European Federation for Animal Science (EAAP) that took place on a virtual platform in December 2020. A concise account of major research efforts of various teams under specific categories is presented, along with main and common conclusions drawn. Through research findings and the discussion that ensued during Session 47, the need for further and more extensive collaboration among research teams, countries and regions was stressed once more. In addition, certain themes arose to stimulate future research in this area.

Keywords. Animal Genetic Resources – Diversity – EAAP2020 – Resilience.

Diversité des ressources génétiques animales pour des systèmes agricoles résilients

Résumé. La diversité des ressources génétiques animales est un facteur important de résilience des systèmes d'élevage à différentes échelles, en particulier si cette diversité est associée à une diversité de pratiques de gestion. Cet article décrit les différents éléments et conclusions présentés dans la session 47 de la Conférence Annuelle de la Fédération Européenne de Zootechnie (EAAP) qui s'est déroulée sur une plateforme virtuelle en décembre 2020. Il synthétise les principaux efforts de recherche menés par différentes équipes dans des catégories spécifiques, ainsi que les conclusions majeures et communes aux différents travaux de recherche. Les résultats présentés lors de la session 47 et les discussions qui en ont découlé soulignent une fois de plus la nécessité d'encourager et de renforcer la coopération entre les équipes de recherche, entre les pays et entre les régions. Enfin, certains thèmes ont été évoqués pour stimuler de prochaines recherches dans ce domaine.

Mots-clés. Ressources Génétiques des Animaux – Diversité – EAAP2020 – Résilience.

I – Introduction

Livestock diversity facilitates the adaptation of production systems to future challenges and is theoretically a source of resilience in the face of greater climatic and socio-economic variability. Diversity in livestock production systems may be considered at all scales, from individuals and breeds to species and ecosystems.

The presentations of the Session 47: *Diversity of animal genetic resources for resilient farming systems*, (2nd part of the Full day Workshop of EAAP 2020 under the general title: “**Combining the diversity of resources and farming practices to ensure resilience at different scales**”), focused on the challenges and drivers of change (socio-technical, socio-economic and environmental aspects) that the livestock sector faces in the Mediterranean and other less-favoured areas. The Workshop was initiated by the EAAP Mediterranean Working Group and organized jointly with the Livestock Farming Systems Study Commission. The various authors provide information on several issues related with the diversity of animal genetic resources, their capacities to express a good balance between production, reproduction, health performance, and/or to valorize scarce and diverse feed resources.

This article provides a general overview of the recent developments related with the potential contribution of animal genetic resources to the development of resilient farming systems. The article is structured in three sections, dealing with (i) the impact of climate change on breed resilience and adaptation, (ii) methodological approaches and genomic selection and (iii) gene-banking strategies with particular reference to the implications for local breeds and resilient farming systems, connected also with monitoring and documentation aspects.

II – Climate change aspects, breed resilience and adaptation

Several constraints due to climate change impede the sustainability of livestock production in the Mediterranean basin. The ability of livestock to breed, grow, and lactate to their maximal genetic potential, and their capacity to maintain health is strongly affected by climatic features and the Mediterranean region has been identified as a highly susceptible region to climate change and accompanying systemic failures.

In this context, Karatzia *et al.* (2022) assessed the response of a local sheep breed (the Karagouniko sheep breed) managed in extensive or semi-extensive systems at different stressors that compromise animals' welfare. The study was initiated by the existing needs to reintroduce Karagouniko breeding males in highly productive crossbred flocks) aiming to improve the flock response to some constraints of the biophysical environments, such as the sensitivity to thermal stress (Perucho *et al.*, 2019). Selection on heat tolerance is challenging due to the complexity of heat stress response and the antagonism between heat tolerance and productivity. Thus, breeding strategies to improve heat tolerance vary according to the production system.

Stakeholders, and mostly the breeders, seek to improve the resilience and the ability of adaptation of their animals. Resilience could be understood, as the ability of the animals, to undergo minimal perturbation from their performance trajectory and to get a fast recovery when submitted to an environmental challenge (climatic, disease, nutritional, restriction etc.), while adaptation is the ability of the animals to live, breed and perform in their pedo-climatic environment and traditional system of production (Astruc *et al.*, 2022).

Locally adapted breeds in warm environments have developed specific characteristics that allow the potential use of these breeds adapted to harsh conditions to improve thermotolerance of more productive breeds when farm resources and animal health are not limiting the survival of highly selected breeds (Carabaño *et al.*, 2019). Several research efforts focus on phenotyping to identify heat tolerant animals on farm and on developing methods to combine the knowledge from all “-omics” technologies. Reaction norm models are useful tools to characterize resilience of farm animals to extreme weather conditions (Carabaño *et al.*, 2020).

Further to the above, when dealing with local breed adaptation, we should not only focus on animal characteristics but also take into account social and technical dimensions of adaptation. The study of Perucho *et al.* (2021) discuss this topic with the example of four French Mediterranean sheep breeds. Specific farmer-led breeding practices to improve flock adaptation to biophysical constraints illustrate that several levels of organisation play a role, both at the farm scale and at the collective breed management scale.

Letaief and Bedhiaf-Romdhani (2022), describe the national efforts to improve camel breeding in Tunisia. In Southern Tunisia, camels are traditionally reared under pastoral production systems and they are mainly herded for meat production. Camel milk is characterized by its therapeutic value, yet its sale is always considered a taboo. Camel keepers are facing various constraints such as high feeding costs, diseases and jackal attacks. For future prospects, national efforts should be made to convince camel owners to invest in milk. Furthermore, other research should be conducted to identify the genetic potential of Tunisian camel for milk and meat production in order to use this information for genetic improvement.

III – Methodological developments and genetic/genomic applications

This section of the session has focused on presentations exploring various methodological approaches and the implementation of genomic characterization and improvement of various local breeds.

A simulation approach of differentiated extents of crossbreeding and heterosis effects to explore the effective use of rotational crossbreeding as a means to increase within-breed genetic diversity in the Holstein cattle breed and whole herd performance was presented by Quénon *et al.* (2020). Croué *et al.* (2020) pursued and tested the development of a software to determine breed of origin per allele for three-way dairy crossbred cattle, in order for the crossbred population to be included in genomic evaluations. Further, another study explored imputation accuracy of various tools in cross-bred dairy cows from Normande and Holstein crossbreds, as part of the GenTORE project (Maugan *et al.*, 2020). FImpute was found to be the most suitable one for crossbred animals, and imputation for crossbred dairy cattle was deemed feasible for the purpose of routine genomic evaluations.

In the study by Ginja *et al.* (2020a), multi-source genetic markers were used to genotype over 4500 individuals from 114 cattle breeds distributed worldwide, in order to assess the ancestry, genetic diversity and historic admixture of American Creole breeds. Genetic influences were identified both from the Iberian cattle and by African cattle. These findings stressed the need for conservation of these unique genetic resources and for the state-of-the art genomic tools to become available for undervalued breeds, such as the Creoles, kept in marginal regions.

In a research study within the OPTIBOV project, copy number variation (CNV) mapping was used for 120 whole genome sequences from five traditional Dutch cattle breeds and five individuals of the Holstein Friesian breed, to assess genetic variation and identify functional genes. Substantial variation in CNVs was observed among breeds. Thus, further study of genes underlying the breed-specific CNVs will be conducted (Gonzalez-Prendes *et al.*, 2020). Furthermore, within the OPTIBOV project, genomic characterization of three Portuguese native cattle was pursued to explore optimal performance, through identification of markers for ecosystem adaptation and disease resistance in addition to production trait improvement (Ginja *et al.*, 2020b). Future deliverables of these efforts will be a genotyping assay for more diverse traditional cattle and for improvement of breeding programmes. Within the same project, a whole-genome scan of sequence data for selective sweeps in three South African indigenous cattle breeds (Afrikaner (16), Nguni (24), Tuli (10)) was performed to explore the genetic basis of their adaptive characteristics to local climate conditions and tolerance to tick-borne diseases (Makgahlela *et al.*, 2020). Putative selective sweeps were identified across the breeds, with 233 putative regions. Gene ontology identified genes related to skin pigmentation, coat colour and fertility, and provided an insight to genetic mechanisms that influenced selection in these breeds.

In French dairy small ruminant local breeds, breeders are increasingly addressing the issue of selecting more adapted and more resilient sheep and goats. Global warming, new health challenges, and societal demand for more agro-ecological and sustainable systems are strong drivers and incentives for this impetus. Novel adaptation and resilience-related traits have been / are under study, thanks to various projects. Some of them might rapidly be / are already included in selection criteria. Building more balanced breeding goals should benefit from more efficient genomic selection and also from international cooperation. This puts an emphasis on the importance of joining research and development, and academics' and stakeholders' input (Astruc *et al.*, 2022).

The AGRICYGEN project presented during session 47, is an ongoing interdisciplinary project for genomic evaluations to improve the whole system of small ruminants in Cyprus (Hadjipavlou *et al.*, 2020). This entails genomic studies of Cyprus Chios sheep, Damascus goats, crops and legumes grown for animal feed and soil microorganisms that improve crop growth performance and quality, while enriching Cyprus soils in an ecological manner.

IV – Gene banking and documentation

Gene banks as the reservoirs of genetic diversity can offer several options for the future, supporting various and more resilient farming systems. The role and implications of Gene Banking strategies towards strengthening the livestock sector to respond to the new challenges was addressed within the IMAGE project. Tixier-Boichard *et al.* (2020) presented the outcomes of IMAGE relevant with the links of Gene Banks and local breeds management. Three key questions were addressed: 1) how to characterize adaptation, 2) the optimization of gene banking cost, and 3) the commitment of policy makers. The additional constraints that local breeds are facing on the collection process for Gene Banks, either because they are raised in remote areas, their health status is poorly known, or they face problems due to inbreeding were discussed. Furthermore, the establishment of a multi actor decision-making body (including scientific experts on genetics and reproduction) will ensure the efficient functioning of Gene Banks.

Several aspects of cooperation and coordination between countries were raised, concerning not only Gene Bank management, but also the monitoring and documentation of livestock breeds. In this direction, the European Focal Point (ERFP) WG Documentation and Information and the EAAP Mediterranean WG have initiated activities to stimulate interaction and cooperation in the region in aspects related with the documentation of AnGR. Ligda *et al.* (2022) present a preliminary analysis of the status of AnGR documentation in the Mediterranean region, by analysing specific country datasets from DAD-IS. The analysis of the data showed the wide variation between countries, but also between species within country. This variation reflects the changes in policies and priorities in the country and the level of organization in each livestock sector. The various gaps, either related to the lack of sufficient structure(s) for population monitoring and data flow organization or on knowledge gaps on the breed characterization, need oriented approaches and cooperation within and across countries, and among various stakeholders.

V – Conclusions

The efficient management of animal genetic resources (AnGR) remains a challenging task that requires deep knowledge of the populations, as well as sufficient monitoring systems that will allow the implementation of sustainable breeding programs and will ensure the conservation of AnGR for a viable future.

Within Session 47 of EAAP2020, the need to strengthen the within-country (stakeholders), across countries, regional and international cooperation was emphasized, through research initiatives towards enhancing the genetic characterization and breed /population management under contemporary conditions and specific pressures. For this objective, it is important to mobilize funds from national, regional, international research collaborations and breeding schemes.

Themes for ongoing and future research collaboration arose, such as the implication for sheep and goat breeds facing extreme temperatures (too high or too low) at various times of the year, not just heat stress, other health challenges, societal demands and the need to create agro-ecologically sustainable systems. Breed resilience due to genetic background and how to identify it was also discussed, focusing also on the measurable heat and other stressor indicators that could be used in selection programmes. The study of local breed adaptation requires interdisciplinary, as well as participative approaches that will consider farmers' viewpoints and practices. Finally, it was stressed that Gene Banks can serve several objectives, such as to re-introduce lost genetic variants, increase variability and re-orient breeding objectives. In this context, participants agreed that adequate training in gene banking management is highly needed and that the creation of genebanks must be done before local breeds become endangered.

References

- Astruc, J.M., Larroque, H., Buisson, D., Palhiere, I., Lagriffoul, G., Legarra, A., Clement, V. and Moreno-Romieux, C., 2022. Benefits from recent and on-going projects on adaptation & resilience in French dairy sheep & goats. *Options Méditerranéennes*, Series A, 129.
- Carabaño, M.J., M. Ramón, A. Menéndez-Buxadera, A. Molina and C. Díaz, 2019. Selecting for heat tolerance. *Anim. Front.*, 9(1):62-68.
- Carabaño, M.J., Hazard, D., Tsartsianidou, V., Arsenos, G., Pineda-Quiroga, C., Ramón, M., Díaz, C., Tryantafyllidis, A., Larroque, H., Ugarte, E., Buisson, D. and Serrano, M., 2020. Climate resilience in dairy sheep production in Europe. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 455.
- Croué, I., Boichard, D. and Croiseau, P., 2020. A SNP-BLUP genomic evaluation with breed-specific SNP effects for three-way dairy crossbreds. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 461.
- Ginja, C., Fonseca, R., Kugonza, D.R., Guimarães, S., Pires, A.E., Crooijmans, R., Bruno De Sousa, C., Kantanen, J., Gaspar, D., Ghanem, N., Blaschikoff, L. and Makgahlela, M., 2020a. OPTIBOV-PT: Genomic characterization of Portuguese native cattle for optimal performance. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 461.
- Ginja, C., Gama, L.T., Cortés, O., Zaragoza, P., Martín-Burriel, I., Vega-Pla, J.L., Penedo, M.C.T., P. Spönenberg, P. Cañón, J., Sanz, A., Egito, A.A., Alvarez, L.A., Giovambattista, G., Agha, S., Rogberg-Muñoz, A. and Lara, M.A., 2020b. Assessing the ancestry of American Creole cattle using genetic markers. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 456.
- Gonzalez-Prendes, R., Kugonza, D.R., Makgahlela, M., Crooijmans, R.P.M.A., Ginja, C., Ghanem, N. and Kantanen, J., 2020. Characterization of Traditional Dutch Cattle Breed Specific Copy Number Variations. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 457.
- Hadjipavlou, G., Fasoula, D., Ioannides, I.M. and Omirou, M., 2020. The AGRICYGEN project: genomic studies of animals, plants and microbes under Cyprus conditions. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 459.
- Karatzia, M.A., Sossidou, E.N., Tsiokos, D. Ligda and C., 2022. Effects of heat stress on welfare in Karagouniko sheep breed. *Options Méditerranéennes*, Series A, 129.
- Letaief, N. and Bedhief, S., 2022. Camel herd management under pastoral system in southern of Tunisia. *Options Méditerranéennes*, Series A, 129.
- Ligda, C., Charvolin-Lemaire, E., Hadjipavlou, G., Fadili, M., Sturaro, E. and Djemali, M., 2022. Documenting Animal Genetic Resources in the Mediterranean: interaction and cooperation in the region. *Options Méditerranéennes*, Series A, 129.
- Makgahlela, M.L., Ginja, C., Zwane, A.A., Ghanem, N., Kantanen, J., Kugonza, D.R., Nxumalo, K.S. and Crooijmans, R.P.M.A., 2020. Whole-genome scan of sequence data for selective sweeps in South African indigenous cattle breeds. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 460.
- Maugan, L.H., Croiseau, P., Croué, I., Lefebvre, R., Hoze, C. and Fritz, S., 2020. Imputation accuracy of crossbred dairy cows. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 460.
- Perucho, L., Ligda, C., Paoli, J.C., Hadjigeorgiou, I., Moulin, C.H. and Lauvie, A., 2019. Links between traits of interest and breeding practices: several pathways for farmers' decision making processes, *Livestock science*. v.220, 158-165.
- Quénon, J., Magne, M.A. and Ingrand, S., 2020. Combining categories of crossbred females to improve the overall performance of a dairy cattle herd. 71st EAAP Annual Meeting, *Book of Abstracts*, p. 457.
- Tixier-Boichard, M. and IMAGE Consortium, 2020. Gene banking strategies to ensure resilience of farming systems in less favoured areas. 71st EAAP Annual Meeting. *Book of Abstracts*, p. 458.