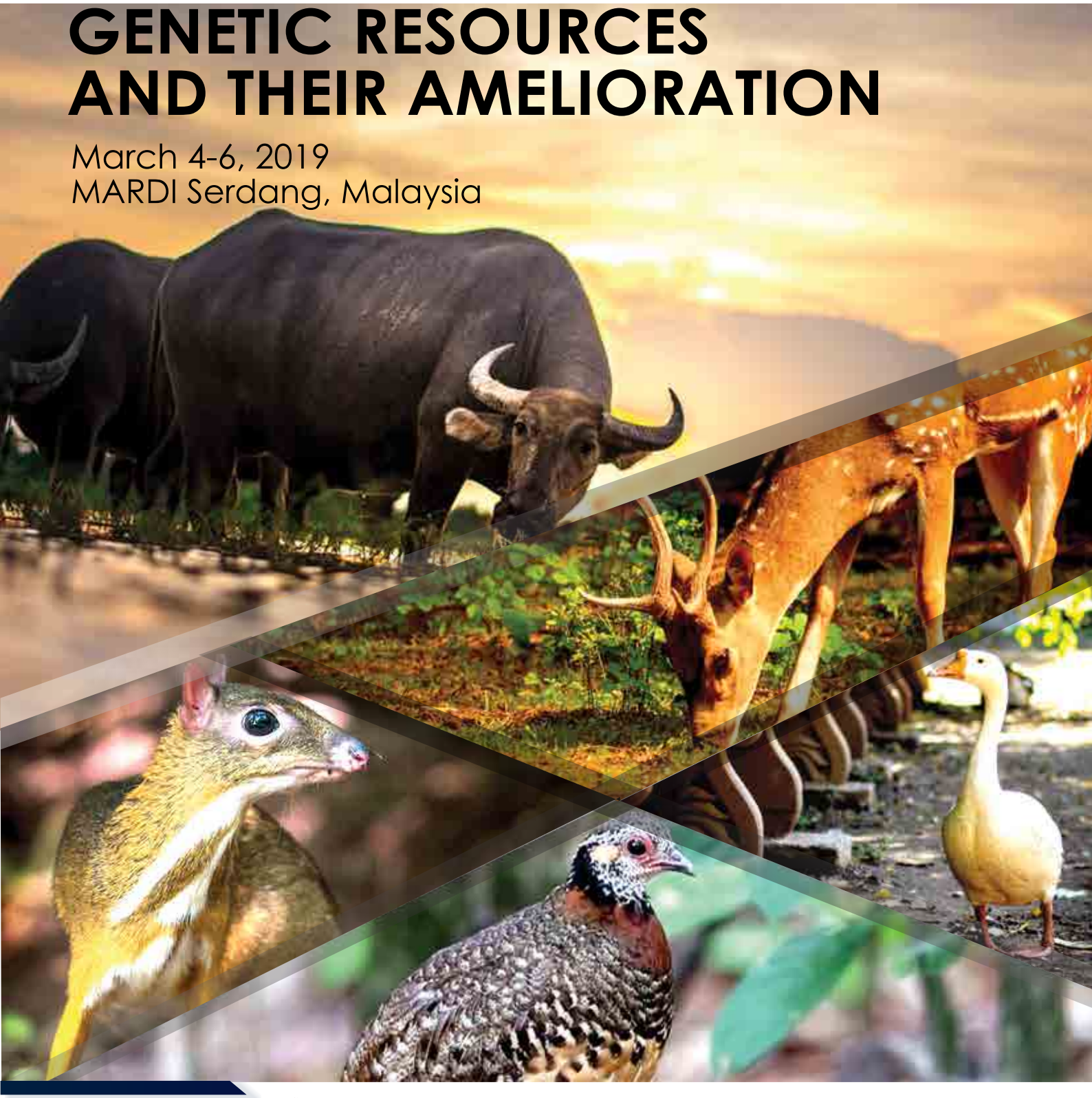
Proceedings and Recommendations

Regional Workshop on UNDERUTILIZED ANIMAL GENETIC RESOURCES AND THEIR AMELIORATION

March 4-6, 2019
MARDI Serdang, Malaysia



MINISTRY OF AGRICULTURE & AGRO-BASED INDUSTRY

MARDI

APAARI

Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources
APCoAB

Australian Government
Australian Centre for International Agricultural Research

PERHILITAN

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Indigenous Kedah-Kelantan cattle grazing in an integrated production system with oil palms practiced by many smallholder producers in Malaysia – Photo courtesy of Mohd. Rosly Shaari, MARDI.

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Contents

Foreword

The Second Report of the State of the World's Animal Genetic Resources (AnGR) and analysis of Sub-regional reports on AnGR in Asia and the progress report of Global Plan of Action for AnGR in Southwest Pacific suggested that vigorous efforts still need to be made to strengthen the main elements of sustainable management of AnGR. It has been amply highlighted that to check erosion and loss of AnGR, to achieve food security, improve human nutritional status, and enhance rural development, the efforts to conserve, develop, improve and sustainable use of AnGR needs to be enhanced at national, regional and global level. APAARI under its APCoAB program thus organized a *Regional Workshop on Underutilized AnGR and their Amelioration* from March 4-6, 2019 at MARDI, Malaysia.

The Workshop provided a platform for sharing experiences/knowledge relating to underutilized AnGR of Asia-Pacific that have food and nutritional value, gave a sub-regional assessment of the importance of most potential AnGR and also provided a status of their R&D for exploring the possibilities of their commercial use and eventual benefit to smallholder farmers.

The Workshop was attended by about 60 participants from 14 countries in the Asia-Pacific region who deliberated on various relevant aspects of AnGR aspects in five technical sessions which covered the status of underutilized AnGR and the regional priorities for underutilized AnGR in conservation, improvement and utilization, value addition, marketing and export, partnership and capacity development, biotechnology for enhancing utilization, biotechnology for enhancing utilization and regional information sharing system including focal point for the conservation and utilization of AnGR. One session exclusively consisted of a panel discussion on legal and policy framework support to promote utilization of underutilized AnGR.

I am pleased to see that very useful recommendations have emerged from the deliberations on conservation, improvement and use of underutilized AnGR, on value addition, marketing and export, on partnership and capacity development, on use of biotechnological methods for enhancing utilization and on knowledge sharing. Besides, an Asia-Pacific Consortium for was recommended as a common platform for regional collaboration and networking in underutilized AnGR. Also need to establish an Asia Pacific AnGR Information System was highlighted and for which APAARI was requested to take initiative. Setting up of an Asia-Pacific Regional Gene Bank for Gametes and Embryos to facilitate sharing of genetic materials was also recommended.

The various recommendations would indeed help in revisiting national and regional research and development priorities for underutilized AnGR. It is a challenge now for countries and institutions and so also for APAARI to see how the recommendations are carried forward in

both national and regional level. APAARI, despite its limited resources is committed to promote regional collaboration and networking in scoping for collaborative projects and knowledge and data sharing of underutilized AnGR.

Ravi K. Khetarpal
Executive Secretary, APAARI

Acknowledgements

On behalf of APAARI, and its program APCoAB and my own behalf, I would like first to thank the Co-Organizers, Malaysian Agricultural Research and Development Institute (MARDI), Council of Agriculture (COA), Taiwan, and Australian Centre for International Agricultural Research (ACIAR) and collaborators, Department of Veterinary Services (DVS) Malaysia, Department of Wildlife and National Parks (WILDLIFE) Malaysia and Ministry of Agriculture and Agro-based Industry (MOA) Malaysia for their whole-hearted support in the organization of the Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration, which was held on March 4-6, 2019 at MARDI Headquarters in Serdang, Malaysia.

We thank immensely Dr. Zunika Bt Mohamed, Deputy Secretary General (Policy), Ministry of Agriculture and Agro-based Industry, Malaysia for gracing the occasion and delivering a very inspiring speech during Opening Session.

Whilst organizational support was important, strategic and technical inputs of individuals were also very critical. We place on record, our immense gratitude to Datuk Dr. Mohamad Roff Bin Mohd Noor, Director General, Malaysian Agricultural Research and Development Institute (MARDI), Malaysia, for his meticulous planning of organization of this workshop and unstinted support. We are equally thankful to Dr Chung-Hsiu Hung, Director General, Council of Agriculture (COA), Taiwan, for his benign presence during the opening session and for providing the financial support to APCoAB program under which this workshop was organized. Leadership provided by Dr Ravi Khaterpal, Executive Secretary, Asia-Pacific Association of Agricultural Research Institution (APAARI), Bangkok, for implementing the workshop agenda and constant support, is thankfully acknowledged. Our sincere thanks also are extended to all the co-chairs, rapporteurs, speakers, panellists and participants.

Successful and professional organization of the Workshop is a very hard work of the members of various committees. Sincere appreciation is extended to all committee members of MARDI and APAARI Secretariat, for their concerted and untiring efforts and invaluable contributions in the preparatory phase as well as during the event. They have worked constantly behind the scene to manage with all technical, financial, logistic and administrative aspects of organization of the Workshop.

Sincere thanks are accorded to all the co-editors, especially Dr M. Ariff Omar and his team from MARDI, for their intensive involvement in collation, compilation and critical editing in giving shape to the proceedings in the present form.

I hope that the recommendations presented in this document will draw attention of the policy makers, administrators, researchers, farmers and other stakeholders towards efficient conservation and sustainable use of underutilized animal genetic resources in Asia-Pacific region.

Rishi Tyagi
Coordinator, APCoAB

The Organizers

Asia-Pacific Association of Agricultural Research Institutions (APAARI)

http://www.apaari.org

The APAARI, with its headquarters in Bangkok, is a unique voluntary, membership-based, self-mandated, apolitical and multi-stakeholder regional organization in the Asia-Pacific region. It promotes and strengthens agriculture and agri-food research and innovation systems through partnerships and collaborations, capacity development and advocacy for sustainable agricultural development in the region. Since its establishment in 1990, APAARI has significantly contributed towards addressing agricultural research needs and enhancing food and nutritional security in the region. The close links, networks, partnerships and collaborations with stakeholders that APAARI has developed over the years, as well as its goodwill, authority and focus on results, make the Association an important actor in the region. The ultimate aim of APAARI is to help in realizing sustainable development goals in Asia and the Pacific.

Malaysian Agricultural Research and Development Institute (MARDI), Malaysia

http://www.mardi.gov.my

MARDI is an agency under the purview of the Ministry of Agriculture and Agro-based Industry with the main objectives of generating and promoting appropriate technologies towards the advancement of the food, agricultural and agro-based industries. MARDI is mandated to fulfill the following functions: (1) to conduct research in the fields of science, economy and social science with regards to the production, utilization and processing of all crops (except rubber, oil palm and cocoa), livestock and food, and integrated farming, (2) to serve as a center for collation and dissemination of agricultural and food technologies, (3) to provide technical and consultancy services in food, agricultural and agro-based industries and (4) to provide technical training to cater for the development of the food, agricultural and agro-based industries. MARDI also provides grant-in-aid for scientific, technical and economic research and development related to food, agricultural and Agro-based industries. MARDI has evolved from capacity building, establishment of farming and cropping systems to technology commercialization, total quality management and culture of excellence in attaining national and international recognition. MARDI is currently headed by its Director General Datuk Dr. Mohamad Roff Bin Mohd Noor.

Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB)

http://www.apcoab.org

The APCoAB, established in 2003 under the umbrella of APAARI, has the mission to harness the benefits of agricultural biotechnology and bioresources for human and animal welfare

through the application of latest scientific technologies while safeguarding the environment for the advancement of society in the Asia-Pacific region. APCoAB's main objectives are to (i) serve as neutral forum for the key partners engaged in research, development, commercialization and education/learning of agricultural biotechnology as well as environmental safety in the Asia-Pacific region, (ii) promote the application of biotechnological tools for bio-prospecting, conservation and sustainable use of bioresources and (iii) facilitate and promote the process of greater public awareness and understanding relating to important issues of IPRs, sui generis systems, bio-safety, risk assessment, harmonization of regulatory procedures, and access and benefit sharing in order to address various concerns relating to adoption of agricultural biotechnology and sustainable use of bioresources; and (iv) facilitate human resource development for meaningful application of agricultural biotechnology and use of bioresources to enhance sustainable agricultural productivity, as well as product quality, for the welfare of both farmers and consumers.

Council of Agriculture (COA)

http://www.tari.gov.tw/english

The COA, Taiwan, is the competent authority on agriculture, forestry, fishery, animal husbandry and food affairs in Taiwan. Its responsibilities include guiding and supervising provincial and municipal offices in these areas. Under the council, there are Department of Planning, Department of Animal Industry, Department of Farmers' Services, Department of International Affairs, Department of Science and Technology, Department of Irrigation and Engineering, Secretariat, Personnel Office, Accounting Office, Civil Service Ethics Office, Legal Affairs Committee, Petitions and Appeals Committee and Information Management Center respectively in-charge of related affairs.

Australian Government
Australian Centre for International Agricultural Research

Australian Centre for International Agricultural Research (ACIAR)

http://aciar.gov.au

The ACIAR is a statutory authority within the Foreign Affairs and Trade portfolio operating under the ACIAR Act. ACIAR contributes to the objectives of advancing Australia's national interests, promoting economic growth and increasing sustainability through assisting and encouraging Australian scientists, and institutions to use their skills to develop solutions to agricultural problems in developing countries. Its mandate is to plan, fund and manage projects across a broad range of agricultural and development areas. Approximately three quarters of the Centre's research budget is allocated to bilateral collaborative development-related research between Australia and developing countries. The remaining quarter of the research budget is allocated to multilateral development related research through contributions to international agricultural research centres. Besides, ACIAR provides training and development activities, including fellowships and support for training courses, as well as training provided within research projects, to help build capacity in research application and implementation in partner countries.

The Department of Veterinary Services (DVS) Malaysia

http://www.dvs.gov.my/

The Department of Veterinary Services (DVS) Malaysia was established in 1888 as an agency to control exotic and domestic animal diseases. Over the years, the structure and functions of the Department have evolved to meet the growing demand for veterinary services. The

Department is under the Ministry of Agriculture and Agro-based Industry Malaysia The current objectives of DVS are 1) to strengthen and maintain the health status of animals believed to be conducive to industrial animals, 2) to ensure public health through the control of zoonotic diseases, and the creation of clean and safe animal-based foods, 3) to promote sustainable livestock production and value-added industries, 4) to explore, develop and promote optimal use of technologies and resources in animal-based industries and 5) to organize animal welfare practices in all aspects of preservation and production. The Department carries out enforcement duty on animal welfare through Animal Welfare Act 2015 (ACT 772). It also provides consultation, enforcement, research and development, surveillance and training for livestock industrial benefits The Department is currently headed by its Director General Dato' Dr. Quaza Nizamuddin Bin Hassan Nizam.

The Department of Wildlife and National Parks (WILDLIFE) Malaysia

http://www.wildlife.gov.my/

The Department of Wildlife and National Parks (WILDLIFE) is a government agency which is responsible for the protection, management and preservation of wildlife and national parks in Peninsular Malaysia. The Department carries out enforcement duties on biodiversity conservation through the Wildlife Conservation Act 2010 (ACT 716) and International Trade in Endangered Species Act 2008 (ACT 686). The Department is under the purview of the Ministry of Water, Land and Natural Resources. WILDLIFE Malaysia is committed to the conservation of wildlife and its habitat for future generations. Amongst its objectives is to strengthen the wildlife conservation programs through management, enforcement, enrichment and research of wildlife. Maintaining the integrity of Protected Areas for the benefits of research, education, economic, aesthetic, recreation and ecological functions have always been its priorities. WILDLIFE has always strived to enhance knowledge, awareness and public participation towards wildlife conservation. The Department is currently headed by its Director General Dato' Abdul Kadir bin Abu Hashim.

Acronyms and Abbreviations

ABS	Access and Benefit-Sharing
ACB	ASEAN Centre for Biodiversity
ACIAR	Australian Centre for International Agricultural Research
AHP	ASEAN Heritage Parks
AI	Artificial insemination
AnGR	Animal Genetic Resources
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources
ART	Assisted reproductive technologies
ASEAN	Association of Southeast Asian Nations
COA	Council of Agriculture, Taiwan
CBD	Convention on Biological Diversity
CGRFA	Commission on Genetic Resources for Food and Agriculture
CHM	ASEAN Clearing House Mechanism
COA	Council of Agriculture
DAD-IS	Domestic Animal Diversity Information System
DAGRIS	Domestic Animal Genetic Resources Information System
DNA	Deoxyribonucleic Acid
DVS	Department of Veterinary Services
FAO	Food and Agricultural Organization of the United Nations
GMOs	Genetically modified organisms
GnRH	Gonadotropin Releasing Hormone
GPA	Global Plan of Action
CVASU	Chattogram Veterinary and Animal Sciences University
ICAR-NBAGR	Indian Council of Agricultural Research-National Bureau of Animal Genetic Resources
ICSI	Intracytoplasmic sperm injection
ICT	Information and Communications Technology
ILRI	Institute Livestock Research Institute
INDEL	Insertions and Deletions

IT	Information Technology
IVD	*in vivo* derived
IVF	*in vitro* fertilization
IVP	*in vitro* produced
LPPELD	League for Pastoral Peoples and Endogenous Livestock Development
MAEPS	Malaysia Agro Exposition Park Serdang Malaysia
MAHA	Malaysia Agriculture, Horticulture and Agrotourism
MARDI	Malaysian Agricultural Research and Development Institute
MOA	Ministry of Agriculture and Agro-based Industry Malaysia
MoAFW	Ministry of Agriculture & Farmers' Welfare India
MOET	Multiple ovulation embryo transfer
NGOs	Non-Governmental Organization
OPU	Ovum pick up
PCAARRD	Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development
PNG	Papua New Guinea
QTL	Quantitative trait loci
R&D	Research and Development
SCNT	Somatic cell nuclear transfer
SE	South East Asia
SNP	Single Nucleotide Polymorphisms
TLRI	Taiwan Livestock Research Institute
UAE	United Arab Emirates
UOG	University of Goroka Papua New Guinea
WILDLIFE	Department of Wildlife and National Parks

Executive Summary

The Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration was held on March 4-6, 2019 at MARDI Headquarters in Serdang, Malaysia. The workshop was organized by the Asia-Pacific Association of Agricultural Research Institutions (APAARI), Malaysian Agricultural Research and Development Institute (MARDI), Asia-Pacific Consortium on Agricultural Biotechnology and Bioresources (APCoAB), Council of Agriculture (COA), Taiwan, and Australian Centre for International Agricultural Research (ACIAR) in collaboration with Department of Veterinary Services (DVS) Malaysia, Department of Wildlife and National Parks (WILDLIFE) Malaysia and Ministry of Agriculture and Agro-based Industry (MOA) Malaysia. The objectives of the workshop were to assess the current status of underutilized AnGR at sub-regional level and R&D status of priority native breeds that are needed to promote the use of underutilized AnGR in the Asia-Pacific region, to identify the knowledge gaps and way forward in defining regional priorities concerning underutilized AnGR, to create awareness on the role and value of underutilized AnGR that have potential for diversification of the food basket and to formulate strategies to strengthen the institutional, legal and policy framework for sustainable utilization of underutilized AnGR.

A total of 63 participants from 14 countries in the Asia-Pacific region (Bangladesh, Bhutan, China, India, Iran, Kenya, Laos, Malaysia, Nepal, Philippines, Pakistan, Sri Lanka, Taiwan and Thailand) attended the workshop. The participants were from a number of national organizations such as research institutes, universities and research councils dealing with the management and conservation of underutilized AnGR.

The workshop comprised of presentations from 15 invited speakers who provided the background and status of underutilized AnGR in the region as well as presently available technologies in enhancing the management and breeding of underutilized AnGR. The presentations were delivered in three sessions: Technical Session I on **The Status of Underutilized AnGR for Food and Agriculture at Sub-regional Level**, Technical Session II on **Thematic Presentations of Underutilized AnGR** and Technical Session III on **Strategies for Conservation and Utilization of Underutilized AnGR** followed by Technical Session IV on **World Café Discussion – Regional Priorities for Underutilized AnGR** in five key areas: (1) conservation, improvement and utilization; (2) value addition, marketing and export; (3) partnership and capacity development, biotechnology for enhancing utilization; (4) biotechnology for enhancing utilization and (5) regional information sharing system and focal points for the conservation and utilization of AnGR and Technical Session V on **Panel Discussion on Legal and Policy Framework Support to Promote Utilization on Underutilized Animal Genetic Resources**.

The **Major Recommendations** arising from the workshop are:

On **conservation, improvement and use** of underutilized AnGR, each country within the Asia-Pacific region is recommended to have in place an enabling policy to protect and

conserve AnGR. The assessment of underutilized AnGR has to be carried out at national level to gather information on geographical distribution, population dynamics, risk status, and indigenous knowledge and experience in the management of underutilized AnGR. The rights of smallholder farmers owning these underutilized AnGR are to be safeguarded through filing of their intellectual property rights and agreement on sharing of benefits.

On **value addition, marketing and export**, that improvement of technology, facility, training and education on value-added products of indigenous AnGR are highly recommended. Farmers engaged in keeping underutilized species should be provided with enhanced skill and knowledge to enable them to develop and commercialize these value-added products. Steps should be taken to initiate and develop-branding and national certification to promote products derived from indigenous species. The public should be exposed to these products through awareness campaign to promote these products. The governments of APAARI member countries are recommended to provide the legal provisions to protect the originality and exclusivity of indigenous animal products. The marketing of products from indigenous animals should be enhanced and their production be made more consistent and their high quality maintained through R&D and training modules.

On **partnership and capacity development**, it is recognized that many stakeholders of special groups, NGOs, entrepreneurs, farmers and research institutions are to be included in the management of underutilized AnGR. To ensure sustainable partnership, the stakeholders need to be identified and engaged at national and regional levels based on priorities identified on underutilized AnGR. To build partnership, a networking of interest groups and institutions could be initiated to collaborate on selected key issues such as expertise development, methods/ technologies, deliverables and budget, and identify areas of common interest or current challenges of underutilized AnGR. Sharing of data and knowledge in specific areas of AnGR management including food security, is recommended to be strengthened through involvement of country personnel in workshops, seminars and training courses. A centralized data bank, also acting as repository of contributed information on AnGR, could provide easy access to member countries. Exchange of genetic materials of indigenous breeds is very crucial and should be given priority. For capacity building, awareness on the importance of status, risk issues and conservation methods of AnGR should be shared through seminars and workshops and hands-on trainings on modern biotechnologies. Selected advanced technologies in the preservation of genetic materials and multiplication of breeding animals may assist in the sustainable management of underutilized AnGR in member countries.

On **biotechnology for enhancing utilization**, the issues constraining the use of biotechnological methods in livestock production are lack of expertise, data, financial support and facilities. It is highly recommended that an Asia-Pacific Regional Genebank for gametes and embryos to facilitate regional sharing of genetic materials and enhance the mechanism for intra-regional exchange of AnGR be formed. A consortium for Asia-Pacific for underutilized AnGR is recommended as a common platform for regional collaboration and networking in underutilized AnGR. Collaborative projects among countries in the Asia-Pacific region are proposed on specific areas such as breed characterization, genomic profiling, sexing and cryo-preservation of gametes and value-added products of underutilized AnGR. Hands-on training for researchers, extension agents and farmers should be organized to upgrade their skills and knowledge in the multiplication and management of AnGR. Knowledge in management of AnGR could also be imparted through conferences, seminars and newsletters. Awareness programs could be conducted to expose farmers to easy-to-do biotechnological methods in the identification and breeding of underutilized AnGR. APAARI may facilitate the scoping for partners and fund

providers from public and private sectors for financial support through regional-wide proposals in the conservation and utilization of underutilized AnGR.

On **regional information sharing system and focal points**, there is a need to tailor the AnGR information system to meet each country's specific attributes. A regional information system should have defined objectives (kinds of data to share, end users and involvement of local communities), be user friendly in its usage and promote public awareness to educate the local community on AnGR. It is recommended that an Asia Pacific AnGR information system which meets the regional requirements be set up. The information system is suggested to be linked to DAD-IS and DAGRIS to facilitate the systematic gathering of AnGR information in the region.

Background and Objectives

Livestock biodiversity is important for food and livelihood security, particularly in the developing countries. About 70% of the world's rural poor keep livestock and rely on them as an important component of their livelihoods. Maintaining livestock diversity is a challenging task due to several constraints: (i) lack of knowledge of characteristics of breed, geographical distribution and population size, (ii) lack of conservation framework for threatened breeds or even structured breeding programs that could improve productivity, and (iii) current policies and legislation affecting the livestock sector rarely pay attention to support sustainable management of AnGR[1]. Global Plan of Action (GPA) for AnGR and the Interlaken Declaration were adopted by the International Technical Conference on AnGR for Food and Agriculture on September 3-7, 2007. Interlaken Declaration recognizes that the existing diversity of animal species has not been used to the extent possible for increased food production, improved human nutrition and to further sustain rural communities or in creating more production systems. To check the erosion and loss of AnGR and ensure the achievement of food security, improvement of human nutritional status, and enhancement of rural development, the efforts to conserve, develop, improve and utilize sustainably AnGR should be enhanced at national, regional and global levels[2]. The Second Report of the State of the World's AnGR provides a comprehensive assessment of livestock biodiversity and management[3]. Analyses of this report and also Sub-regional reports on AnGR in South Asia[4] and Southeast Asia[5] suggest that vigorous efforts still need to be made to strengthen the main elements of sustainable management of AnGR. Priorities include (i) improving knowledge in the characteristics of different types of AnGR and their production systems, (ii) developing institutional framework of AnGR, (iii) improving awareness, education, training and research in all areas of AnGR management, and (iv) expanding and diversifying the conservation programs[6]. To achieve the above, there is a need to strengthen global and regional level activities related to the management of shared resources, capacity development through the transfer of technologies and sharing of knowledge, policy framework and public awareness that facilitate the sustainable use, development and conservation of AnGR of which 70% are in the developing countries[7].

The increasing demand for food has changed the way AnGR are maintained and utilized. For the past centuries, managing AnGR has evolved from proculture to agro-technical to domestication phases. Domestication has revolutionized food production, thus allowing food to be produced in large amounts and enabling food to be traded for economic benefits instead of just feeding the community. The demand for larger quantity and higher quality of food by the growing population has encouraged selection of AnGR for breeding purposes using conventional or molecular approaches.

Albeit the success of domestication and selection of AnGR for food production, problems

[1] www.fao.org/docrep/012/al389e/al389e.pdf
[2] www.fao.org/3/a-a1404e.pdf
[3] www.fao.org/3/a-i4787e.pdf
[4] www.fao.org/docrep/pdf/010/a1250e/annexes/Subregional%20Reports/Asia/SouthAsia.pdf
[5] www.fao.org/docrep/pdf/010/a1250e/annexes/Subregional%20Reports/Asia/SouthEastAsia.pdf
[6] www.fao.org/3/a-i4787e.pdf
[7] http://agtr.ilri.cgiar.org/agtrweb/documents/library/docs/ex-brf.pdf

emerge when faced with current challenges such as climate change, natural disasters, and pest and disease outbreaks. The increased homogeneity of the population of domesticated animals makes it more vulnerable to these challenges and herds of animals can easily be wiped out when struck with an epidemic, jeopardizing the food security of the region. The underutilized AnGR is an important source of genetic pool that can help in improving the currently available breeds utilized for food production. However, not much information is known on these animals in the Asia-Pacific region. Hence, there is a need in understandingthe status and nature of AnGR to enable strategic planning of their sustainable utilization and conservation for better food security in future. The Regional Workshop will provide a platform for sharing experience and knowledge relating to underutilized AnGR of Asia-Pacific region that have food and nutritional value. Among the expected outcomes of the workshop are: (i) assessment of the importance of AnGR, status of their R&D to exploring the potential of their commercial use and eventual benefit to smallholder farmers, (ii) developing a Road Map to ensure the efficient management including conservation and sustainable use of underutilized AnGR for food and nutritional security in Asia-Pacific region, and (iii)exploring the possibilities of project formulation and establishing a regional network for knowledge sharing of other related issues.

The key objectives of the Workshop were:

1. to assess the current status of underutilized AnGR at sub-regional level and R&D status of priority native breeds needed to promote the use of underutilized AnGR in the Asia-Pacific region,
2. to identify the knowledge gaps and way forward in defining regional priorities concerning AnGR and create awareness on the role and value of underutilized AnGR that have potential for diversification of the food basket and
3. to formulate strategies to strengthen the institutional, legal and policy framework for sustainable utilization of underutilized AnGR.

Opening Session

Datuk Dr. Mohamad Roff Bin Mohd Noor, Director General MARDI, Malaysia

It is a great honour for me to welcome all of you, coming from various parts of the world to Malaysia and being present at the Regional Workshop on Underutilized Animal Genetic Resources and Their Amelioration. On behalf of MARDI, I would like to express my most sincere appreciation for your participation in this very much needed workshop.

It is a great recognition for Malaysia, and MARDI, specifically to be given the honour to organize and collaborate with various esteemed Asia-Pacific agricultural-based institutions in conducting this workshop. Thank you to APAARI, Asia Pacific Consortium on Agricultural Biotechnology and Bioresources, Council of Agriculture Taiwan, and Australian Centre for International Agricultural Research for consenting to be co-organizers of this much needed workshop in Malaysia. On behalf of the co-organizers, I would like to extend my sincere appreciation to the Department of Veterinary Services Malaysia (DVS), Department of Wildlife Natural Parks Malaysia (WILDLIFE Malaysia) and Ministry of Agriculture and Agro-based Industries Malaysia for their support in organizing and conducting this workshop.

Of late, the gradual changes in the global climatic pattern continue to disrupt our food supply. The sustainability of present livestock breeds and crop varieties continues to haunt us as we weather through climate change. The Asia-Pacific region, blessed with a large depository of animal species, is not exempted from the effects of climate change too. Hence, cooperation among national and regional economies becomes even more crucial in managing and maintaining underutilized animal genetic resources.

Hence, within the next three days of this workshop, I urge you to take the opportunity to deliberate, discuss, form network and engage with each other on this topic of concern. With your own understanding and reflection, kindly digest the technical and plenary sessions, and translate your thoughts into practical recommendations on the best way forward to balance the conservation and utilization of underutilized animal genetic resources for the purpose of livelihood, food and nutritional security in the Asia-Pacific region.

Altogether, we have approximately 60 participants and experts from 11 countries from the Asia-Pacific region attending this workshop. I thank you for making time for being here. Your contribution on this very pertinent subject would assist in ensuring the sustainability of future food production and underutilized animal genetic resources. I look forward to much more like-minded collaboration on enhancing the strategic utilization of animal genetic resources.

I wish to thank the local organizing committee from MARDI, DVS and WILDLIFE and APAARI for their commendable efforts in organizing this workshop entitled "Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration."

To the international speakers and participants, I do wish you a pleasant stay in Malaysia and to all local delegates and participants, thank you for your support. We really appreciate your presence and last but not least, I wish everyone a fruitful workshop.

Dr Ravi Khetarpal, Executive Secretary, APAARI

Dr Ravi Khetarpal, Executive Secretary of the Asia-Pacific Association of Agricultural Research Institutions (APAARI) firstly acknowledged the presence of Dr Zunika Mohamed, Deputy Secretary General (Policy) of Ministry of Agriculture and Agro-based Industries Malaysia, Dr Mohamad Roff Mohd Noor, Director General of MARDI, Dr Chung-Hsiu Hung, Director General of Council of Agriculture (CoA) Taiwan, Mr Fakhrul Hatta Musa, Deputy Director General I (Conservation) of Wildlife and National Parks Department Malaysia, Dr Wan Mohamed Kamil Wan Nik, Director of Livestock Technology Resources Development Division of Department of Veterinary Services Malaysia, Dr Rishi Kumar Tyagi, APCoAB Coordinator of APAARI Bangkok, invited speakers, participants coming from different countries in the Asia-Pacific region and members of the Organizing Committee at the opening session of the Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration.

He extended welcome greetings on behalf of APAARI to everyone to this very important workshop on underutilized animal genetic resources.

As an introduction, APAARI is a FAO-led initiative established in 1990. It has grown to be one of the vibrant regional organizations in agricultural R&D. Currently, APAARI has 80 members comprising national agricultural R&D institutes of member countries, regional international organizations, institutions of higher education and the private sector. APAARI has developed Strategic Plan 2017-2022: Pathways to Strengthen Agri-Food Research and Innovation Systems in Asia and the Pacific in four thematic areas: (i) Mobilization, management and use of natural resources for sustainability,(ii) Management of risks and uncertainties, (iii) Inclusive development and integration of value chains targeted at benefiting smallholders, and(iv) Analysis, strengthening and formulation of public policies and overarching regulatory frameworks in support of the transformation and development of agri-food systems (AFS). This has led to the strengthening of the APAARI secretariat to align its programs to the targets and indicators of the UN Sustainable Development Goals. APAARI has therefore developed the agricultural biotechnologies program through the APCoAB with its sponsor CoA of Taiwan. The current workshop is one of the 3-workshop series: underutilized crops, animal and fishery genetic resources, conducted between 2017 and 2019. The animal genetic resources topic is an important one since animal production has increasingly becoming important in agricultural development.

APAARI has also focused on the social sciences, especially on developing agricultural technology indicators in assessing the funding efficiency of R&D contributions to national wealth. This APAARI –ACIAR initiative is important from the investment policy angle since it will provide directions to the national agricultural development strategies. Besides APAARI is looking into agricultural education to examine how it can assist in achieving the UN Sustainable Development Goals. Working

with UNESCO, SEARCA and Chulalongkorn University, Thailand, APAARI has begun a program to map the education system, assess the gaps and bring all skills in agricultural innovation to be embedded in national educational system. A risk assessment program on agricultural pesticides management in crop and animal production in the Asia- Pacific has been initiated by APAARI with University of Rutgers USA to assist in the development of green agriculture and reduction in chemical residue in agricultural produce which will facilitate international trade of agricultural commodities.

This workshop is aimed directly at attaining the food and nutrition security. The UN Sustainable Development Goals specifically address the objective of zero hunger and poverty. Unfortunately, the recent joint report of FAO, WHO, World Food Program and UNESCO has concluded that no progress has been made in reducing world hunger and poverty which exist the most in the Asia-Pacific region.

The present workshop is an outcome of several earlier agreements, including Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration, which aim to assess the risk and R&D status, deliberate on regional cooperation and chart the way forward in the management and utilization of underutilized animal genetic resources. It is expected that a regional network in the Asia-Pacific region will strengthen the collaboration in the utilization of these genetic resources.

Dr Ravi ended his opening remarks with words of thank to Dr Mohamad Roff Mohd Noor of MARDI who willingly agrees to be the co-host with APAARI, Dr Rishi Tyagi of APAARI, Dr Ainu Husna Suhaimi and members of the Organizing Committee of MARDI for their full cooperation in successfully organizing this very important workshop.

Thank you and happy deliberations.

Dr Chung-Hsiu Hung, Director General, COA

Good morning. It is my great pleasure to be with you here today at the opening ceremony of the "Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration". On behalf of the Council of Agriculture, Taiwan, I would like to thank MARDI and APAARI for co-hosting this meaningful event.

As you are all aware, agricultural production and food industries have changed dramatically over the past few decades. With the continuous economic development and improved living standards in recent years, the demand for animal protein in the daily diet has increased sharply. Therefore, it has become an important issue to provide a platform for sharing experiences and knowledge relating to underutilized animal genetic resources that have food and nutritional value.

Most Taiwanese livestock farmers face challenges of high land prices, rising environmental awareness, import-dependent feeds and expensive laborers. Therefore, the local livestock industries operate at a rather high production cost. Despite these challenges, livestock farmers and the government have been working closely throughout the years on restructuring the industry and modernizing its production and marketing. A large-scale national pilot project, "Germplasm Preservation and Utilization in Domestic Animals", was initiated in 1987, with three methods for preserving livestock germplasm, including maintaining live populations, cryopreserving germ cells, and establishing DNA stores. Animal resources thus are bounteous and preserved for improving exotic breeds in terms of future production performance and efficiency. My colleague from the Livestock Research Institute will elaborate more on the "Status of underutilized animal genetic resources for food and agriculture at sub-regional level' in the next section.

I am confident that this workshop will provide a great opportunity for all the participants to review the current situation and the challenges that we are facing. And I believe that, with your contributions and input, this workshop will yield fruitful outcomes and valuable suggestions in order for us to tackle the tasks ahead.

Finally, I would like to express my gratitude to MARDI and APAARI for their meticulous preparations for this event. My sincere thanks also to the gracious presence of all assembled here. I wish the workshop great success.

Thank you for your attention.

Dr. Zunika Bt Mohamed, Deputy Secretary General (Policy), Ministry of Agriculture and Agro-based Industry, Malaysia

I wish to first convey greetings from our Deputy Minister, YB Mr Sin Tze Tzin who could not be here today due to other unforeseen commitments. He however, sent his warmest greetings to all of you and wishes all a good workshop.

It is my pleasure to represent him today and so let me begin by expressing my sincere thanks to the Organising Committee for the invitation to officiate the Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration. We are grateful with God's blessings and guidance that we are able to gather this morning for today's event.

It is indeed a great pleasure for me to welcome all speakers and participants to this workshop. '*Selamat Datang*' to all.

Let me also congratulate the organisers from Malaysia - MARDI, DVS and WILDLIFE, APAARI and COA for successfully organising this workshop. We are very proud that Malaysia is chosen to be the venue for this event. It is really a great pleasure for me to see many international experts in animal genetic resources gathering together this morning. Your commitment to be here today is much appreciated and I am confident these next few days will be filled with a lot of knowledge gaining, experience sharing and fruitful discussions. I hope all the participants will take this opportunity to learn and gain as much knowledge as possible from this 3-day workshop for the better management of animal genetic resources in the respective countries.

As I was on my way to MARDI this morning, I passed the Malaysian Agro Exposition Park or MAEPS, Serdang where we just successfully had MAHA 2018 a couple of months ago. My thoughts went back to MAHA 2018 and I was reminded of how blessed we are being in Malaysia where there are so many different species, breeds, and varieties of animals, plants and crops providing us with a galore of different types of food, dishes and delicacies. It seems that with that much variety, we will forever have ample amount of resources to fulfill all our needs and a day where all of these resources disappear seem impossible.

Unfortunately, the reality is we might lose all that we have, one day. According to the Food and Agriculture Organization of The United Nations (FAO), of the 7,600 breeds of livestock reported to FAO by its Member Countries, more than 1,500 are at risk of extinction or are already extinct. The rate of losing a breed is about one in a month. For the first six years of this century, we have lost forever, more than 60 animal breeds. This is alarming. When we lose a breed, we also lose their unique genetic make-up. So, we also lose one defense mechanism against future threats to food security.

It is without a doubt, climate change is worrying everyone. In any platforms, local and global, topics of how climate change can impact our lives and how to overcome it always tops the list. For animal and livestock as well, scientists are predicting that climate change scenarios will have dramatic effects on livestock production such as heat stress caused by rising temperatures, will impair reproduction; water, feed and fodder availability will be affected by climate change as well as by increased demand for fuel crops, which will reduce the amount of land and water available for feed crops and vectors that carry animal diseases will be able to expand their ranges to higher elevations and latitudes as temperatures rise, threatening many traditional breeds and leading to further genetic erosion.

To overcome pressures of climate change to a country, utilizing own genetic resources would probably be the way to go. Being native, usage of traditional breeds, which are generally more resistant to diseases, and more resilient to rising temperature, will have higher chance for sustainability. As native livestock populations are more adaptable to environmental changes, it ensures better food security in the future.

Hence, the organization of this workshop for the Asia-Pacific region is very timely. Our region is blessed with mega-biodiversity countries and holds a reservoir of approximately 15,000 vascular animal and plant species and we need the most efficient way to protect these precious resources. The platform provided by this workshop will encourage discussions, sharing of ideas as well as build friendship and network for better cooperation on the impactful initiatives in the future.

I hope this workshop will achieve its objectives which also include: assessing the importance of most potential animal genetic resources, status of their R&D for exploring the possibilities of their commercial use and eventual benefit to smallholder farmers and developing a Road Map to ensure efficient management including conservation and sustainable use of underutilized animal genetic resources. Let us together support available global initiatives such as the Global Plan of Action for Animal Genetic Resources declared at The Interlaken Conference and Asia-Pacific Strategic Plan for Biodiversity 2011-2020. This global 10-year framework comprises of a shared vision, a mission, strategic goals and twenty ambitious yet achievable targets, collectively known as the Aichi Biodiversity Targets.

Before I end this opening speech, I would like to congratulate again the committee members from the various agencies and organizations for all the hard work to organise this workshop.

I wish you all a very fruitful and enriching workshop. To all international delegates, I hope that you will enjoy your stay here and sample our varieties of foods, culture, flora and fauna that you would be able to explore during the workshop and the technical visit.

With that and BISMILLAH HIRRAHMAN NIR RAHIM hereby declare 'The Regional Workshop on Underutilized Animal Genetic Resources and Their Amelioration' open.

Status of Underutilized Animal Genetic Resources for Food and Agriculture at Sub-Regional Level

Co-chairs : **Abdul Rashid Baba** (MARDI, Malaysia) and **Jialin Han** (ILRI, China)

Rapporteurs : **Mohd Hafizal Ahmad** (DVS, Malaysia), **Nasyatul Ekma Mohd Hussin** (MARDI, Malaysia), **Badmanathan a/l Munisamy** (WILDLIFE, Malaysia)

South and West Asia

Arjava Sharma (Ex ICAR-NBAGR, India)

The region is made up of South Asia (Afghanistan, Bangladesh, Bhutan, Iran, Maldives, Nepal, India, Pakistan and Sri Lanka) and West Asia (Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, UAE and Yemen). South Asia covers 5% of world's land area and is home to 2 billion people, a fourth of the world human population, while West Asia has 3% of the world's land area with 240 million people. South Asia is richer in biodiversity compared to West Asia. The region contributes 12 of the 15 important animal species to world food animal production. There is more scope for food production in South Asia which currently augments its domestic supply with imports to meet increasing demand compared to West Asia. AnGR are significant as they contribute to the region's food security since local AnGR fit well with the low input smallholder production system and integrated crop production system. South Asia has 34.9% of Asian livestock population, comprising mainly of cattle, buffalo, goats, sheep, asses and poultry compared to only 6% found in West Asia, mainly camels, sheep, goats and poultry (turkeys). The number of breeds of livestock found in the region is large – 176 (cattle)), 118 (sheep), 117 (goat), 56 (buffalo), 39 (pig), 61 (horse) and 141 (poultry) in South Asia and 99 (cattle), 134 (sheep), 64 (goat), 39 (horse) and 50 (poultry) in West Asia. India alone has 43 (cattle), 43 (sheep), 34 (goat) and 16 (buffalo) native breeds. However there are also underutilized AnGR in this region which have been neglected and not fully exploited due to their unknown useful traits, whose utility has faded with time, not fitted to the intensive production system and little scope for product marketing. Among them are camels – an important species for the arid areas of the region – which are utilized for meat, milk, transportation and draught purposes, yak in the higher altitude and mithun in the humid areas for meat production and draught function.

A number of strategies are proposed to harness the AnGR potentials: exploration and identification of underutilized AnGR, identification of unique qualitative and quantitative attributes, phenotypic and genotypic characterization, risk assessment, development of niche markets for specific products, safeguard of

traditional production system and sensitization and awareness programs. India has initiated the inventory process of its indigenous AnGR through registration, breed and molecular characterization, identification of beneficial traits and promotion of community-based conservation. There is a need to monitor the risk exposure of native breeds of livestock. It is also important to create niche markets for the products derived from underutilized AnGR to ensure a continuum of the conservation effort. Legislation on livestock production has to be made clear and awareness program be conducted to safeguard indigenous breeds of livestock.

South-East Asia

Synan Bagio (PCAARRD, Philippines)

South-East Asia comprises of 11 countries in the ASEAN grouping. It is estimated that livestock contributes less than 20% of the gross value in agriculture in the region. Most of the animal production activities are undertaken by smallholders. Livestock is raised for food, additional income, assurance, financial buffer in case of crop failure, religious rituals, and ethnic delicacies. Cattle and buffalo are no longer used for draught and transportation purposes. Although the region is rich in animal biodiversity, the AnGR are in danger of genetic loss due to the absence of organized breeding, conservation efforts and utilization strategies. Animal products are often not efficiently produced and marketed. Presently, consumers' preference has shifted to naturally or organically-produced animal products. Presence of special attributes of native breeds, such as their unique meat qualities, has lured consumers to consume native animal products. Native breeds are said to have heat resistance which may be useful to improve the breeding efficiency of livestock raised in the tropics. However, access to information on breed characteristics of AnGR is often limited by the lack of data management system. Among the strategies suggested to harness the potentials of native breeds include use of new technologies to characterize genetic traits, identification of breed characteristics for future benefits, implementation of breed improvement programs, engagement of public and private entities and politicians in the implementation of R&D programs.

Formulation of enabling policies on AnGR should be carried out to sustain production and promote specific products derived from native breeds targeting towards specific markets. Capacity building and facility development for the production of native breed products are also important to be given priority. An example is the development of Itik Pinas in the Philippines that was achieved through consultation with public sector and industry players in R&D program, breed improvement and commercialization of its products. Itik Pinas Kayumanggi is an improved native breed of duck that produces 55-75% more eggs with 85% of the eggs weighing 65g or more compared with the native breed. There is a need to continue the breeding and selection of AnGR to improve the productivity of native breeds while maintaining the traits that enhance their fitness and adaptability to the environment and their unique attributes for specific products. The production of native breeds could further be improved by developing feeding, health and management protocols especially suited for small farm conditions. The commercialization of products of native breeds could be pursued further with new processing, branding and marketing strategies.

East Asia

Tu, Po Ann (CAO, Taiwan)

The East Asia region (China, Japan, North Korea, South Korea, Taiwan and Mongolia) has seen rapid rate of growth for meat and dairy products, mainly attributable to China which has experienced very rapid rise in per capita income and associated diversification away from food staples for animal products. East Asia has proceeded faster than any other regions in Asia in meat and milk production, but has not kept pace with the region's increasing demand. Although Asia possesses a large animal population, its share of the world's animal output is still low. Taiwan's livestock industry is driven by livestock germplasm exchange facilitated through global trade, thus incorporating high percentage of exotic blood in livestock breeding and use of high output international trans-boundary breeds replacing local breeds in enhancing livestock production. Native AnGR such as Lanyu miniature pigs which are facing threat of genetic erosion, habitat loss and social value sinking are now being researched for medical purposes.

Many indigenous breeds of livestock possess special adaptive traits for disease resistance and ability to survive in adverse conditions such as high temperature and poor quality feed and water. The region is rich in AnGR with China alone having more than 300 domestic livestock and poultry breeds. Japan has relatively rich diversity in AnGR among the countries in the region with exotic breeds and crossbreds playing an important role in animal production and nearly 30 breeds are preserved. In many countries, underutilized AnGR face threats of survival, although it is often recognized that the adaptive and unique characteristics of native breeds such as prolificacy, early maturity, heat, disease, and roughage tolerance and special meat flavor provide useful genes for future needs. Taiwan has built the Taiwan Animal Germplasm Center which includes a cell bank for-sperm, oocycte, and embryo. To preserve and utilize germplasm of domestic animals, a large scale national project has been initiated in 1987. As an example, the Black Muscovy ducks with black facial skin are being conserved under a traditional breeding scheme led by Taiwan Livestock Research Institute. The indigenous Yellow cattle have been sequenced with many genotypes identified through SNP and INDEL variant data. Similarly, Japan has established the Genetic Resources Center, Naro to preserve AnGR in the forms of fertilized eggs, semen and somatic cells and in situ populations.

Several challenges and opportunities lay ahead in conserving AnGR such as preserving domestic AnGR for the improvement of exotic breeds in the future for improved production, performance and efficiency, sequencing local animal genomes to improve health, adaptability, and production, improving adaptability of livestock breeds to climate change, and pest and disease outbreaks, and developing DNA-based technology for prediction of genetic merit. In China, samples of embryos, blood and DNA are preserved in the Centre of Livestock and Poultry Germplasm Resources for future use. To enhance the quality and safety of agricultural products, Taiwan, China and Japan have implemented traceability scheme through the use of ICT, thus improving the efficiency of supply chain management. A number of research strategies have been outlined to preserve AnGR: researching and utilizing molecular techniques to determine the genetic characteristics of AnGR, comprehensive assessment of genetic diversity of native breeds, identifying intra species genetic variations, DNA libraries and genome sequencing of native breeds to reveal genetic bases for disease resistance, adaptation to environmental stresses and production efficiency.

The Pacific

Alan Quartermain (UOG, Papua New Guinea)

The Pacific region comprises of 18 island countries or territories with 70% of the population and 84% of the land area found in Papua New Guinea (PNG). Livestock husbandry is given low priority in these island states constrained by poor local skills and knowledge, and lack of resources, facilities and funding. The focus is on family self-sufficiency which is currently not meeting the domestic demand. Indigenous pigs and chicken are the important animal species raised by the inhabitants, mainly in small scale farms. Most populations of animal species, except pigs and chicken, are crossbred. There are limited exports of beef from Vanuatu and crocodile skins from PNG. Generally, there is good information on production systems but less is known about genetic qualities and potentials of many of these AnGR. Much genetic diversity is available but no systematic crossbreeding and selection programs of the available breeds of livestock have been implemented, except for sheep in PNG, Fiji and Samoa and goats in Fiji. The indigenous pig and chicken populations are subject to genetic contamination through crossbreeding with exotic breeds.

There is need to focus on evaluation and effective use of the indigenous breed diversity. Some of the successful breed-types are Fiji Fantastic (Barbados Black belly x Wiltshire Horn) and PNG Highlands half-bred sheep, Anglo-Nubian x Indigenous goats of Fiji, Rusa deer in New Caledonia and crocodiles in PNG. Brahman and Brahman crossbred cattle are significant in terms of population size in Fiji, PNG, Vanuatu and New Caledonia. Sheep are preferred over goats in PNG, Vanuatu, New Caledonia, Fiji and Samoa. PNG retains the original goat genotype of early colonial era and is increasing in population size. Pigs are well distributed across the region originally derived from PNG. Traditional production systems for pigs in these Melanesian countries are well documented. Native chickens with high level of genetic diversity are found in all countries within the region with many native chickens been upgraded with exotic breeds. Recent initiatives include the conservation of indigenous pig breeds in Fiji and establishment of native chicken flocks comprising of unique genotypes and genetic diversity in Niue and Cook Islands. Muscovy ducks have been successfully farmed in several countries. Rusa deer are domesticated and found wild in New Caledonia. Farming of crocodiles of both species is well established in PNG. Swamp buffaloes found unsuited to local farming conditions have dwindled in population since early colonization.

Several strategies are proposed to include conservation and utilization of AnGR of available breeds, and conventional breeding and improving the productivity of native pigs and chicken using local feed resources. Among the feasible interventions which could be implemented within the region are promotion of Zebu-based cattle production in the Melanesian countries and Samoa based on assessment of necessary geographic and human resources, expansion of sheep and goat production using available genetic resources within the region, identification of more effective utilization strategies of indigenous pigs and chicken and further development of Rusa deer in countries other than New Caledonia and PNG.

Key Discussion Points

(Discussants: Arjava Sharma, Hamid Reza Bahmani, Johar Ali, Mohammad Rafiqul Islam)

1. Iran's inventory of underutilized AnGR comprising of 27 sheep, 12 goat, 5 horse and 5 camel native breeds may add to the list of underutilized AnGR of the West Asia sub-region. Some of these breeds are trans-boundary breeds shared between the two sub-regions of West and South Asia.
2. Swamp buffaloes were once used for farm work but have been displaced by farm machinery. On-going efforts are carried out to breed swamp buffaloes for meat and milk through crossbreeding with river buffalo to increase their milk production.
3. Mithun is a valuable genetic resource for meat production found spread in many humid areas within the region. R&D efforts should be expanded to improve Mithun to tap its potential meat production, presently raised in semi-domestication environment.
4. The use of molecular techniques in the breeding and breed development of native species should be enhanced alongside conventional breeding. Genetic progress could be achieved in a relatively shorter time compared to conventional breeding and selection methods.
5. The new biotechnological techniques used to produce new improved genotypes should not be imposed on the pastoral system utilized by smallholder farmers whose farm output is dependent on low inputs from pastoral system. Underutilized native AnGR should be improved through strategic breeding and their unique attributes identified to produce products of specific quality that are marketable. The creation of these new native products could encourage farmers to continue to raise indigenous breeds when demand for these products increases. Indigenous AnGR must first be documented of their attributes and population dynamics before any decision can be made on conservation, priorities and development of the native breeds for future use.

TECHNICAL SESSIONS II

Thematic Presentations on Underutilized Animal Genetic Resources

Co-Chairs : **Ilse Kohler-Rollefson** (LPPELD, Germany) and **Mohd Noor Hisham Mohd Haron** (DVS, Malaysia)

Rapporteurs : **Shariffah Nazari** (DVS, Malaysia), **Thayalini a/p Kathiraser** (MARDI, Malaysia) and **Amal Ghazali Nasrom** (WILDLIFE, Malaysia)

Underutilized animal genetic resources for food and nutrition – regional scenario on their genomic adaptation

Jialin Han (ILRI, China)

While demand for animal-sourced food is on the increase, climate change is threatening the sustainability of extensive livestock systems where indigenous AnGR play an important role in many regions of the world. Heat stress from climate change has reduced meat, milk and egg yield as well as reduced animal reproductive efficiency and immunity. Intensive livestock systems have also been affected by climate change from limited availability of feed and water resources. New genomic resources could unlock the basis of disease resistance and climatic adaptation of many AnGR through nested association mapping populations for genomic dissection of adaptability traits, genome-wide SNP maps of global animal diversity and transcriptome analyses of indigenous AnGR under disease and harsh environmental challenges. Whole genome sequencing of native sheep breeds sampled from habitats of extreme environments has provided insights into their rapid genetic adaptation to these environments. Whole genome resequencing has also revealed world-wide ancestry and adaptive introgression events of domesticated cattle in the East Asia region.

Genomic analyses of cattle from geographically diverse breeds in China and three indicine breeds from India have shown the relationship of ancient cattle to the present-day cattle. Phylogenetic analyses have also confirmed the *Bos javanicus* introgression in Chinese indicine cattle and the yak introgression into Tibetan taurine cattle. Long term natural selection within a species and historical hybridization or introgression among livestock species have led to the accumulation of advantageous genotypes responsible for the enhanced genetic adaptation to environments of different extreme climatic conditions.

Characterization, inventory and monitoring of underutilized AnGR

Adrien Kumar Raymond (DVS, Malaysia)

AnGR have been defined variously as those breeds or strains of farm animals which appear to have significant potential for use yet whose potential is scarcely exploited in food production and agriculture. Examples of underutilized AnGR found in Asia are Kedah-Kelantan cattle, Bali cattle, Katjang goats and Yellow cattle. The underutilized breeds hold great genetic diversity and a vast tradition of indigenous knowledge are linked to these breeds. In Asia as it is all over the world, AnGR are under threat. Particularly under threat are the underutilized breeds of livestock as they lack utility and perceived to be lacking in economic potential. Inventory, characterization and monitoring are the first steps in the management of these AnGR.

However, countries need to have a proper system of administration to manage AnGR effectively. Inventories are undertaken to determine the distribution and composition of breeds and breed habitats. An inventory of breeds will mainly include information on their population sizes, geographic distributions and population trends over time. From the Second State of the World's Report on AnGR, it appears that South East Asia has among the lowest rates of baseline surveys of population size and more emphasis needs to be given to improve inventory in this region. Characterization includes both phenotypic characterization as well as genetic (molecular) characterization. The term phenotypic characterization of animal genetic resources generally refers to the process of identifying distinct breed populations and describing their phenotypic and performance characteristics within a given production environment. Molecular or genetic characterization refers to the detection of variation as a result of differences in either DNA sequences. Comprehensive national inventories, supported by regular monitoring of trends and associated risks, are basic prerequisites for effective management of AnGR. Monitoring is typically used to understand the rates of changes or the effects of management practices on AnGR populations and their habitat. Updating the Domestic Animal Diversity Information System (DAD-IS) developed by FAO needs to be practiced by all countries. Countries should commit significantly more funding and undertake capacity building to enhance the sustainable development and conservation of underutilized AnGR.

Breeding strategies for underutilized AnGR

Ming Che Wu (TLRI, Taiwan)

The ability to pool and deliberately mix semen from many sires and then use this mixture for instrumental insemination of larger groups of dams is a valuable tool for breeding of poultry populations. In mule duck production with two-species crossbreeding via artificial insemination of laying ducks sired with mixed semen from Muscovy duck, it is an essential application of

multiple-sires instrumental breeding. In free range production, females of native chicken and laying ducks can be multiple-sire mated to ensure a higher fertility rate of ovulated eggs. Although frozen semen are commercially available in dairy cattle mating system, but there are not for all dairy breeds, especially not in the case of local breeds. Application of artificial insemination using frozen semen and embryo transfer may facilitate sire-daughter mating, brother-sister mating or son-dam mating to increase genetic homogeneity without inbreeding depression of reproduction performance. Inbreeding quickly brings to the surface any detrimental genes that are present in a population. Some excellent inbred lines of chicken, pig and dairy cattle have been developed with selection for high growth and good reproduction.

For maintaining genetic biodiversity and conservation of underutilized indigenous animals, a sound registry of mating plan with artificial insemination of mixed semen from two or more breeds could be implemented to enlarge the female population for later back-crossing and inbreeding to genetically identified sires. With the facility of paternal DNA test, single-sire breeding can be used with extended semen and intra-uterine insemination to test the allele effect of sire genome on their economic traits of beef cattle, goat, deer, rabbit, sheep, pig and poultry breeds in a small scale farming system. Researchers should work closely with farmers, keepers of indigenous breeds, through mutually beneficial outreach programs. Animal recordings of photographs location, population, sex ratios and experience in managing these native species are important to be stored in the gene bank. Farmers should be trained in artificial insemination and breeding techniques to improve their animals.

Molecular biotechnologies for underutilized AnGR

Ainu Husna MS Suhaimi (MARDI, Malaysia)

Molecular biotechnologies are applicable in various fields and for various purposes. In the context of AnGR conservation, the application of molecular biotechnologies is in the form of genetic markers. DNA sequences in a genome contain many repetitive elements which are highly variable and mutate frequently. The characteristics of these elements make them suitable as molecular markers. There are many types of molecular markers and these markers evolve with technologies. From the traditional, hybridization and chromosome-based markers, the common DNA markers are either gene -based, linked to QTL or are genome -based markers such as SNP panels. In term of application, there are three main purposes to use molecular markers which are for genetic characterization, trait-linked purposes and genomic analysis to explore and obtain molecular information.

In MARDI, molecular markers are used for all the above purposes. Characterization of breeds has been performed on local cattle, goats, buffaloes and native chickens. Traits linked to production such as high growth, high fertility and resistance to diseases have been studied using various molecular markers. This paper describes two examples of molecular marker research in MARDI. Based on available commercialized SNP Panel for local goat and cattle, a simple, more specific and cheaper SNP panels have been developed. The panels allow determination of the purity in indigenous goats and cattle in Malaysia. In this study, it was discovered that the remaining Malaysian indigenous goats, Kambing Katjang, only has 70% purity and 30% of mixed Kalahari, Jamnapari, Boer and Savannah breeds. A

study of the Elite Kedah–Kelantan cattle revealed purity of 94% KK followed by 7% of mixed Brahman, Bali and Yellow cattle. Another genomic approach utilized in MARDI is microarray technology which can be used to unravel unknown information on fertility and other complex physiological processes.

Differential hypothalamic gene expression was observed between cows with different stages of ovarian activities and when analyzed, identified novel and known genes, and possible interactions at the transcription level in the possible control of Gonadotropin Releasing Hormone (GnRH) genes and interactions were identified This information adds to the knowledge bank towards better management of postpartum cows in the tropical region. Thus, molecular biotechnology is a tool that can be used in the multiplication of underutilized AnGR. There are challenges to this approach which include small population size, lack of breeding animals and most livestock producers are smallholder farmers. However, there are much potential in molecular biotechnology approaches that could be exploited and more consortiums should work together on genome information and leverage on Asia-Pacific network to move forward.

Animal genetic resources in the ASEAN countries and the three objectives of the Convention on Biological Diversity

Elpidio V. Peria (ACB, Philippines)

The Convention on Biological Diversity (CBD) includes animal genetic resources (AnGR) under biological resources defined as genetic resources, organisms or parts thereof, populations, or any other components of ecosystems with actual or potential use of value for humanity. CBD conservation program includes *in situ* and *ex situ* conservation. *In situ* conservation of AnGR is conducted through an established system of protected areas, regulation and management of biological resources, protection of ecosystems and habitats and maintenance of viable populations of species in natural surroundings. Promotion of environmentally sound and sustainable development in areas adjacent to protected areas, rehabilitation and restoration of degraded ecosystems, prevention and control of introduction of invasive alien species, preservation and maintenance of knowledge, innovations and practices of indigenous people and local communities would be parts of in-situ conservation.

CBD defines the guidelines to protect and encourage customary use of biological resources in accordance with traditional cultural practices and supports local populations to develop remedial actions in degraded areas. *Ex situ* conservation of AnGR involves establishment and maintenance of facilities, adoption of measures for recovery and rehabilitation of threatened species for reintroduction into their natural habitats, as well as regulation and management of collection of biological resources from natural habitats and cooperation in providing financial support and other forms of assistance for *ex situ* conservation facilities in developing countries. The methods and strategies for *in situ* and *ex situ* conservation of biodiversity for food production and agriculture need to be improved and information on them is to be made more widely available.

The ASEAN Centre for Biodiversity (ACB) has promoted the establishment of protected areas of high conservation importance, thus, preserving in total a complete spectrum of representative ecosystems in the ASEAN region. The setting up of ASEAN Heritage Parks (AHP) brings a number of benefits which include capacity building support, technical assistance, visibility, inter-AHP

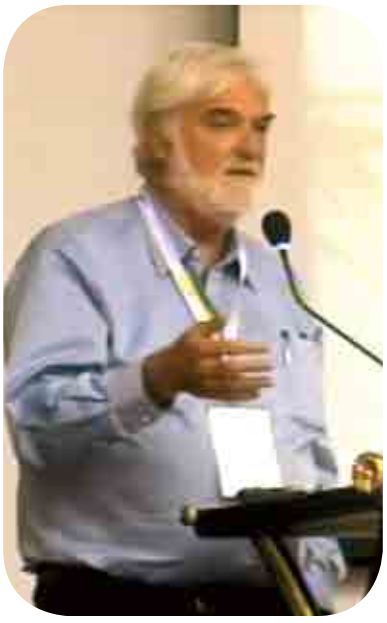
collaboration, national and sub-national complementation and regional platform for information sharing. The ASEAN Clearing House Mechanism (CHM) was set up to improve accessibility and sharing of biodiversity information, generate knowledge on products, promote scientific and technical cooperation and serve as a tool to show progress in biodiversity conservation.

CHM has the potentials to provide a sound understanding of the range of species involved and their distribution, characteristics, uses and risk status, including information on associated biodiversity and wild relatives of domesticated species. It is within the function of CHM to identify gaps in research involving the status, inventory and characterization of AnGR in the region. It is hoped that the interfacing of AnGR and CBD objectives, and corresponding measures could be strengthened. Thus biodiversity mainstreaming in AnGR could be pursued further to carry out the various interfaces. ASEAN CHM could become a good option for information sharing on underutilized AnGR.

Market-driven approaches to conservation and utilization of AnGR

Steven Staal (ILRI, Kenya)

Asia is projected to double its demand for livestock products from current level by 2030. As supply from domestic production has not been keeping pace with demand, net imports of beef and poultry may significantly increase. Two models of livestock production could be identified in many developing countries within the Asia-Pacific region: (1) small informal household or smallholder production system which is characterized by having multiple objectives of income, risk reduction, diversification, insurance against enterprise failure and social capital and (2) large formal enterprise production system with few objectives. The large production system is often highly subsidized and is capital intensive. It emphasizes on mechanization and economies of scale. Up to 40% additional return to livestock in other benefits could be expected from smallholder system that often practices maximum use of low cost resources, optimizing farm synergies and minimum use of purchased inputs. The demand and product profile of the large enterprises focus on highly processed and value added products, and high relative demand for food safety and quality, while that of the smallholder system entails traditional processing, low cost products and low relative demand for food safety and quality. Indigenous AnGR can use farm resources to economically raise them in smallholder system but they are not easily commercialized in large enterprises.



One of the main issues in keeping indigenous breeds of livestock is securing the smallholders' livelihoods by raising new genotypes of greater productivity than keeping local breeds for public benefit. Therefore, the demand for improved productivity is frequently in conflict with diversity conservation. The private sector could utilize the potentials of the underutilized AnGR, especially the indigenous breeds which possess adaptive characteristics such as heat tolerance, disease resistance and diet suitability. Structured crossbreeding systems provide an opportunity for the conservation of indigenous breeds. Demand for specific products from indigenous breeds with unique taste and quality may grow as consumer disposable income grows. There are market demand for products derived from indigenous breeds such as village chicken of South East Asia and native black pigs in the Philippines and Vietnam. Countries in the region can promote conservation and utilization of indigenous and underutilized AnGR through formulation of policy and legal

framework. Also empowerment of local communities in breed management, support of markets for specific products through branding and certification, investment in germplasm banks for breeds at risk as a long term insurance against losses of indigenous genetic resources and breeding centre for pure lines and breed improvement programs for productivity and resilience could be parts of the promotion agenda for AnGR.

Key Discussion Points

(Discussants : Johar Ali, Hamid Reza Bahmani, Han Jianlin, Kabirul Islam Khan, Ravi Khetarpal, Ilse Köhler-Rollefson, Shairah Abdul Razak, Synan S. Baguio)

1. The question on how effective has molecular biotechnology been utilized in the conservation of underutilized animal genetic resources can be viewed in the improved documentation of breed characteristics of indigenous breeds. This information would assist in deciding which breeds to be selected for conservation and utilization for food and non-food production purposes. One example is the identification blue egg chicken which has caught consumers' interest.
2. The degree of completeness of documenting breed characteristics, both at phenotypic and molecular levels, varies among countries of the Asia-Pacific region. Through DAD-IS, FAO has made progress in documenting breed information and initiating capacity building in the conservation of AnGR. FAO has published two reports Global Plan of Action for AnGR and the Interlaken Declaration - pertaining to the conservation and utilization of AnGR.
3. Taiwan has developed genetically modified organisms (GMO) such as goats, cattle, chicken and fish mainly for non-food purposes (medicinal and recreational). All GMOs are tagged and strict guidelines are in place to ensure that GMOs do not enter into the mainstream food production systems. Farmers who keep indigenous chickens are also involved in outreach programs where training on AI and breeding management are included, besides providing a platform to share information and photographs with researchers via the Internet using various ICT tools.
4. Concentration should be focused on local populations of indigenous breeds by knowing their genetic background, for example, breed composition analysis on Katjang goats or KK cattle in Malaysia. Since we only need specific SNP for the local population, there is no need to include commercial breeds.
5. The perception of native breeds as being less productive still prevails in many communities. The improvement of native breeds for higher productivity may displace them from the traditional system to intensive system which currently faces several environmental issues such as greenhouse gas emissions and waste disposal. Strategies have to be formulated on how the native breeds could be preserved in their original habitats in the farmers' traditional system.

TECHNICAL SESSION III

Strategies for Conservation and Utilization of Underutilized Animal Genetic Resources

Co-Chairs : **Alan Quartermain** (UOG, PNG) and **Redzuan Ibrahim** (WILDLIFE, Malaysia)

Rapporteurs : **Mohd Hafizal Ahmad** (DVS, Malaysia), **Nurulhuda Md. Ozman** (MARDI, Malaysia), **Badmanathan a/l Munisamy** (WILDLIFE, Malaysia)

Reproductive biotechnologies for underutilized AnGR

Abdul Rashid Baba (MARDI, Malaysia)

Animal reproductive biotechnology has been used successfully for the genetic improvement and dissemination of various livestock species. *In vivo* and *in vitro* assisted reproductive technologies (ART) are highlighted as potential tools for improving the quantity and quality of underutilized AnGR in the Asia Pacific region. The *in vivo* reproductive techniques are AI, multiple ovulation and embryo transfer (MOET) and other associated reproductive techniques such as ovum pick up (OPU), gamete freezing and sexing. The oldest reproductive technique, AI, has been widely used in breed improvement of dairy cattle and meat livestock species such as cattle, sheep and goat. The success of semen cryo-preservation has increased the application of AI globally with the ease in semen transportation in liquid nitrogen tanks. The genetic potential of selected males can be widely distributed within a country or globally. Where AI is for the genetic improvement through the male selection, the MOET technique has increased the use of female selection for more rapid genetic gain.

Globally, the number of *in vivo*-derived (IVD) dairy and beef cattle embryos from live donors and *in vitro*-produced (IVP) embryos has increased from 294,890 in 1972 to 1,604,294 in 2016 with the corresponding number of embryo transfers at 391,225 and 964,895, respectively. Currently, sperm and embryo sexing are available commercially. The ability to choose the required sex has enhanced the utilization of AI and MOET to suit the requirement of individual farm production targets such as beef (male) and dairy (female).

The *in vitro* reproductive technologies discussed are *in vitro* fertilization (IVF), Somatic cell nuclear transfer (SCNT) and Intracytoplasmic sperm injection (ICSI). The IVF technology has moved from laboratory testing to application in the field. Increasing number of oocytes is being collected through ultrasound ovum pick up technique. This makes it possible to recover oocytes from genetically selected donor cows as compared to abattoir-derived oocytes which are of unknown genetic quality. In 2016, 448,113 *in vitro* produced cattle embryos were transferred. The increase in IVP application is the result of advancement in the IVF technique resulting in improved *in vitro* maturation and fertilization, and subsequent

embryo development. These techniques are today employed worldwide. However, the IVF technique needs further improvement, as only approximately 30 – 40% of the bovine oocytes matured and fertilized under *in vitro* conditions would develop to the transferable stages of morula and blastocyst.

In the study of SCNT in MARDI, 36.4% of SCNT-reconstructed embryos using bovine ear skin fibroblast cells as donor karyoplasts cleaved to the two-cell stage compared to 23.5% oocytes which cleaved parthenogenetically in the absence of sperm and fertilization. Furthermore, the SCNT-reconsturcted embryos produced from the procedures developed in MARDI, developed to the 16-cell stage. In comparison, the parthenogenotes were arrested at the 8-cell stage. The pregnancy rates of eight recipient dams based on the transfer of cloned and *in vivo*-derived embryos were both 25%.

In livestock, ICSI technique offers great opportunity for the studies of oocyte activation and fertilization, development of transgenic animals, and generation of sex-preselected offspring. Generally, the success of ICSI procedure was related to the quality of spermatozoa and oocytes, effective activation of oocytes, and ability of oocytes to cleave subsequent to sperm injection. The various ART discussed are some of the available useful reproductive tools for the production, conservation and enhancing the utilization of the underutilized AnGR currently available in the Asia Pacific region.

Avian genetic resources

Khabirul Islam Khan (CVASU, Bangladesh)

Avian species are important sources of animal proteins and minerals. About 10,000 avian species can be found around the world; among them are fast-growing chickens and industrialized species. The genetic diversity of different avian species between and within breeds is increasing due to breeders' effort, subsistence production, and commercialization. Genetic diversity of avian species is becoming threatened through breed erosion and disappearance, and due to inbreeding which decreases diversity. The changing climate scenarios have also contributed to the decrease in production and increases in disease and mortality rates. Underutilized avian germplasm can mitigate the effect of climate change and help to maintain genetic diversity. To protect the erosion of genetic diversity there is a need to conserve these valuable genetic materials in both in-situ and ex-situ settings. Nonetheless, due to urbanization, rapid disease outbreaks have positioned *ex situ* conservation using cryo-preservation method as the best option to conserve the underutilized avian genetic resources than in-situ conservation. To improve the genetic potentialities of these underutilized genetic resources both line breeding and crossbreeding can be introduced in consideration of effective population size and inbreeding. However they require consistent and objective breeding decisions.

Within the Asia-Pacific region there are many avian genetic resources that are underutilized, such as Red Jungle Fowl, Naked Neck and Assel chickens and Negeshari ducks. Any genetic improvement program of avian species requires the definition of production and breeding goals, evaluating human capacity and capabilities, assurance of effective population size, importance of appropriate recording of performance, prediction of selection response and crossbreeding effects, evaluation of animals and consideration of profitability and conservation aspects.

Modern methods of *in situ* and *ex situ* conservation of underutilized AnGR

Tengku Rinalfi Putra Tengku Azizan (UPM, Malaysia)

This presentation describes (1) the management aspect in the conservation of False Gharial (*Tomistoma schlegelii*), a freshwater crocodilian species with a very thin and elongated snout and (2) nutrition of wild Asian elephants in riparian areas of Royal Belum Tropical rainforest. False Gharial is facing threats from human related activities and displacement by saltwater crocodiles. Crocodilian genome carries genes that code for antimicrobial and accelerated wound healing properties. This provides a commercial opportunity to manufacture antibacterial drugs based on False Gharial. *Ex situ* conservation effort of False Gharial is hindered by the poor breeding performance of the crocodilian while in captivity.

One of the challenges in elephant conservation is managing human-elephant conflict in riparian areas where elephants are occasionally found raiding crops in human settlements. Elephants are active during the day and their diets may consist of more than 83 wild plant species. Their natural diet can be affected by ecological variation and their status of nutrient requirement. Modern methods of conservation are possible with the innovative use of tools previously used for other species. Assisted breeding for reptiles is possible although issues such as anesthetic protocol, stress level induction and baseline data for many of the species are still unknown. In wild mammals, the way forward is to use remote sensing methods in order to minimize contact and focus on data collection on natural indices to get actual situation in the environment.

Conservation and improvement of small ruminant genetic resources for sustainable food production

Satendra K. Singh (MoAFW, India)

Underutilized AnGR are found among species, breeds and sexes. They are not fully utilized because they have been cut-off from the mainstream breeds of choice in commercial livestock production. Through globalization highly productive livestock breeds are easily available across continents. Industrial demand has prompted the livestock industry to concentrate on a small number of breeds whose productivity can be regulated in intensive production systems. Thus exploration of native breeds as commercial breeds has been

neglected. The low utilization rate of indigenous breeds of livestock is further aggravated by the lack of knowledge on the characteristics of these breeds, thus denying their potential utilization for commercial production. Kadak Nath chicken and Bechur cattle in India are examples of AnGR which have been highly utilized. Organized breeding programs of indigenous breeds such as Bengal goats have lowered kid mortality rate from 69% to 12.5%. There are concerns that the underutilized indigenous breeds may lose their unique characteristics once taken out of their natural habitats and be placed in intensive system when they have been improved genetically for high productivity.

Access and benefit-sharing of underutilized livestock breeds under the Nagoya Protocol Framework

Ilse Köhler-Rollefson (LPPELD, Germany)

Access and Benefit-Sharing (ABS) of AnGR has had a low profile and even the Mandatory Nagoya Protocol has not changed this, as country representatives struggle with the understanding of the implications of ABS for the livestock sector. In the course of the discussions around this topic the original rationale of ABS as a tool for conserving genetic resources has been lost. The core argument of this paper is that the ABS concept – which was originally developed with wild biodiversity in mind – needs to be adapted to address the specific characteristics and requirements of the sector. If tweaked in the right way, ABS for AnGR could support the conservation of these AnGR that matter most in the context of climate change and for achieving food security within planetary boundaries.

The promotion of Community Protocols, a key element of the Nagoya Protocol, could be the starting point for conserving climate resilient livestock breeds *in situ* to ensure access to them in the future. Developing countries should push for an enabling mechanism in the relevant international body such as the Commission on Genetic Resources for Food and Agriculture (CGRFA). The current flow of improved genetic materials has been from the North to South and rarely the reverse. Community protocols that concern farmers' knowledge and experience in handling underutilized AnGR which have been agreed upon at international level must now be developed at national level.

Access to underutilized AnGR begins with conservation efforts of these indigenous breeds in their traditional habitats. Intensive systems that raise single improved breed are in contrast to habitats of challenging feed and environmental attributes of pastoral system of the smallholders. A case in point is the Brela camels of Pakistan which survive on local feed stuffs but have been exported for their milk yield trait. In India the camel population is on the decline although camel milk for its unique medicinal properties could be an alternative to cow's milk. Furthermore, it is suggested that *ex situ* conservation of underutilized AnGR should be decentralized into a number of sites be given priority. Keepers' rights to these indigenous breeds must be safeguarded and economic benefits derived from them are to be shared fairly between the keepers and the private entities that commercially exploited these AnGR.

Key Discussion Points

(Discussants: Ravi Khetarpal, A.K. Panda, Uddhav Paneru, Elpidio V. Peria, Ilse Köhler-Rollefson)

1. There is a need to conserve underutilized AnGR for many purposes other than for food production. This has been shown with miniature pigs of Taiwan and False Gharial in Malaysia. The utilization of False Gharial can be promoted further through the development of new antimicrobial and wound healing products through more intensive R&D efforts.
2. Goat's milk has medicinal properties for diabetic control. The phenotypic and molecular characteristics, population size, risk status and local experiences in handling of many of the goat genetic resources presently found in many areas of the Asia-Pacific region have not be comprehensively documented to allow for decisions to be made on their conservation and utilization targets. Policies related to conservation of these underutilized AnGR need to be adopted and support to keepers of these animals be given priority to ensure the successful utilization of these genetic resources.
3. The Ministry of Agriculture should be made aware of the Convention on Biological Diversity (CBD) and lead in the implementation of the terms agreed at the CBD. In some ASEAN countries, biological use of CBD has been implemented, for example, in Vietnam and Laos, for agriculture, forestry and rural development.
4. Many perceive the indigenous AnGR as less productive and inefficient in productivity. How do we value the characteristics of underutilized AnGR which are able to utilize feed materials of low quality and convert these feeds into more valuable end products. We should value underutilized AnGR for their unique characteristics and keepers of these indigenous breeds are to be provided the opportunity to share the benefits derived from them throughout the value chain.
5. Indigenous breeds should be given priority in the conservation in Asia-Pacific region. The reliance of the dairy industry on imported breeding stocks for high milk yield has led to the issue of A1 milk. The indigenous breeds are thought to be the alternative to modern dairy breeds to produce health benefiting milk constituents.

TECHNICAL SESSION IV

World Café Discussion
Regional Priorities for Underutilized AnGR

Moderator : **Mohamed Ariff Omar** (MARDI, Malaysia)

Rapporteurs : **Thayalini a/p Kathiraser** (MARDI, Malaysia), **Amal Ghazali Nasrom** (WILDLIFE, Malaysia), **Mohd Hafizal Ahmad** (DVS, Malaysia), **Badmanathan a/l Munisamy** (WILDLIFE, Malaysia), **Shariffah Nazari** (DVS, Malaysia)

1. Conservation, improvement and use

It is known that there are underutilized species of mammals and birds whose utility and benefits have not been well documented. Underutilized AnGR have the potentials to be promoted in sustainable production systems for food production and non-food use. **On conservation of underutilized AnGR**, member countries within the region are urged to formalize enabling policy to protect and conserve AnGR. Legislation is already enforced to protect AnGR in India, Bhutan and Taiwan. A dedicated focal organization such as FAO could enhance regional collaboration in managing underutilized AnGR. Adulteration of indigenous breeds of livestock through indiscriminate crossbreeding with exotic breeds could be minimized through regional collaboration. The sustainable management of underutilized livestock breeds could be enhanced by providing genetic materials, veterinary services and assisting farmers in the marketing of indigenous products.

On improvement of underutilized AnGR, it is pertinent that the assessment of underutilized AnGR be carried out at national level to gather information on geographical distribution, population dynamics and risk status. Population viability analysis should be conducted to assess the population status of underutilized AnGR. For endangered species, efforts to formalize *ex-situ* conservation are highly recommended. This could be achieved through protection of existing populations to allow sustainability of genetic diversity and cryo-conservation of genetic materials. *In situ* conservation of present ecosystem could help to keep those species which are in danger of extinction to multiply. The farming community should be engaged in breed improvement, awareness and educational programs. Indigenous knowledge and experience are to be tapped to ensure the commitment of local players and enrichment of the conservation efforts of these AnGR.

Recommendations:

i. Enabling policy to be formulated to protect and conserve AnGR available in each country of the Asia-Pacific region.

ii. The assessment of underutilized AnGR be carried out at national level to gather information on geographical distribution, population dynamics and risk status.

iii. Training to be conducted to share knowledge and skills to extension agents and farmers to develop entrepreneurship.

2. Value addition, marketing and export

Underutilized AnGR hold future benefits for improving the livelihoods of smallholder

farmers if their products or by-products can be successfully commercialized**. On value addition,** improvement in technology, facility, human capacity and education in the development of products derived from indigenous species is important. Farmers engaged in keeping these underutilized species should be provided with enhanced skill and knowledge to enable them to commercialize the value-added products. Through, selective breeding of the underutilized indigenous breeds could genetically be improved but value-added products of indigenous breeds could further be enhanced through brand promotion and certification programs. Although, currently awareness about these products is not generally widespread among consumers, it could be enhanced through promotional campaigns using many IT platforms such as website and chats, thus expanding their market and product reach. The formulation of legal framework to ensure the value-added products from underutilized AnGR remained exclusive, exotic and organic, should be considered. The marketing of products derived from native animals would have the advantage of exotic flavor and specific quality compared to current commercial products.

On marketing, good branding and certification of the products from indigenous AnGR would help to promote them. Government approved special authority could provide much needed certification of products from native animals. To differentiate these products from other animal products, value identification is essential to leverage on specific unique properties of the products. It is important that the consumers be made aware of products from indigenous breeds. Efforts are to be increased to expand the markets of these products which could be accomplished through the improvement of logistics to provide better access to the products and participation in exhibitions and expositions. The government of each country in the Asia-Pacific region could formulate legislation to encourage the development and expansion of these indigenous products through provision of tax reliefs, subsidies and incentives. Many issues pertaining to the marketing of products from indigenous species need to be addressed. Products from native animals should be priced differently from those derived from commercial livestock products because of their unique properties.

Recommendations:

i. Improvement of technology, facility, personal training and education on value-added products of indigenous AnGR is recommended.

ii. Development of brand and national certification to promote products derived from indigenous species to be initiated.

iii. Public awareness campaign to be held to promote the products derived from indigenous AnGR.

iv. The governments of the countries within the region to be recommended to provide the legal provisions to protect the originality and exclusivity of indigenous animal products.

v. The marketing of products from indigenous animals to be increased, and their production to be made consistent and high quality of the products to be maintained.

3. Partnership and capacity development

On **partnership**, it is recognized that the community of stakeholders of special groups, NGOs, entrepreneurs, farmers and research institutions having interests in the affairs of underutilized breeds of–livestock exist at national and regional levels. Many stakeholders and partners, whose interests and priorities may vary, are involved in managing the indigenous livestock species. Stakeholders involved in the management of underutilized AnGR need to address the issues of common interest such as climate change, funding and poverty eradication. Local experts and farmers with knowledge and experience on indigenous breeds should be encouraged to form interest groups, examples such as the porcupine breeding and free range chicken farming. Sustainable partnership among the stakeholders could be assured through contract farming and producer

associations. Private sector entities could create added values to underutilized AnGR that would eventually benefit all parties of the stakeholder community. A vast pool of data and knowledge existed over many years of raising these indigenous breeds in many countries and an arrangement on data and knowledge gathering and sharing should be put in place. Government could play an important role in providing clear policies that can match with research institution expertise on AnGR issues. The facilitator, often the national organization entrusted with the sustainable management of these underutilized AnGR, could be the lead agency at the national level. Sharing of data and knowledge in specific areas of AnGR management including food security, could be strengthened through involvement of country personnel in workshops, seminars and training courses. A centralized data bank which may act as repository of contributed information could provide easy access to information on membership or charged basis.

For **capacity building**, the awareness on the importance of status, risk issues and conservation methods of AnGR is emphasized and delivered through seminars, and workshops and hands-on training on available modern technologies. Selected advanced technologies adopted in the preservation of genetic materials and multiplication of breeding animals may assist in the sustainable management of underutilized AnGR. Exchange of genetic materials of indigenous breeds is very crucial and should be given priority as per national and international laws/convention/treaties.

Recommendations:

i. To ensure sustainable partnership, the stakeholders of special groups, NGOs, entrepreneurs, farmers and research institutions having interests in managing underutilized indigenous livestock breeds need to be identified at national and regional levels based on interest and priorities of underutilized AnGR.

ii. To build partnership, a networking of interest groups and institutions could collaborate to work on selected key issues such as expertise, methods/technologies, deliverables and budget, by identifying areas of common interest or current challenges of underutilized AnGR.

iii. Sharing of data and knowledge in specific areas of AnGR management including food security to be strengthened through involvement of country personnel in workshops, seminars and training courses.

iv. A centralized data bank, also acting as repository of contributed information on AnGR, could provide easy information access to member countries on membership or charged basis. Exchange of genetic materials of indigenous breeds should be given priority.

v. For capacity building, the awareness on the importance of status, risk issues and conservation methods of AnGR should be shared through seminars, workshops and hands on trainings on available modern technologies. Selected advanced technologies in the preservation of genetic materials and multiplication of breeding animals may assist in the sustainable management of underutilized AnGR.

4. Biotechnology for enhancing utilization

Biotechnology is used to improve livestock breeds and conserve indigenous breeds. Many biotechnological tools such as reproductive biotechnology, molecular genetics, feed biotechnology and bioinformatics can be applied to improve the management of underutilized AnGR. The issues constraining the use of biotechnological approaches in livestock production are lack of expertise, data, financial support and facility. Development and sharing of databases of AnGR in Asia-Pacific which include information on genetic/genomic sequences data, population size, field performance as well as technical skill and expertise would facilitate the efforts to conserve AnGR in the Asia-Pacific region. Hands-on training for researchers, extension agents and farmers can be organized to upgrade skills and knowledge in the multiplication

and management of AnGR. Knowledge in management of AnGR could also be imparted through conferences, seminars and newsletters. Awareness programs could be conducted to expose farmers to easy-to-use biotechnological methods in the identification and breeding of underutilized AnGR. Consumers should also be informed on the products of biotechnologies through these awareness programs. As financial support often hinders the efficient management of AnGR, APAARI may facilitate in scoping for partnerships and fund providers to overcome the financial constraint. The private sector could also be involved for the utilization of underutilized AnGR. To circumvent the lack of infrastructure in the conservation and utilization of indigenous breeds, an Asia-Pacific regional gene bank could be set up as a pooled depository of gametes and embryos to be shared among countries in the region and provide enhanced mechanism for intra-regional exchange of gametes of AnGR. Laboratories involved in biotechnological research of AnGR should be encouraged to share data and technology. Regional databases could be created at the local level to assist in the management of AnGR. A common platform can be organized through a consortium for Asia-Pacific underutilized animal genetic resources comprising of public and private sector entities and NGOs to develop breed improvement programs. The consortium could provide a platform for sharing knowledge, skills and technologies, fostering consumer awareness and private sector involvement, harmonizing regulations and networking on AnGR among interested parties.

Recommendations:

i. APAARI may facilitate the scoping for partners and fund providers from public and private sectors for financial support through region-wide proposals in the conservation and utilization of underutilized AnGR.

ii. Setting up of an Asia-Pacific Regional Gene Bank for gametes and embryos to facilitate regional sharing of genetic materials and enhance the mechanism for intra-regional exchange of AnGR.

iii. A consortium for Asia-Pacific underutilized AnGR be set up as a common platform for regional collaboration and networking in knowledge and data sharing of underutilized AnGR.

iv. Collaborative projects among countries in the Asia-Pacific region to be proposed on specific areas such as breed characterization, genomic profiling, sexing and cryo-preservation of gametes and value-added products of underutilized AnGR.

5. Regional information sharing system and focal points

At present the regional information sharing system on AnGR is based on two databases: (1) DAD-IS developed by FAO which is found to be less user-friendly in data entry and the data are not validated and (2) DAGRIS of ILRI too not user-friendly to farmers. There is a need to tailor the AnGR information system based on each country's specific attributes. A regional information system should have defined objectives (kinds of data to share, end users and involvement of local communities) and promotion of public awareness in schools, universities and extension agencies to educate the local community on AnGR, including schools, universities and extension agencies. It is recommended that a new regional database information system be established as an FAO funded-organization with sufficient facility and capability. The format for the regional database can be adapted from the already successful databases developed and implemented by some countries in the Asia-Pacific region. Data to be included in the regional information system should be validated by both national and regional committees of experts on AnGR. The proposed Asia-Pacific AnGR information system has to be user-friendly using various ICT tools and should include information on breed characteristics, genetic parameters and genomic profiles as well as organizations, centers of excellence, experts, research facilities and equipment, and training and educational videos on AnGR. It is desirable that the regional information system be farmer-friendly also so as to encourage the farmers to share their experience in handling the

local AnGR, especially the underutilized species. Those specific AnGR species with immediate economic values and cultural foundation are to be organized by the local livestock associations. Intellectual property rights issues with shared data are to be addressed among the stakeholders on ownership and sharing of potential benefits. The regional information system can be linked to DAD-IS and DAGRIS.

Recommendation:

An user-friendly Asia-Pacific AnGR information system which meets the regional requirements and linked to DAD-IS and DAGRIS is needs to be developed to facilitate the systematic gathering of information on underutilized AnGR in the region.

TECHNICAL SESSION V

Panel Discussion on Legal and Policy Framework Support to Promote Utilization of Underutilized AnGR - Perception of Panelists

Co-chairs : **Steven Staal** (ILRI, Kenya) and **Wan Mohd Kamil Dato' Wan NIk** (DVS, Malaysia)

Rapporteurs : **Shariffah Nazari** (DVS, Malaysia), **Thayalini a/p Kathiraser** (MARDI, Malaysia) and **Amal Ghazali Nasrom** (WILDLIFE, Malaysia)

Ilse-Köhler-Rollefson (LLPELD, Germany)

The concepts of animal genetic resources and breed have always been assumed to be similar. However there are differences between them. Breed is more of a cultural concept while animal genetic resources concept is more of an ecological concept and a part of the environment. Indigenous breeds have evolved over many centuries of existence to develop unique attributes in their adaptability and chemical composition which may become useful in future demand. Currently in the USA, for example, they have reduced the number of dairy cows without compromising on milk production. Problems faced, currently, are negative changes that affect the nutritional value of product due to genetic mutations caused by inbreeding. This intensification of livestock has caused a problem in the dairy industry, especially in the A1 milk issue. In another aspect, we need to understand the traditional livestock system, as well as the social culture of the community as both of them are related. In Rajasthan, for example, improvement of the camel dairy industry is an effort mainly to conserve the camels. In general, in order to preserve and improve genetic resources, we need to develop our own system and avoid following the western system. Another issue is on keepers' rights over their indigenous breeds which should be protected and benefits derived from them be equally shared.

Ravi Khetarpal (APAARI, Thailand)

Legislations and guidelines exist on the conservation of AnGR at the national and international (FAO) levels. Consumers' demand for low price animal products may lead to loss of indigenous breeds that could not compete with commercial breeds in terms of yield. The rights of the keeper of underutilized animal genetic resources have to be recognized. These rights include the intellectual property rights over the ownership of the animals and intrinsic knowledge and experience over many decades in handling the indigenous breeds of livestock. Currently, there is no international legal framework in place to address the IPs and sharing of benefits arising from indigenous breeds. As these AnGR are in the hands of smallholder farmers in the rural areas the whole community involved in raising these animals should be engaged in the protection of biodiversity of such germplasm. At the national level countries in Asia-Pacific are encouraged to use economic and policy analysis tools in arriving at decisions pertaining to the conservation and utilization of underutilized AnGR. Serious concern should be given to address the loss of immunity and reduced fertility in purebred selection of modern dairy

cattle and to emphasize on stress traits in the selection program to increase the adaptability of the animals to the modern intensive production system. Long term sustainable utilization of indigenous breeds depends much on the conservation of stress traits.

Alan Quartermain (UOG, Papua New Guinea)

It is important to acknowledge that through culture and knowledge of local communities that protection of the underutilized AnGR can be realized. This is observed in the case of native pigs, chicken and goats in Vanuatu Island. There are potentials for products of underutilized AnGR in the market place. This could be achieved through more intensive promotion, such as shown with honey bee in Papua New Guinea. Development policy should stress on making use of local natural resources available as a unified system of agriculture and animal activities.

Steven Staal (ILRI, Kenya)

In the context on policy and legal framework, the issue on systems with indigenous resources and their market is important to be addressed. The introduction of exotic breeds is principally driven by demands and economics. So many producers tend to focus on high productivity of animals. Just as we have organic consumers and local products but sometimes the willingness to pay decreases. SE Asia is a real gold land for these indigenous animals as the economy continues to expand and the demand for native products is likely to rise due to higher disposable income. Not many efforts have been recorded to grow these indigenous products which would have influenced the conservation and utilization decisions of underutilized AnGR and improved rural livelihoods. There are many examples of case studies taken from the private sector in investing decisions and promoting opportunities in purebred animals in intensive systems. This in the end will decrease the opportunities for indigenous species. APAARI could initiate the setting up of an inventory of markets and livestock systems, including the private sector participation, to fill the knowledge gap on understanding the markets for underutilized AnGR.

Khabirul Islam Khan (CVASU, Bangladesh)

We know that indigenous species are changing in capability and objective. And also they are being impacted by climate change. Currently, there is no common legal framework for promotion of AnGR. Understanding the common interest in managing underutilized AnGR among the stakeholders should be included in the discussion on AnGR. The promotion of underutilized AnGR among members of the public should continue. To promote sustainable farming and management of farm animals, it is pertinent to address the issues of animal welfare and environmental sustainability. Cattle, buffalos, goats and many other ruminants need to be exposed to modern technologies in their development. The national laws and regulation of livestock industries already existed in many countries. Nonetheless, we need to review these laws and share our knowledge to develop the national level policy for each producing country in order to promote more use of underutilized AnGR.

Key Discussion Points

(Discussants: Johar Ali, Sivananthan Elagupillay, Ravi Khetarpal, AK Panda, Elpidio V. Peria, Arjava Sharma)

1. For conservation of underutilized AnGR there can be a multi-prong approach of conventional breeding and use of molecular genetics to allow smallholder farmers a choice on raising the commercial breeds in intensive system or underutilized indigenous breeds in traditional production system.
2. For conservation of indigenous breeds, especially in riparian areas, the management of elements of prey and predator in the food chain of many species is crucial to ensure their survival. Food production activities in modern agriculture often resort to over

use of chemicals to control pests and diseases and this may impact the survival of indigenous species. The underutilized AnGR are our national heritage and also an important part of our culture that needs to be preserved. The indigenous species must co-exist with the community and ways to ensure this long-term mutually beneficial relationship must be sought.

3. The efforts in conservation of underutilized AnGR must adapt with local cultural system and not merely mimicking those practices common in developed countries. When farmers are involved in the conservation effort, it is done through continuous engagement of awareness and advocating the benefits through education, and not forcing on them.
4. When formulating policies affecting the management of native species, the concerns and interests of many parties in the stakeholder community must be considered, so that positive impacts may emanate which eventually benefit all interested parties in the community.
5. CBD is flexible for governments to work within the international framework stressing on national priorities. In protecting keepers' rights over their indigenous breeds concerns should also address on the sustainability of the crop-animal systems.
6. Priorities on underutilized AnGR should be addressed at national and regional levels. Possibly a regional network on underutilized AnGR could look into specific needs of the countries.
7. Local knowledge on the handling of indigenous livestock species and wildlife species especially in areas where they co-exist should be documented to reduce human-wildlife conflicts. There are many reports (example of wolf introduction in Canada) on the relationship of wildlife species and pastoralists from which lessons can be learnt.
8. One Health approach is pertinent in managing the exploitation of natural resources and the environment. This is to ensure that the exploitation of natural resources does not end up with negative impacts on the environments. Preservation of native livestock species requires a balance of the interests of the keepers and care of the environment to ensure that indigenous species maintained their unique attributes for future need.

Plenary Session

Co-chairs : **Steven Staal** (ILRI, Kenya) and **Wan Mohd Kamil Dato' Wan NIk** (DVS, Malaysia)

Rapporteurs : **Shariffah Nazari** (DVS, Malaysia)

During the Plenary Session, summary of the deliberations made in the workshop were presented. The Rapporteurs from each session compiled the major recommendations of their respective sessions. Dr. **Noraini Samat** consolidated and presented the recommendations of each Technical Session. Dr. **M. Ariff Omar** summarized and presented the recommendations of World Café Discussion to set the regional priorities for underutilized AnGR. It was unanimously agreed that management of underutilized AnGR is of paramount importance to contribute towards food security and improve the livelihoods of the smallholder farmers.

This session was followed by Closing Remarks by the dignitaries.

Closing Remarks

Ravi Khaterpal, Executive Secretary, APAARI, mentioned that the workshop has been very useful as almost all important aspects of management of underutilized have been discussed by the experts of the region. He mentioned that the workshop objectives are accomplished by the participation of each delegate in the deliberation. He assured that the proceedings of the workshop will be brought which will be helpful for effective conservation and sustainable use of underutilized AnGR in Asia-Pacific region. He mentioned that MARDI is a very valuable partner of APAARI and expressed sincere thanks to the Director General, MARDI for agreeing to organize this workshop. He acknowledged the efforts made by MARDI team for organizing the workshop in very professional manner. He assured that within limited resources, APAARI is committed to serve its member countries and the Asia-Pacific region for improving the livelihoods of smallholder farmers. He thanked all the co-organizers of the workshop for their technical and financial contribution.

Mohamad Roff Bin Mohd Noor, Director General, MARDI, presented his remarks which are reproduced as below:

All praise to Allah, we have reached the end of the third day of the Regional Workshop on underutilized Animal Genetic Resources and their Amelioration.

I hope that it has been an enlightening experience for all, with all the knowledge sharing and stimulating discussion on addressing major issues in underutilized animal genetics resource at this workshop.

Indeed, indigenous animal genetic resources are our rich treasure and must be preserved, but we also need to strategically find ways to explore and sustainably utilize these resources for the benefit of the region, country, farmers, environment and the animals themselves.

Sustainable utilization of underutilized animal genetic resources is very important not only for

food security reason and to face the negative impacts of climate change, but will also have economic benefits and bring additional income to improve the wellbeing of smallholder farmers in this region. Hence, I am very happy to hear that there are many recommendations presented by our expert speakers and participants. The recommendations are not only on technical matters but also for policy interventions and economic approaches which are all important to facilitate utilization of the animal genetic resources.

I also highly appreciate the thoughts and ideas churned in the world cafe sessions. I truly hope APAARI will take our hopes and suggestions by heart and help facilitate us in the areas identified. I personally believe that having a consortium specific for animal genetic resources as well as empowerment of the farmers and facilitating grant applications are two of the recommendations that would need full support by APAARI.

Rest assured, MARDI as member of APAARI and other national agencies especially present here today will give full support to make the outcomes of this workshop a reality.

Last but not least, I would like again to take this opportunity to thank APAARI for inviting MARDI to jointly organise this very important workshop. Many thanks too to COA, APCoAB, ACIAR as well as to our local committee from MARDI, DVS and WILDLIFE Malaysia. The synergy between these agencies has been outstanding and I believe this workshop is very relevant, and will benefit many countries. Thanks to all moderators, facilitators and chairmen which have been a great help in the sessions. For all speakers and participants, my sincere congratulations and thanks to all of you for giving your full support and actively involved in the discussions. Hope you have obtained valuable information in underutilized animal genetic resources and how it can be applied to our countries.

On a personal note, it has been a privilege and an honour for me to be part of this event, being able to meet and exchange ideas with eminent people from different parts of the world, understanding their various agriculture industries and nation's culture.

On behalf of MARDI, I hope we have served you well throughout the event. With that, I end my closing remarks and wish all of you to have a safe flight back home. Thank you.

Launching of Book

APAARI under its program on APCoAB organized a Regional Expert Consultation on Agricultural Biotechnology - Scoping Partnerships to Improve Livelihoods of Farmers in Asia and The Pacific during 29-31 May 2018. The Country Status Reports on Agricultural Biotechnology were compiled and published by APAARI in a book form. The book entitled '**Agricultural Biotechnology - Scoping Partnerships to Improve Livelihoods of Farmers in Asia and The Pacific – Strategic Papers and Country Status Reports'** was launched by Mohamad Roff Bin Mohd Noor, Director General, MARDI, Malaysia.

Rishi Tyagi, APCoAB Coordinator, APAARI, proposed a vote of thanks to all dignitaries, experts, participants, co-organizers and staff of APAARI secretariat. He also thanked and expressed his gratefulness to all the Committee Members from MARDI involved in the efficient organization of the workshop, especially the 'Women Power' of MARDI.

Major Recommendations

The **Major Recommendations which** emerged from the workshop were:

1. **Conservation, improvement and use** of underutilized AnGR: Each country within the Asia-Pacific region is recommended to have in place an enabling policy to protect and conserve AnGR. The assessment of underutilized AnGR has to be carried out at national level to gather information on geographical distribution, population dynamics, risk status, and indigenous knowledge and experience in the management of underutilized AnGR. The rights of smallholder farmers owning these underutilized AnGR are to be safeguarded through filing of their intellectual property rights and agreement on sharing of future benefits.
2. **Value addition, marketing and export**: Improvement of technology, facility, training and education on value-added products of indigenous AnGR are highly recommended. Farmers engaged in keeping these underutilized species should be provided with enhanced skill and knowledge to enable them to develop and commercialize these value- added products. Steps should be taken to initiate and develop—branding and national certification to promote products derived from indigenous species. The public should be exposed to these products through awareness campaign to promote these products. The governments of countries of Asia-Pacific are recommended to provide the legal provisions to protect the originality and exclusivity of indigenous animal products. The marketing of products from indigenous animals should be enhanced and their production be made more consistent and their high quality maintained through R&D and training modules.
3. **Partnership and capacity development**: It is recognized that many stakeholders of special groups, NGOs, entrepreneurs, farmers and research institutions are to be included in the management of underutilized AnGR. To ensure sustainable partnership, the stakeholders need to be identified and engaged at national and regional levels based on priorities identified on underutilized AnGR. To build partnership, a networking of interest groups and institutions could be initiated to collaborate on selected key issues such as expertise development, methods/ technologies, deliverables and budget, and identify areas of common interest or current challenges of underutilized AnGR. Sharing of data and knowledge in specific areas of AnGR management including food security, is recommended to be strengthened through involvement of country personnel in workshops, seminars and training courses. A centralized data bank, also acting as repository of contributed information on AnGR, could provide easy access to member countries. Exchange of genetic materials of indigenous breeds is very crucial and should be given priority. For capacity building, awareness on the importance of status, risk issues and conservation methods of AnGR should be shared through seminars and workshops and hands-on trainings on modern biotechnologies. Selected advanced technologies in the conservation of germplasm and multiplication of breeding

animals may assist in the sustainable management of underutilized AnGR in member countries.

4. **Biotechnology for enhancing utilization**: The issues constraining the use of biotechnological methods in livestock production are lack of expertise, data, financial support and facilities. It is highly recommended that an Asia-Pacific Regional Genebank for gametes and embryos to facilitate regional sharing of genetic materials and enhance the mechanism for intra-regional exchange of AnGR be established. A consortium for Asia-Pacific for underutilized AnGR is recommended as a common platform for regional collaboration and networking in underutilized AnGR. Collaborative projects among countries in the Asia-Pacific region are proposed on specific areas such as breed characterization, genomic profiling, sexing and cryo-preservation of gametes and value-added products of underutilized AnGR. Hands-on training for researchers, extension agents and farmers should be organized to upgrade their skills and knowledge in the multiplication and management of AnGR. Knowledge for management of AnGR could also be imparted through conferences, seminars and newsletters. Awareness programs could be conducted to expose farmers to easy-to-use biotechnological methods in the identification and breeding of underutilized AnGR. APAARI may to facilitate the scoping for partners and fund providers from public and private sectors for financial support through region-wide proposals in the conservation and utilization of underutilized AnGR.

5. **Regional information sharing system and focal points**: There is a need to tailor the AnGR information system to meet each country's specific attributes. A regional information system should have defined objectives (kinds of data to share, end users and involvement of local communities), be user-friendly in its usage and promote public awareness to educate the local community on AnGR. It is recommended that an Asia-Pacific AnGR information system, which meets the regional requirements, be established. The information system is suggested to be linked to DAD-IS and DAGRIS to facilitate the systematic gathering of AnGR information in the region.

Action Points for APAARI

1. APAARI may take initiative for the establishment of Asia-Pacific information system on underutilized AnGR which meets the regional requirements, and linked to DAD-IS and DAGRIS. This information system is to facilitate the systematic gathering of information on AnGR in the region. The APAARI-led information system also serves as repository for data and information on breed and molecular attributes, population status, risk assessment and keepers' experience as well as markets for indigenous animal genetic resources and their products.
2. APAARI may facilitate the setting up of a consortium for Asia-Pacific animal genetic resources as a common platform for regional collaboration and networking in knowledge and data sharing of underutilized AnGR.
3. APAARI may facilitate the scoping for partners and fund providers from public and private sectors for financial support through regional-wide proposals in the conservation and utilization of underutilized AnGR.
4. APAARI may facilitate setting up of an Asia-Pacific Regional Gene Bank for gametes and embryos to facilitate sharing of genetic materials and enhance the mechanism for intra-regional exchange of animal genetic resources.

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Technical Program

DAY 1: Monday, March 4, 2019

08.30	**Hotel pick-up for MARDI** *Venue: Tan Sri Yusuf Hashim Hall, MARDI Serdang*
08:30-09:00	**Registration**
09:00-10.30	**Opening Ceremony** ***Arrival of*** **YB Dr. Zunika Mohamed** Deputy Secretary General (Policy) Ministry of Agriculture & Agro-based Industry (MOA), Malaysia ***Doa' recital*** **Welcome remarks by** **Datuk Dr. Mohamad Roff Bin Mohd Noor** Director General Malaysian Agricultural Research and Development Institute (MARDI), Malaysia **Dr Ravi Khetarpal** Executive Secretary Asia-Pacific Association of Agricultural Research Institutions (APAARI), Bangkok **Dr Chung-Hsiu Hung** Director General Council of Agriculture (COA), Taiwan **Opening remarks by** **YB Dr. Zunika Mohamed** Deputy Secretary General (Policy) Ministry of Agriculture & Agro-based Industry (MOA), Malaysia ***Gift exchange*** **Group photo session**
10.30-11:00	***Tea/Coffee break***

TECHNICAL SESSION I

Status of Underutilized Animal Genetic Resources for Food and Agriculture at Sub-Regional Level

Co-chairs: **Abdul Rashid Baba & Jialin Han**

11:00-11:20	***South and West Asia*** **Arjava Sharma** Former Director ICAR-National Bureau of Animal Genetic Resources (NBAGR), India
11:20-11:40	***South-East Asia*** **Synan Bagio** PCAARRD, Philippines Officer-in-Charge Livestock Research Division, DOST-PCAARRD, Philippines
11:40-12:00	***East Asia*** **Tu, Po An** Associate Researcher Livestock Research Institute, Council of Agriculture (COA), Taiwan
12:00-12:20	***The Pacific*** **Alan Quartermain** Professor of Agriculture University of Goroka (UOG), Papua New Guinea
12:20-12:35	**Discussion**
12:35-13:45	***Lunch***

TECHNICAL SESSION II

Thematic Presentations on Underutilized Animal Genetic Resources

Co-chairs: **Ilse Köhler-Rollefson & Mohd Noor Hisham Mohd Haron**

14:00-14:20	**Underutilized animal genetic resources for food and nutrition-regional scenario** **Jialin Han** Senior Scientist ILRI-CAAS Joint Lab, International Livestock Research Institute (ILRI), China
14:20-14:40	**Characterization, inventory and monitoring of underutilized AnGR** **Adrien Kumar Raymond** Former Senior Research Officer Department of Veterinary Service (DVS), Malaysia
14:40-15:00	**Breeding strategies for underutilized AnGR** **Ming Che Wu** Chief, Animal Breeding and Genetics Division Taiwan Livestock Research Institute (TLRI), Taiwan
15:00-15:20	**Discussion**

15:20-15:50	***Tea/Coffee Break***
15:50-16:10	**Molecular biotechnologies for underutilized AnGR** **Ainu Husna MS Suhaimi** Deputy Director Livestock Science Research Centre, Malaysian Agricultural Research & Development Institute (MARDI), Malaysia
16:10-16:30	**Animal genetic resources in the ASEAN and the three objectives of the Convention on Biological Diversity** **Elpidio V. Peria** Programme Specialist Development & Implementation Unit, ASEAN Centre for Biodiversity (ACB), Philippines
16:30-16:50	**Market-driven approaches to conservation and utilization of AnGR** **Steve Staal** Program Leader Policies, International Livestock Research Institute (ILRI), Kenya
16:50-17:10	**Discussion**
17:10-19:00	*Visit to MAEPS Agro Tourism Park*
20:00-22:00	***Workshop Dinner***

DAY 2: Tuesday, March 5 2019

TECHNICAL SESSION III

Strategies for Conservation and Utilization of Underutilized Animal Genetic Resources

Co-chairs: **Alan Quartermain & Redzuan Ibrahim**

09:00-09:20	**Reproductive biotechnologies for underutilized AnGR** **Abdul Rashid Baba** Former Principal Senior Research Officer MARDI, Malaysia
09:20-09:40	**Avian genetic resources** **Khabirul Islam Khan** Professor, Dept. of Genetics and Animal Breeding Chottagram Veterinary & Animal Sciences University (CVASU), Bangladesh
09:40-10:00	**Modern methods of in situ and *ex situ* conservation of underutilized AnGR** **Tengku Rinalfi Putra Tengku Azizan** Senior Lecturer, Faculty of Veterinary Medicine Universiti Putra Malaysia (UPM), Malaysia
10:00-10:30	**Discussion**
10:30-11:00	***Tea/Coffee Break***

11:00-11:20	**Conservation and improvement of small ruminant genetic resources for sustainable food production** **Satendra K. Singh** Scientific Advisor Ministry of Agriculture and Farmers Welfare (MoAFW), India
11:20-11:40	**Access and benefit-sharing of underutilized livestock breeds under the Nagoya Protocol Framework** **Ilse Köhler-Rollefson** Head and Coordinator League for Pastoral Peoples and Endogenous Livestock Development (LPPELD), Germany
11:40-12:00	**Discussion**
12:00-13:30	***Lunch***

TECHNICAL SESSION IV

World Café Discussion – Regional Priorities for Underutilized AnGR

Moderator: **Mohamed Ariff Omar, MARDI, Malaysia**

	Table 1. Conservation, improvement and use *Facilitator*: **Sivananthan Elagupillay**, WILDLIFE, Malaysia
	Table 2. Value addition, marketing and export *Facilitator*: **Saifullizam Abdul Kadir**, DVS, Malaysia
	Table 3. Partnership and capacity development *Facilitator*: **Shahril Faizal Abdul Jani**, MOA, Malaysia
	Table 4. Biotechnology for enhancing utilization *Facilitator*: **Ainu Husna MS Suhaimi**, MARDI, Malaysia
	Table 5. Regional information sharing system and focal points *Facilitator*: **Jianlin Han**, ILRI, China
16:30-17:30	**Compilation of Recommendations**

DAY 3: Wednesday, March 6, 2019

TECHNICAL SESSION V

Panel Discussion on Legal and Policy Framework Support to Promote Utilization of Underutilized AnGR

Co-chairs: **Steven Staal & Wan Mohd Kamil Dato' Wan Nik**

09:00-10:30	***Perception of Panellists*** **Ilse Köhler-Rollefson**, LPPELD, Germany **Ravi Khetarpal**, APAARI, Thailand **Allen Quartermain**, UOG, Papua New Guinea **Steven Staal**, ILRI, Kenya **Khabirul Islam Khan**, CVASU, Bangladesh
10:30-11:00	***Tea/Coffee Break***

PLENARY SESSION

Co-chairs: **Ravi Khetarpal & Sadi Sujang**

11:00-11:30	**Presentation of Technical Session** **Noraini Samat**, MARDI, Malaysia
11:30-12:00	**Presentation of World Café Discussion** **Mohamed Ariff Omar**, MARDI, Malaysia
12:00-12:30	***Brief Remarks by the Co-Organizers*** **Closing Remarks** **Ravi Khetarpal** Executive Secretary Asia-Pacific Association of Agricultural Research Institutions (APAARI), Thailand **Mohamad Roff Bin Mohd Noor** Director General Malaysian Agricultural Research and Development Institute (MARDI), Malaysia **Vote of Thanks** **Rishi Tyagi** APCoAB Coordinator Asia-Pacific Association of Agricultural Research Institutions (APAARI), Thailand
12:30-13:30	***Lunch***
14:00-16:00	Visit MARDI facilities
14:00-14.30	Introduction to Centre of Marker Development & Validation (CMDV)
14.30-14.45	Depart to CMDV
14.45-15.45	Technical visit - CMDV
15.45-16.00	Depart to MyGeneBank
16.00-17.00	Technical visit - MyGeneBank
17.00	Visit to Putrajaya

Organizing Committee 2019

Regional Workshop on Underutilized Animal Genetic Resources and their Amelioration (AnGR)

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Mr. Zul Hazwan Abd Aziz (MARDI)

Photo Gallery

Registration of Participants

Invited guests, organizing committee members and participants

International participants

International participants

Gift Presentation Ceremony

Dr. Ravi K. Khetarpal, APAARI to Dr. Mohamad Roff Mohd Noor, MARDI

Dr. Ravi K. Khetarpal, APAARI to Dr. Chung Hsiu Hung, COA

Dr. Mohamad Roff Mohd Noor, MARDI to Dr. Chung Hsiu Hung, COA

Dr. Mohamad Roff Mohd Noor, MARDI to Dr. Zunika Mohamed, MOA, Malaysia

Participants Corner

Technical Session IV: World Café Discussion

Table I - Conservation, improvement and use

Table II - Value addition, marketing and export

Table III - Partnership and capacity development

Table IV - Biotechnology for enhancing utilization

Table V - Regional information sharing system and local points

Technical Session V: Panel Discussion

Ilse Köhler-Rollefson, Alan Quartermain, Khabirul Islam Khan, Ravi K. Khetarpal and Steven Staal

Plenary Session

Mohamed Ariff Omar, Malaysia

Noraini Samat, Malaysia

Closing Ceremony

Ravi K. Khetarpal, APAARI

Mohamad Roff Mohd Nor, MARDI

Rishi K. Tyagi, APAARI

Book Launching

Books title :

Agricultural Biotechnology - Scoping Partnerships to Improve Livelihoods of Farmers in Asia and The Pacific. APAARI

Visit to MARDI Facilities

Centre for Marker Discovery & Validation (CMDV)

Centre for Marker Discovery & Validation (CMDV) is a part of Biotechnology Research Centre of MARDI. CMDV was officially operational in 2011. The major research thrusts are discovery and validation of molecular markers, establishing molecular breeding, and analyzing DNA fingerprinting in crops, livestock and fisheries for varietal identification, genetic traceability and quality control. CMDV is currently working on different crops such as coconut, mango, pineapple, rice and also durian, our king of fruits. As for livestock commodities, research is being conducted on tilapia fish, goat and cattle. CMDV is a one stop center well equipped with high throughput equipment in molecular techniques and bioinformatic platform for research and services.

MyGeneBank™

MyGeneBank™ is a program under Agro-biodiversity Resources Utilization and Conservation of Agrobiodiversity & Environment Research Centre MARDI. The mission of MyGeneBank™ is to conserve, manage and utilize agrobiodiversity resources as national heritage for food security and future generation. The facilities in MyGeneBank™ complex include seed gene bank, botanical and phytochemical laboratories, herbarium, insect museum, and histological and microbial culture collections. MyGeneBank™ has several field gene banks for different crops in different locations: Seberang Perai (rice, wild rice), Jerangau (vegetables, fruits, herbs), Jelebu (fruits), Kemaman (fruits), Kuala Kangsar (fruits), Serdang (vegetables) and Bintulu (fruits), with a total area of more than 200 hectares. Research activities include collection of genetic resources, identification of species, genetic diversity analysis, bio-prospection, conservation and cryopreservation.

MAEPS Agro Tourism Park

MAEPS Agro Tourism Park, Serdang was established to serve as an Agro -Tourism Center & Showground The agricultural park or garden or Laman Agro MAEPS consists of 8 agricultural showgrounds to showcase Malaysia agriculture industries which include herbs, vegetables, flowers and livestock. It is a worthwhile agricultural experience that will stimulate our five senses while exploring the beautiful landscapes and fantastic attractions. The tram ride for a short tour brings participants to experience various interactive activities such as honey harvesting, food and drinks sampling at the herbs showground, and agricultural demonstration.

Herbal Garden

Stingless Bee Honey

Workshop Dinner for Participants and Speakers

Steamboat and grill style dining

Appreciation Dinner for the Organizing Committee

Women Power

Members of the various local committees of the workshop

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