

Current Status of Animal Genetic Resources in Oman

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ABSTRACT

Oman is endowed with a wealth of biodiversity. It has a wide diversity of animal genetic resources (AnGR), which are indigenous. After preparation of the first country report on the state of Oman's AnGR in 2002, the Ministry of Agriculture and Fisheries (MAF) started a breeding strategy for sustainable management, utilization and conservation of AnGR in line with the basic elements and the steps used and developed by FAO. AnGR in Oman consist of cows, sheep, goats, camels, horses and poultry that are located in varying numbers across the Sultanate. Most of the cows (58%) are located in the Southern part on Oman (Dhofar governorate) while, more than 70% of sheep and goats population concentrates in the North of Oman and the majority of camels (60%) are located in Dhofar governorate. Numbers of local poultry are low, raised at research stations and in some villages. There are modest numbers of horses in the Royal Cavalry and the rest are located at the Royal Court Affairs. MAF has carried out considerable work (*in-situ* and *ex-situ*) for conservation of farm animal genetic resources such as cattle, sheep, goats and poultry in collaboration with Sultan Qaboos University, Ministry of Environment and Climatic Affairs, and Diwan of the Royal Court. MAF has very good herds and flocks from different local species distributed in four-research stations. It also has a gene bank for cryopreservation for semen, embryos and ova.

Key words: Conservation, Animal Genetic Resources and Oman.

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INTRODUCTION

Oman is endowed with approximately 47 species of terrestrial mammals and around 10 domesticated species (MAF, 2012). Wild and domesticated mammals are a natural wealth and authentic Omani heritage. Animal genetic resources are so adapted and become very specific and characteristic to different agroecological regions of the country that they are called by their names as Dhofari, Sahrawi and Batinah etc. Goats, cattle, camel and sheep are the most important livestock species in Oman. The production and consumption of animal products are steadily increasing but still large numbers of live cattle, goats, sheep, as well as chilled and frozen meat products, are introduced into the country. The local Omani animal breeds are well adapted for demanding environmental conditions. There is already much interest in Omani breeding animals by the other neighbor countries.

The breeding populations are kept at research stations, from where top quality males are distributed to the farmers every year. Most of livestock population concentrated in the Southern part of Oman (Dhofar governorate), this is mainly due to the availability of the natural pastures. Goats represent about 70% of total livestock population in Oman (Figure 1); they are vital natural resource in desert and mountain regions, as they are able to convert the scarce plant sources to edible food. Oman has taken several steps to develop and conserve its animal genetic resources either individually or globally in collaboration with international organizations/ institutes. Presently, the intensive efforts are going on as per the Orders of His Majesty to establish Animal and Plant Genetic Resources Center in the Sultanate under the umbrella of The Research Council. It has mission to promote the recognition, sustainable exploitation and valuation of the

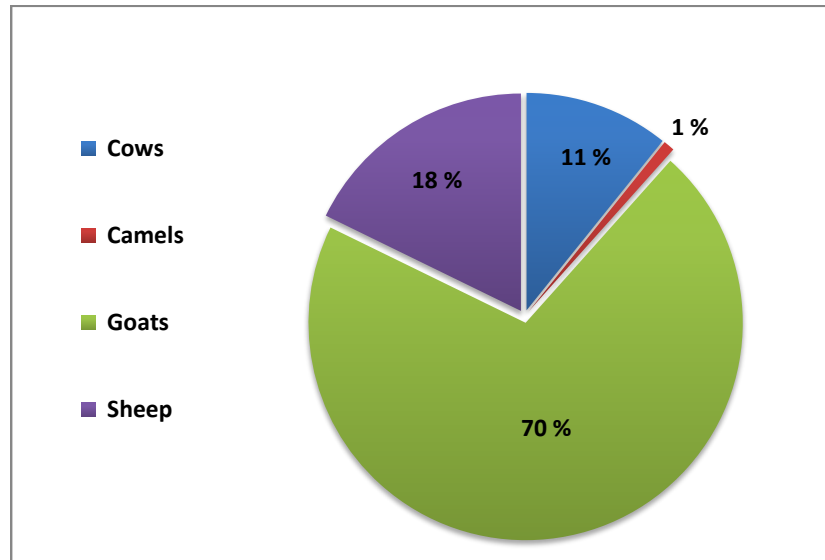


Figure 1. Percentage of local livestock population in Oman. Source, Agriculture Census 2013, MAF.

genetic diversity inherent in Oman's animals, plants and microorganisms as a natural heritage resources with aim to have Oman's collaborative organization for advancing sustainable use of animal and plant genetic resources through education, research and innovation and vision. According to the last agriculture census done in 2013, the percentages of the local livestock population are increased in the country (Figure 1; MAF, 2013).

PRODUCTION SYSTEMS

Farmers in Oman follow the traditional animal production systems like nomadic and transhumance but stationary systems exist in agricultural holdings including backyard systems and small units. As well as, large-scale intensive commercial systems (MAF, 2012).

Nomadic System

Livestock owners are moving with their animals looking for pasture and water. This system is low or medium input and it prevails in desert and mountain areas. Camels, goats and sheep are usually raised in this system in small flocks/herds (MAF, 2012).

Transhumance System

It is similar to the nomadic system with a great extent but the livestock owner would have a stationary residence and he moves to and from this residence. In addition, the herd size is larger in the transhumance system. Both systems use local breeds and depend on natural pasture plus supplemental feeding with green fodder, hay and straw,

dates and by-products (MAF, 2012).

Backyard Systems

The farmers raise their animals in mixed flocks/herds that are small numbers of sheep, goats, cattle or local poultry and keep them near their houses where the animals go out grazing in the neighbourhood in the morning and come back in the evening when they give them supplemental feeds and water. The systems of backyard and small farms are considering medium-input systems where most cattle, sheep and goats are produced in Dhofar governorate (MAF, 2012).

Stationary System

Cattle are produced under this system in Dhofar governorate where they graze in some parts of the year but provided with feeds in times of lack of natural pasture. This system is self-sustained in view of its dependence on local breeds and the use of local feed resources like dates and their agricultural by-products (MAF, 2012). Big specialized companies where, stocks are kept in fixed places under good management and environmentally controlled (MAF, 2012) own large commercial farms. Modern techniques are used in production, feeding and watering.

THE STATE OF DIVERSITY

There are many species and breeds in Oman, but numbers of these breeds differ. Some of the breeds within species are classified as breeds at risk due to small

Table 1. Average growth and milk production traits of both North and South local cow breeds.

Trait	North Cow Breed		South Cow Breed	
	Male	Female	Male	Female
Birth Weight (Kg)	15.3	14.9	20.5	18.9
Weaning Weight (Kg)	60.6	58.9	105.6	93.1
Six months Weight (Kg)	68.1	66.6	131.9	106.7
Pre-Weaning Daily Gain (g/day)	499	458	807	715
Post-Weaning Daily Gain (g/day)	210	118	338	185
Daily Milk Yield (Kg/day)	3.6		6.9	

Source: Agriculture and Livestock Research Annual Report, MAF 2015.

Table 2. Average growth and milk traits for local goat breeds.

Breed	Sex	BW (Kg)	WW (Kg)	W6 (Kg)	Pre-Weaning Gain (g/d)	Post-Weaning Gain (g/d)	Daily milk yield (kg/d)
Jabal Akhdar	Male	3.34	16.4	19.8	128	39	1.12
	Female	3.05	14.6	18.0	110	38	
Batinah	Male	3.49	15.6	21.1	130	42	1.05
	Female	3.00	14.8	19.1	115	42	
Dhofari	Male	3.55	12.8	15.5	103	30	1.49
	Female	3.20	11.3	13.5	90	25	
Jabbali	Male	3.21	13.7	17.00	115	45	1.10
	Female	3.06	13.5	16.8	110	41	
Sahrawi	Male	3.00	13.6	19.3	113	55	1.15
	Female	2.73	12.2	16.2	100	42	

BW, birth weight; WW, weaning weight; W6, weight at 6 months; pre-weaning daily gain(BW-WW); post-weaning daily gain (WW-W6); Source: Agriculture and Livestock Research Annual Report, MAF 2015.

population according to the FAO policy, the total numbers of the breed below 10,000 considers as breed endangered. Ministry of Agriculture and Fisheries carries out research programs to improve the productivity of local farm animals through selection.

Cattle

There are two local cow breeds in Oman, Al-Batinah (North of Oman) and Dhofari (South of Oman). The total numbers of the local cattle in Oman reached in 2013 about 316 thousand head (MAF, 2013)

Al-Batinah (North of Oman)

The cattle are light brown with medium size, average conception rate 75% and the average mortality rate is 1.8%. Average adult body weight is 250 kg Table 1 presents average growth and milk production traits for local cows. The breed is found in the Northern part of the country and raised under traditional system in backyards and farms. It is widely used for meat and milk production. The farmers feed their animals with hay mainly Rhodes grass as roughage source in addition to pelleted commercial concentrate mixture (14% crude protein).

Dhofari (South of Oman)

They are dark brown or black with an average conception rate about 70% and mortality rate 1.5%. Average mature weight is 325 kg. Average growth and milk production traits are shown in Table 1. The breed is found in the southern part of the Sultanate and raised under stationary grazing system. The breed is widely used for meat and milk production.

Goats

Five local goat breeds are characterized in both phenotypic and genetic level. These breeds are Al-Jabal Akhdar, Batinah, Dhofari, Jabbali and Sahrawi. They are widely distributed all over the country; the total local goat population in Oman reached more than two millions head (MAF, 2013).

In North of Oman, Al-Jabal Al-Akhdar

Common colour is brown. The breed is medium size with average conception rate 90% and twinning rate 1.29%. Average mature body weight is 36 kg (MAF, 2013). Average growth and milk traits for local goat breeds are shown in Table 2. The breed is widely used for meat

Table 3. Average body weight traits for local sheep breeds.

Breed	Sex	BW (Kg)	WW (Kg)	W6 (Kg)	Pre-Weaning Gain (g/d)	Post-Weaning Gain (g/d)
Local Sheep (North)	Male	3.25	18.8	25.0	152	64
	Female	3.10	16.77	22.0	131	55
Local Sheep (South)		1.9	12.10	14.75	--	--

BW, birth weight; WW, weaning weight; W6, weight at 6 months; pre-weaning daily gain (BW-WW); PSTW, post-weaning daily gain (WW-W6); Source: Agriculture and Livestock Research Annual Report, MAF 2015.

production. Most of its population is concentrated in the Al-Jabal Al-Akhdar and in the Dakhliyah governorate and is mainly raised under medium-input production system.

Al-Batinah

The colours varying from dark brown, light brown and black with white spots in the face, belly, and lower limbs. The breed is of medium size with average conception rate 92 and 1.28% twining rate. Mature weight reaches about 33 kg (MAF, 2013). The breed is widely used for meat production and is raised under medium-input production system.

Sahrawi

This breed is found in the plains and valleys all over the Sultanate. It is characterized by its solid black coloured body with brown stripes around the neck and the belly. The average conception rate is 85%, twining rate 1.25%, and mortality rate 5%. The average yearling weight is 27.0 kg (MAF, 2014).

Jabbali

This breed is widely distributed in the chains of the Al-Hajar Mountains especially in Mudaibi, Ibra and Quriyat and found in Al-Dhahirah. The breeders made lots of improvement in this breed. It is also called as Rahebi or Sawalem. The colour is different from brown to light brown; average conception rate is 85%, twining rate 1.20%, and mortality rate 5%. The average adult weight is 30 kg (MAF, 2014).

In South of Oman, Dhofari

Common colour is white with other occasional colours as black, dark brown, light brown and a mixer of colours. It has a small body covered with short soft hair. The average conception rate is 80% and twining rate is 1.20%. Average mature weight is 26 kg (MAF, 2013). The Dhofari breed is found in the plains and the mountain areas of Dhofar governorate and raised under medium-input system for meat and milk production.

Sheep

There are two local sheep breeds in Oman, the North of

There are two local sheep breeds in Oman, the North of Oman and the South of Oman breeds. The last one called Dhofari sheep and there is not much information available for this breed. The Omani sheep finds in different governorates located in the North of the Sultanate while, Dhofari sheep breed exists only in the South part (Dhofar governorate). The total population for local sheep in Oman not too much reached about 520 thousand head in 2013 (MAF, 2013).

Omani (North of Oman)

Common colour is black but a few sheep are white and brown. Average conception rate is 93% and twining rate - 1.40%. Average weight at maturity reached about 34 kg (MAF, 2014). Average growth rate traits for local sheep breeds are shown in Table 3. The breed is found in the North of the Sultanate, raised under medium-input production system, and widely used for meat production.

Dhofari (South of Oman)

The colour is white with short legs. It is found in Dhofar governorate and used on a small-scale to produce milk and meat under medium input production system. No information available about productive and reproductive traits for this breed, recently the ministry of agriculture and fisheries established a nucleus flock in Salalah research station (Dhofar governorate) with a clear selection program to improve the breed.

Camels

Omani camels are Arabian camels and they are all one-humped, generally of medium size weighing around 350 to 450 kg and two meters height with strong limbs with beautiful colours (Diwan of Royal Court, 2009). In the Southern governorate, the camels tend to be black while in the Northern governorate they are light brown, blonde, or white. Omani camels originally bred from Arab camels in the Arabian Peninsula and Yemen, have acquired hybrid features due to crossbreeding (Diwan of Royal Court, 2009). They can be classified as multipurpose camels that are good for riding, racing, and for producing meat and milk. The average milk production for local camel ranged from 6 to 8 litter per day (FAO, 2012) and average mature weight ranged from 400 to 450 kg (Kadim, 2012). Some Omani tribes are famous for their specific types of camels.

Table 4. Average productive and reproductive traits for the three local poultry lines.

Trait	White	Black	Brown
Day one Body Weight (g)	29.2	28.0	30.8
6 weeks Body Weight (kg)	0.484	0.489	0.478
10 weeks Body Weight (kg)	0.798	0.841	0.803
21 weeks Body Weight (kg)	1.33	1.21	1.36
Conception (%)	86.4	87.2	87.1
Hatching (%)	53.9	36.7	54.9
Egg Weight (g)	44.8	43.2	46.7
Egg Production (Egg)	184	76	146

Source: Agriculture and Livestock Research Annual Report, MAF 2015.

The Omani camels are considered to be of the best pedigree among the camels living in the Arabian Peninsula (Raymond, 2002). The most famous types for the local camels are Samha, Musiha, Fariha, Khumaisa, Khiwara, Ramli, Khuzami and Jabali (website for the Royal Court Affairs www.rca.gov.om).

Horses

Historically, Oman has been famous for its purebred Arab horses. Some historians date the origin of Arab horses in Oman to the time of Prophet Suleiman who presented an Azd delegation with the famous stallion (Zad-Arr-akib) from whom all the Arab horses in Oman have descended. The Royal Stud Farm was established in the mid-1970 in Salalah as a department of the Royal Stables designed to breed the best quality horses with the emphasis on Arabs and thorough breeds. The Royal Stud continues to play an important role in horse breeding each year. Omani horses are Arabian horse, have a small head, proportionate to the rest of their body; large eyes; small, pointed, erect ears; and a short, wide back. Due to their pure bloodlines, Arab horses maintain good health and rarely succumb to illness. They eat less than other breeds and have great endurance for long journeys. Arab horses have a variety of colours, but the most prized is the white. Each horse is given an equine passport by the Omani Horse Register (OHR), which is considered as identity card.

Poultry

Local poultry stocks are found in rural areas and raised in households and farms in small numbers. They used for home consumption and contributes to some extent to family income. Local poultry is disease resistant, adapted to hot weather and show low mortality. Local chickens have medium length legs with single serrated comb. Plumage colour ranges from black, brown to white. The local chickens have low production probably because they are raised under traditional system with inadequate inputs. The population of the local chickens are low and they

considered as at risk. The selection program for improving the local chickens ended with three local lines, white, black, and brown. An experimental was carried out during year 2010 to 2012 to compare the productive traits of the three local poultry lines (white, black and brown). The results of the activity indicated that the brown line was similar to white one in respect of growth and productive traits where the black line was found to be inferior. It was concluded from the results to keep both white and brown lines for undertaking intensive selection program to improve the traits and the black line would be maintained as an important genetic resource. Table 4 presents the average productive and reproductive traits for the three local poultry lines.

The broiler production in Oman starts at the parent level with two main companies taking care of the rearing of the parent stock and production of the hatching eggs. The one-day-old chicks for parent stock are imported from abroad. Most of the broilers in Oman are simple local small-scale production units cycle and producing two cycles per year. This system can be further classified based on the dimension of the tenure in small-scale households holding 30 birds per cycle and medium-scale households holding 130 birds per cycle (SARDS, 2016). The commercial system in Oman can be divided into two big systems: the closed one (intensive) and the open one (semi-intensive). The main commercial system in Oman is the closed one characterized by the existing of two main big integrated factories carrying out all the activities from hatching eggs production to the birds slaughtering: A'Saffa Food, Sohar, and owning the 65.8% of the domestic market (MAF, 2013).

IMPLEMENTATION OF THE GLOBAL PLAN OF ACTION AT NATIONAL AND REGIONAL LEVELS

During the five-year strategic plan (2010 to 2015) for directorate general of agriculture and livestock research, ministry of agriculture and fisheries conducted many regional and national programs to develop and guarantee the sustainable use of the animal genetic resources in Oman. A summary of these programs is as follows: (1) there is a regular meeting every three months between the

researchers at MAF and all stakeholders to put the short and long-term goals and to distribute the costs of national breeding programs. (2) In the international trade for breeding animals, special emphasis is taking into account to support Oman's good animal health status. (3) Gene bank is established in year 2013 to start the cryopreservation for the indigenous sperm, ova and embryo and an international co-operation between the gulf countries will be start soon in this field. (4) Existing *in-situ* conservation programs are extended by establishing two new nucleus herds and flock for Jabal-Akhdar goat breed and the south local sheep breed (Dhofari) which is endangered. (5) For the case for serious animal disease, the veterinary research centre conducting an animal disease mapping for zoonotic and communicable animal diseases. Which covered a viral (rabies), bacterial (brucellosis and John's disease), and a parasitic (Echinococcosis) disease in the livestock of the Sultanate. (6) There are some other diseases that vaccinated against some of them but not covered by the animal disease-mapping project such as: Salmonellosis (bacterial), Newcastle (Viral) in poultry. Glanders and Strangle (bacterial), Equine Influenza (Viral) in equine. Tuberculosis and Clostridial disease (bacterial), FMD and PPR (Viral) in ruminant and (7) Complete database is used for management of *in-situ* and *ex-situ* programs and integrated approach by governments and international institutions is in progress for food security that makes links with climate change, biodiversity, and use of energy, water, and land.

STRUCTURED BREEDING PROGRAMS

Genetic improvement for local farm animal breeds started in the 1990's with the aim of conserving the indigenous breeds by conducting genetic improvement using a clear selection programs of the productive and reproductive traits especially milk and meat production. The selection program for improving indigenous cattle, sheep and goats breeds is a long-term program. The first goal for this program is to increase the genetic potential for Omani local breeds with respect to milk, meat and other reproductive traits. The aims of the breeding program are to (1) determine the genetic potential of the indigenous breeds and identify molecular markers linked to quantitative traits loci (QTL) for production traits using molecular techniques (2) Perform the progeny test for the improved males (3) To have a sufficient and efficient database with full pedigree information. The ministry of agriculture and fisheries distributes every year a large numbers of improved males to the farmers to do genetic improvement for their herds/flocks and monitor the performance of these distributed animals on farm.

CONSERVATION PROGRAMS

The ministry of agriculture and fisheries (MAF) did many

efforts to conserve and maintain local breeds in different livestock species with collaboration with the ministry of environment and climatic affaires and the royal court affaires. MAF is supervising the existing protected areas in Dhofar and monitoring these areas to develop, maintain, and conserve the breeds. It has determined the breeds, which are endangers. Only Dhofari sheep and local poultry breeds in Dhofar are defined as breeds at risk according to FAO guidelines.

In-Situ Management

MAF and the Ministry of Environment and Climatic Affairs (MECA) carry out *in-Situ* conservation and management of AnGR in the Sultanate. MAF is concentrating on the conservation and management of indigenous species where, MECA has reserved areas in different part of Oman with the aim of conserving the ecosystems. In 2004, a special program started to do classification and identification for the local small ruminant and cow breeds in Oman. MAF has nucleus herd/flocks in different area in Oman to maintain and preserve the local breeds at their native place. MAF performed numerous activities towards conservation of local breeds in different species, through on-form management since early 1990's. In case of cows and small ruminants, MAF takes responsibilities to carry out genetic improvement at its different research centres and stations using a reliable selection program and distribute the selected improved rams/bucks to the farmers and small holders to improve their herds/flocks. However, there is a need for extending such activities towards improving indigenous breeds of AnGR.

In 2013, a nucleus herd of Al-Jabal Al-Akhdar goat breed was established in Al-Jabal Al-Akhdar city to conserve the breed. Al-Jabal Al-Akhdar breed is an important goat breed in Oman and some other gulf countries; it is known as a promise breed. This activity carried out to maintain the breed (*in-Situ*) for conservation as an important genetic resource in Oman. The main objectives for this activity are: (1) Conserve and maintain Al-Jabal Al-Akhdar goat breed in its native place (*in-Situ*), (2) Preservation the breed from the genetic degradation and random crossing, (3) Genetic improvement for the productive and reproductive traits for sustainability and to propagate the breed and disseminate the selected improved males to the farmers at the target areas. Another important step started in year 2014 to conserve the Dhofari sheep breed (South sheep breed) which is at risk. A selected nucleus flock was established at its native place to conserve the breed and apply an intensive breeding program to improve productive and reproductive traits.

Ex-Situ Management

MAF started a program in 2010 to conserve AnGR by establishing an international artificial insemination

laboratory at Livestock Research Centre with the aim of collecting and preservation of semen produced from local improved bulls for conservation. Shortly, this lab will be a national gene bank for cryoconservation of sperms, ova and embryos collected from cows, sheep, goats and other species in the near future.

Reproductive and Molecular Biotechnology

The artificial insemination research lab provides high quality semen produced from local improved bulls, for using in artificial insemination at the breeders in different governorates of the Sultanate. This is useful in accelerating the processes of genetic improvement by reducing the generation interval as well as the possibility of testing bulls by doing the progeny test. Bulls are selected according to: (1) high breeding value for milk yield of the mother, (2) morphological and reproductive shape of the testes and good body conformation and semen quality. The genetic diversity between livestock is an important indicator for experts and researchers in the field of livestock management. It assists them to design breeding programs, improve quality, and enhance productivity of the livestock. Subsequently this leads to raising the efficiency of its genetic origins as well as preserving it from genetic drift. Molecular characterization of the genotypes gives precise information about extends genetic diversity, which helps for developing an appropriate breeding program. Genetic characterization study of indigenous cow, goat and poultry populations of Oman using microsatellite DNA markers were done to know the relationship between the local breeds in all governorates in Oman.

For cows, Al-Sinani, 2015 studied genetic distance among six cattle breeds and stated that the study provided evidence that the two Omani cow breeds are distinct breeds and they have significant genetic diversity between them. There was a close distance between Oman North and Pakistani breeds and close distance was found between Oman South and Ethiopian breeds. However, wide distance found between the two Omani, Pakistani and Ethiopian cow breeds and the European breeds. This may be due to some interaction between cattle populations due to the closer geographic distance between the location of the two breeds (Oman North with Pakistani and Oman South with Ethiopian). Moreover, Ethiopian cattle had been imported to the South of Oman (Dhofar governorate) many years ago which may have allowed some level of interaction between the breeds. Likewise Pakistani cattle were introduced to the North part of Oman and genetic interaction might be occurred (Al-Sinani, 2015).

In goats, a research work done by a project funded by AFDF, 2013 to study six indigenous goat breeds to identify genetic relationships among Omani goat populations using 23 microsatellites. The study indicated significant genetic diversity among Omani goat breeds.

It is concluded in the scientific report for the project that, there was a wide genetic distance between Sahrawi Musandam and Dhofari goat breeds, which indicate that both breeds came from different genetic pool. However, a close relationship between Jabbali and Al Jabal Al Akhdar goat breeds was observed. This may be due to the closer geographic distance between the areas (Al Hajar Al Sharqiyah Mountain) in which these two breeds are distributed. Further, Al Jabal Al Akhdar goat breed is considered as a superior breed therefore it may have been used to improve the Jabbali breed. Moreover, migration has a great effect on the reduction of genetic differentiation between populations (Laval et al., 2000). For the local poultry, Al-Qamashoui et al. (2014) studied genetic distance among six Omani chicken subpopulations and found that, there is considerable diversity among Oman indigenous chicken. Phylogenetic tree and structuring analyses agree with geographical distribution of subpopulations and Dhofari population made up a separate cluster from the other studied populations.

LEGISLATION AND REGULATION

The government, in more than anything else, enacts legislation and issues the regulations related to the development and maintenance of AnGR. Several legislations and regulations have been issued since the past 10 years that deal with conservation and utilization of AnGR. Most of them were issued in the form of royal decrees addressing specific issues. The implementation of the laws and regulations need to be monitored effectively to have positive impact on the utilization and conservation of animal genetic resources and to take advantage of opportunities that arise with them.

Conclusion

Sultanate of Oman is characterized by the presence of a great diversity of animal genetic resources, especially for the local goat breeds in view of the existence of mountain ranges, which vary in the level rises to the country. Animal genetic resources in Oman consist of cattle, camels, sheep, goats, poultry, horses, mules and asses. Ministry of agriculture and fisheries carries out animal genetic resources development programs to improve the productivity of the local breed of cows, sheep, goats and poultry. *In-Situ* and *Ex-situ* conservation and management of animal genetic resources in the Sultanate are carried out by ministry of agriculture and fisheries that concentrating on the conservation and management of indigenous species and ministry of environment and climatic affairs which organize reserved areas in different

part of the country with the aim of conserving the ecosystems. It is worth mention that Oman took significant steps to realize food security through enhancing domestic agricultural production which helped the increase in the self-sufficiency rate in some products such as milk and table eggs. However, self-sufficiency rate still low in some other products like red meat and poultry meat.

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