The State of Farm Animal Genetic Resources in Africa

Towards Accelerated Agricultural Growth and Transformation by the Year 2025



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“We have enough resources to feed not just ourselves but other regions too. We must seize this opportunity now.”

– Kofi Annan, 2014



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Foreword

The African Union's Agenda 2063 has identified agriculture as a driver of economic transformation on the continent. The agricultural transformation desired by the Malabo Declaration of 2014 aims to make agriculture in Africa more productive, competitive, sustainable and inclusive. This transformation should, however, take cognisance of the fragility of environments, the rich biodiversity and the complexity of the agricultural production systems.

Malnutrition is a major concern in Africa, particularly the lack of protein, because access is limited and starchy diets are predominant. For generations, this lack of protein has stunted the physical and mental development of millions of children, hence limiting their overall potential. It is important to grasp the hidden, yet lifelong effects of protein deficiency to fully understand the reasons for underdevelopment of Africa's human capital. Although the overall nutrition and protein consumption in Africa improved in the past two decades, the challenge of sufficient protein consumption remains, especially among the poor. Africa must, therefore, endeavour to meet the enormous challenge of feeding itself while preserving the natural resources for future generations.

Indeed, farm animal genetic resources (FAnGR) in Africa are key to poverty alleviation, and contribute significantly towards food and nutritional security. Africa's indigenous animal breeds have many unique characteristics. They are the heritage of Africa's diverse rural communities and contribute significantly to the livelihoods of many rural people, especially in the marginal drylands. They also serve their cultural needs and attract attention because of their competitive advantages in terms of adaptability, disease resistance, ease of management, fertility and meat quality. The resources are not just a source of health, but also of wealth and continue to be among the most-traded food commodities on the continent.

African FAnGR are undervalued, and the awareness about their economic potential among policy makers and the general public is limited. This state of affairs has generally resulted in a lack of appropriate infrastructure,

institutions, capacity and technologies to take full advantage of their potential. Recent concerns on the loss of diversity of these resources have led to renewed initiatives to conserve and better utilise them, and to identify and characterise many breeds that were considered inferior to more conventional international breeds of cattle, sheep, goats, horses, pigs and poultry.

As an integral part of the broader agricultural sector, the management of FAnGR in Africa is guided by the vision and aspirations of the Accelerated African Agricultural Growth and Transformation Goals of the Malabo Declaration of 2014. This agenda is also informed by the Comprehensive Africa Agriculture Development Programme (CAADP) results framework and intends to provide guidance and assistance to countries and Regional Economic Communities (RECs) in formulating priorities within their agricultural investment plans. It is also in line with the Agenda 2063, a 50-year strategy for the African continent in all spheres of social and economic development. Furthermore, it intends to guide and mainstream stakeholders' efforts in addressing major development challenges facing the FAnGR sector.

The African Union recognises the significant contribution of animal genetic resources to food security and nutrition, in promoting health and reducing poverty. The Union is, therefore, supporting the sustainable utilisation and conservation of African FAnGR through the institutionalisation of national and regional policies, as well as legal and technical instruments that are crucial for the judicious exploitation of FAnGR in Africa. These efforts are also aligned with the Livestock Development Strategy for Africa (LIDeSA) 2015-2035, which provides an opportunity to build consensus, mobilise stakeholders and establish strong partnerships to drive the sector in Africa. However, importation of exotic breeds for crossbreeding or breed replacement, climate change, disease outbreaks, restrictions on the availability of natural resources and changing market demands are serious threats to this vast genetic diversity.

Through enhanced collaboration, strategic partnerships and the engagement of all stakeholders, including the civil society and the private sector, significant and important contribution will be made towards sustainable conservation, utilisation and management of Africa's FAnGR for the present and future generations. *The State of Farm Animal Genetic Resources in Africa* identifies the most significant gaps and needs for conservation and utilisation of FAnGR, and provides the basis for designing strategic national, regional and international policies for the implementation of priority activities. It is the first comprehensive publication on African FAnGR and, as such, is intended to be a valuable tool and a reference material for breeders, breed societies, policy makers, scientists and academics, non-governmental organisations, the

private sector and other stakeholders in the management, conservation and utilisation of African FAnGR. It will also ensure that national, regional and international commitments are met.

H.E. Mrs. Josefa Sacko
Commissioner for Rural Economy and Agriculture, AUC

Preface

Despite their importance, many African animal breeds are either facing extinction or undergoing rapid genetic dilution. The absence of regional policies and strategies has resulted in a lack of conservation protection for endangered breeds. Since the adoption of the Global Plan of Action (GPA) for the conservation of Farm Animal Genetic Resources (FAnGR) in 2007, only a few countries in Africa have formulated National Strategic Action Plans (NSAPs) for implementation. In countries where the NSAPs have been developed, low technical and financial capacity as well as a lack of information on the current population status and trends of Animal Genetic Resources (AnGR) hinder their implementation. In addition, the lack of a harmonised characterisation, inventory and monitoring methodology has resulted in lack of robust evidence to inform policy makers.

In order to breach these information gaps, the African Union Commission (AUC) through its specialised technical office, the InterAfrican Bureau for Animal Resources (AU-IBAR), has embarked on the publication of *The State of Farm Animal Genetic Resources in Africa*, which will serve as a reference material for the sustainable management of African animal genetics for food and nutrition security, enhanced livelihoods and shared prosperity of the continent's citizens.

The collation and compilation of information for this publication was participatory and all-inclusive. The primary data and information at the national level were provided by the respective national coordinators of animal genetic resources in all AU Member States (MS) through: 1) a questionnaire prepared by FAO for the publication of the Second Report on the State of the World's Animal Genetic Resources, and 2) a questionnaire prepared by AU-IBAR to gather information and data that were specific to the continent and which were not captured by the FAO questionnaire.

This book covers the main species that are present in Africa – pigs, cattle, sheep, goats, horses, donkeys, camelids, poultry, aquatic resources and bees. It also covers non-conventional species such as guinea fowl, grasscutter and cavies. The data and information from various MS were thereafter analysed,

compiled and the first draft document prepared by the team at IBAR.

After review by a group of independent experts, the document was submitted to stakeholders for revision and validation; first, during the Steering Committee (SC) meetings of Sub-Regional Focal Points (SRFP) attended by the Directors of Animal Production in AU Member States, Livestock Officers in Regional Economic Communities and Regional Coordinators for AnGR in the secretariat of SRFP and national Coordinators of AnGR, and then during the General Assembly of SRFP attended by all stakeholders along the AnGR value chain.

Being the first of its kind, this document suffers from the variation in the quality and quantity of data and information collected from individual countries, making it difficult to have an objective country comparison. In the absence of regular livestock census in many countries, data on population were mainly extracted from FAOSTAT, which contains mainly estimated data for selected species. This was in anticipation that, in the future, breed-specific population size data will be made available. In addition, some species unique to the African continent – such as the grasscutter – are not catered for in some of the data sources, thus contributing to inaccurate representation of the AnGR species diversity in the continent.

Despite the challenges mentioned above, the authors utilised all available verifiable data sources and peer-reviewed publications to ensure a clear representation of the status and trends of AnGR that included Threats and Risks, Genetic Improvement and Conservation Programmes, Policy and Institutional Frameworks, and Priority Actions. The information contained in this pioneer publication will oil the rusty cog of the African livestock sector and drive it towards strategic transformation of the African people's livelihoods and nutritional security.

The publication of this document is a collaborative effort involving all AU member states and other stakeholders in Africa. The contributors included directors of animal production representing the AU Member States, national coordinators for AnGR, and livestock officers from Regional Economic Communities and sub-regional organisations. They all contributed in collecting and providing the information for the compilation of the manuscript. The preparation and finalisation of the document was effectively coordinated by the project team at AU-IBAR.

Prof. Ahmed Elsawalhy
Director, AU-IBAR

Acknowledgements

The State of Farm Animal Genetic Resources in Africa is the result of the work of numerous specialists from African Union Member States, sub-regional, regional and international organisations, whose contribution is acknowledged.

We wish to express our particular thanks to all the national experts who were involved in the data collection. It is difficult to mention all of them here by name, but this work would not have been possible without their hard work over many years.

The preparation of the publication was coordinated and led by AU-IBAR. The teams of authors who collected, reviewed and compiled the document worked closely together with national respondents to transform an immense data set into a coherent and meaningful analytical report. For certain indicators, information was also supplied by international organisations. We are indebted to all of them.

The process of preparing the document was guided by an Experts Group that reviewed the process for data collection, collation and drafting. They provided significant input for the improvement of its quality. We would like to thank all the national coordinators in charge of animal genetic resources, national project focal points and directors of animal production for their cooperation, dedication and patience in providing pieces of information that laid the basis for compiling this publication. We would like to acknowledge the contribution of the team of editors and to express our gratitude to all contributors for their permission to use the photographs contained in this publication.

Special thanks go to the European Union and the African Union Commission for their financial support. Our sincere thanks go to our partners for their support. Their personal involvement and dedication were a pre-condition for completing the report in the expected time and shape.

We are grateful to the European Union for the financial support through the project, **'Strengthening the Capacity of African Countries to Conservation and Sustainable Utilisation of African Animal Genetic Resources'**, DCI FOOD/2013/319-541.

Finally, special thanks to all the smallholder livestock owners and keepers (including women who constitute a large proportion), breeders and breeders' associations, the custodians of animal genetic resources in Africa, whose livestock are at risk of dilution or extinction and whose livelihoods depend on them.

Prof. Ahmed Elsawalhy
Director, AU-IBAR

Executive Summary

Farm animal genetic resources (FAnGR) for food and agriculture are important for millions of inhabitants of Africa and other continents. They play critical roles in economic development, food and nutritional security. The FAnGR sector in Africa faces numerous challenges; therefore, its potential has not been fully exploited to accelerate economic growth and social well-being, as well as reduce poverty, create wealth, and strengthen food security and health.

Africa's indigenous FAnGR are an invaluable treasure. They exhibit unique and rare adaptive attributes. Their value does not attract significant awareness as it is not adequately understood or acknowledged, which has contributed to the lack of concerted efforts towards ensuring their sustainable conservation, utilisation and management.

This publication describes the status of the conservation, utilisation and management of FAnGR in Africa. It is intended to steer the continent's efforts towards improved food and nutrition security, eradication of poverty, and enhanced livelihoods of communities that depend on animal resources through efficient utilisation and conservation of indigenous breeds. The publication attempts to provide a comprehensive assessment of the state of the FAnGR diversity and its management on the continent. It also focuses on the trends in the FAnGR sector, the state of capacity to manage FAnGR, the state-of-the-art in FAnGR management, and gaps and needs in FAnGR management. It covers the main FAnGR species present in Africa, namely pigs, cattle, sheep, goats and chickens. It also covers aquatic genetic resources and emerging or non-conventional species, such as grasscutters, ostriches, guinea fowls and buffaloes. The focus is on in situ breed populations (where animals are maintained in their production environments or in protected areas), but an initial exercise has also been carried out to identify ex situ collections (those which involve the storage of genetic material).

The data used to produce the document are based on information obtained from member states of the African Union and from reviews of literature. Information from member states was extracted from (i) the country reports to

FAO's first and second global reports on the State of the World's Animal Genetic Resources, and (ii) from a structured questionnaire that was administered to all African countries by AU-IBAR to generate additional information on the status of the breeds (including emerging or non-conventional livestock and aquatic resources), the flows of FAnGR, livestock sector trends, overview of FAnGR, characterisation, institutions and stakeholders, breeding programmes, conservation, reproductive and molecular biotechnologies, and integration of the management of FAnGR in national policies and legislations. In order to corroborate the data provided by the countries and to facilitate more detailed information, other sources of information were drawn from literature and/or expert knowledge.

The publication starts by describing the diversity of production systems according to species in Africa. The classification of the systems covers cattle, sheep, goats, pigs and chickens, fish and the emerging or non-conventional species. In order to provide orientation to decision-makers involved in FAnGR development, the publication provides insights into the importance of the different systems across African regions and agro-ecological zones and related trends. It then deals with breed numbers (local, locally adapted and exotic breeds) and provides an indication of the regional distribution of species and breed diversity, including fish and emerging or non-conventional species. It describes the state of species and breed diversity in each region on the African continent, and highlights that, over time, new breeds have been developed. At the same time, other adapted breeds that can produce and survive in marginal areas and harsh environments are being lost. These traits could be lost if nothing is done to ensure that sufficient populations of these breeds are maintained on the continent.

The trends in populations of FAnGR are also presented in this publication, information which provides a current baseline that will allow changes in FAnGR to be monitored and trends examined. The publication also gives the distribution of transboundary breeds of the five main livestock species (cattle, sheep, goats, pigs and chickens).

The status of characterisation, inventory and monitoring of FAnGR in Africa is provided to enable proper identification, recording, monitoring, protection and utilisation of the resources sustainably. The publication examines the status of phenotypic and molecular characterisation, inventory and surveying, and provides an update on the role, progress made in the development of FAnGR and challenges faced in the past and present. It also assesses the potential for development of FAnGR in Africa. New opportunities and steps being taken to characterise (both phenotypic and molecular) FAnGR in Africa, and to take regular inventories and surveys are also presented.

The information provided on breeds and their geographical distribution suggests the approaches needed for genetic improvement and the populations to be characterised. This, in turn, will provide evidence to inform policy decisions on both genetic improvement and conservation. The document reports on breeds at risk of extinction and highlights the present threats to FAnGR in Africa and the inter-related drivers that have negatively impacted on FAnGR including technological advances, consumer preferences, the demands of the global market, the demographic and climatic changes, resource scarcity, policy and legislative drivers, and indiscriminate crossbreeding.

Details of genetic improvement and conservation programmes in Africa are provided. These details vary according to regions, the status, challenges, constraints and opportunities for animal identification and recording. The potential uses of animal recording systems in Africa are also provided. Although genetic improvement methods implemented differ, two major trends emerge, namely conservation and genetic improvement of local breeds through selection, and altering the gene pool of animals by introducing external genes via crossbreeding or other advanced breeding techniques.

There are various constraints hampering the wider implementation of genetic improvement and conservation programmes that require greater attention, including developing realistic and supportive breeding policies. Institutional policy and legislative frameworks for genetic resources are also described in this publication and insight is given into the institutional arrangements on FAnGR utilisation and management. The document stresses on the importance of institutional arrangements in FAnGR management, and the need for developing and implementing effective policies and legislations.

The publication describes the livestock stakeholders and their roles in the management of FAnGR. It summarises the actions and stakeholder involvement to improve the evidence and promote activities and policies relevant to FAnGR. It also provides an overview of the international, regional and national policy, and legislative frameworks developed on the continent related to FAnGR, as well as the obligations and commitments that need to be met. The state of institutional capacities is also reported as well as current information systems and networks on the continent. Progress made in the various international agreements and conventions, with particular emphasis on the Nagoya Protocol on access and benefits sharing and the move towards its adoption by African countries, is reviewed.

In terms of priority actions, the publication identifies the most significant gaps and needs for conservation and use of FAnGR, and suggests the designing of strategic national, regional and international policies for the implementation

of the priority activities. Finally, some conclusions and recommendations are provided, taking into account the issues, challenges and areas that require further attention. The way forward in the sustainable utilisation of African FAnGR is proposed. Tables, figures, case studies and the lessons learnt on the utilisation, management and conservation of Africa's rich animal heritage provide illustrative backgrounds.

Diversity of production systems within species in Africa

The livestock production systems in Africa can be broadly classified into agro-pastoral and pastoral systems, mixed crop-livestock systems and landless systems. These have contributed to the production of specialised indigenous livestock breeds such as the Boran and Tuli cattle for beef in East and Southern Africa respectively, the Ashanti pig in Central and West Africa, the Boer goat for chevron production in Southern Africa, the West African Dwarf Goat in West and Central Africa, and the Barki and Beni Guil sheep for mutton in North Africa. Dairy cattle and goats, poultry, pigs and rabbits (mainly exotic breeds and their crossbreeds) are kept under intensive (stall-feeding) or semi-intensive (backyard/tethering) systems either as livestock-only or with small-scale crop production. Mixed crop-livestock systems are found in temperate and sub-humid climates with high rainfall and potential for crop-farming. Agro-pastoral and pastoral systems represent a significant proportion of the production systems on the continent.

For successful fisheries and aquaculture, appropriate production systems are essential and there are a number of options available to the fish farmers. These options have advantages and disadvantages, and there is a need to prioritise the development of systems that will significantly increase productivity. The systems and technology used in fisheries and aquaculture have developed rapidly in the last 50 years. They vary from very simple facilities to high technology systems. Five main production systems can be listed in the fisheries sector, namely, the cage culture system, the pond culture system, the recirculating aquaculture systems, the longlines systems and the flow-through systems.

Africa is endowed with various honeybee flora, which create fertile ground for the development of beekeeping. Bee production systems include: (i) the migratory beekeeping production system where hives are systematically migrated for honey production and for crop pollination, (ii) the traditional beekeeping representing the oldest and the richest practice, which has been carried out for many years, (iii) the transitional system, and (iv) the modern

system of beekeeping that aims at obtaining maximum honey crop, season after season, without harming the bees.

FAnGR in Africa

Africa's FAnGR are renowned for adaptation to their local and similar environments. Most countries have at least one livestock breed used by farmers that is considered to be well adapted to the local environment such as heat stress, diseases, parasites, and limited availability of feed and water.

A total of 2, 250 breeds for the conventional (1,819) and non-conventional (431) species were reported for the whole continent. The total number of indigenous breeds is 1,099 comprising the following: cattle, 444; sheep, 284; goats, 212; pigs, 50; and chickens, 109. For exotic breeds in Africa, a total of 720 were reported. This comprises the following: cattle, 248; sheep, 79; goats, 77; pigs, 96; and chickens 220. African countries are home to local specialised beef cattle and specialised multipurpose cattle breeds with potential to make a substantial contribution to the world beef trade. The numbers of local specialised beef cattle, specialised multipurpose cattle, camel, goat and sheep breeds are higher than those of exotic breeds.

The high number of breeds in Africa indicates their importance. Africa has a rich biological diversity of native fish resources with more than 2,608 unique freshwater species and 842 marine species. For marine and coastal aquaculture, 59 taxonomies were reported while for inland aquaculture 69 were reported. The relatively few species farmed in Africa demonstrates the potential for further use of aquatic genetic resources in aquaculture on the continent.

About 6,591 bee breeds occur in Africa. The bee fauna can be described as moderately diverse, with six of the seven bee families officially recognised. In 2013, there were about 10.6 million managed hives in East Africa. Reasonable round estimates of managed hives in Central Africa and North Africa were 3.2 million and 2.5 million respectively. Awareness and scientific understanding of emerging or non-conventional species is increasing and the development of this sector has been shown to be important in not only fulfilling nutritional and income-generating requirements, but also serving to protect the environment.

Unconventional animal species are currently not utilised to their full potential and have much to offer. The distribution of buffaloes is considerably reduced. In many areas they are largely limited to reserves, with their population at approximately 4.8 million head. East Africa has a total population estimated at between 500,000 and 1 million head for the three sub-species of savannah buffalo.

The total donkey population in Africa is 20 million head. There have been population fluctuations over the years across the continent, with increases in the semi-arid areas of the continent, notably in East, North and West Africa. The horse population has gradually increased since 2000 from 4.3 million to 6.1 million head.

The total number of rabbits was approximately 18.8 million head in 2014; their population trend in Southern and Central Africa was low and stable from 2000 to 2014. It was static in North Africa until 2010 and increased thereafter. A similar trend was observed in East Africa. In West Africa, the rabbit population doubled between 2009 and 2010. Several countries, among them Ghana, Kenya, Malawi, Mauritius, Mozambique, Nigeria, Sudan, Tanzania, Togo and Zambia now have national rabbit-rearing programmes.

There are significant numbers of regional transboundary breeds for most species, which highlight the need for cooperation at regional or sub-regional levels in order to ensure sustainable development, utilisation, management and conservation of these resources.

Characterisation, inventory and monitoring of FAnGR

Characterising and taking inventory of FAnGR are important for the management of these resources. Approximately, 43 per cent of the countries in Africa have mandated key government departments or institutions under the line ministries to monitor their FAnGR. Of these countries, 25 per cent have indicated that actions of the mandated institutions are planned. The major constraint in these countries remains inadequate budgets. Currently, most African countries integrate the collection of data on FAnGR within their national human and housing population censuses. However, records have often shown that this approach does not capture the true status of FAnGR in those countries. Information suggests that approximately 40 per cent of the countries have not made any progress at the national level in establishing an inventory of their FAnGR. Some 81 per cent of the countries reported that baseline surveys were undertaken before and after the adoption of the Global Plan of Action (GPA) whereas 19 per cent indicated that the baseline surveys were undertaken only for some species.

Threats to FAnGR

The analyses show that there are numerous breeds of livestock that are considered endangered, due to genetic dilution, or are at risk of extinction. Examples are the Kouri cattle found around Lake Chad, the Lagune cattle,

the Baoulé cattle (West Africa) and the Desert Goat (Algeria). There is an urgent need to conserve these breeds. For nearly 90 per cent of the countries, the main threats associated with loss of breed numbers or diversity in FAnGR were reported to be the lack of conservation programmes. The other main threat mentioned by 86 per cent of countries was lack of understanding on the true value of many of the FAnGR. Some 81 per cent of the countries identified crossbreeding as a main threat associated with loss of breed numbers or diversity in their countries. Disease outbreaks and impacts of climate change were the next important factors identified by 69 per cent of the countries as being threats associated with loss of breeds. This was followed closely by policy issues (67 per cent of countries) and intensification of agriculture (60 per cent of countries). The factors least identified by countries were the lack of reproductive technologies (36 per cent of countries) and the export of animals (26 per cent of countries).

Farm Animal Genetic improvement programmes

There is an increasing interest in animal identification and recording systems in Africa. Although most of the countries surveyed reported activities on the identification and recording of individual animals, these figures largely reflect what is happening at national research and breeding stations, and at a few commercial farms. There is little or no recording taking place in the smallholder sub-sectors. Governments are the most involved with identification of livestock species. Other key players include breed associations and a few individual commercial farmers.

The analysis of information on the development of artificial insemination (AI) shows that African governments are encouraging the use of AI to improve the national herds and flocks. In the majority of the countries, the need to quickly increase the number of dairy animals required to increase milk production has led to the establishment of local centres for semen collection. AI is widely used for cattle, and to a lesser but increasing extent, for other species such as pigs. Embryo transfer activity is still developing in Africa and national governments play a vital role in the provision of embryo transfer services. Multiple ovulation and embryo transfer (MOET) has been practised in specialised centres in Africa since 1930. However, the impact has not been significant for small-scale farmers.

Several attempts to improve FAnGR in Africa have been made, mainly by 'upgrading' with temperate breeds in crossbreeding programmes. Some remarkable results, especially for meat production in different species,

have been obtained from well-designed crossbreeding schemes such as in Zimbabwe and several countries in East Africa. The introduction of exotic genetic material is often not controlled and invariably results in haphazard mating systems. The sustainability of these programmes has often been hampered by the inability of government breeding stations and farmers' herds to produce adequate numbers of the desired crossbred genotypes to meet demand. The lack of exit strategies to ensure continued provision of crossbreeds when government or donor funding runs out has been another obstacle to sustainable crossbreeding programmes. Consequently, smallholder dairy producers have often resorted to milking their low yielding indigenous cows as a result of shortage of crossbred females.

A number of selection programmes have existed or exist in Africa where FAnGR are introduced into communities for 'improvement' purposes by government departments, NGOs, donor organisations, private companies or charities. South Africa is one of the few countries in Africa with genetic evaluation programmes. Participation of smallholder farmers has not always been considered in the design of these improvement programmes. Financial and other constraints at breeding stations have hindered increase in the populations of the improved herds or flocks. Furthermore, the general absence of appropriate strategies and schemes for the multiplication and dissemination of the improved indigenous breeding stock has limited their utilisation. It is noted that individual farmers do not always have breeding strategies and in some cases, are at variance with stated government policies.

In fisheries, selection programmes have been haphazard, and the limited results have not reached farmers. Poor broodstock management has led to inbreeding on fish farms and at research stations. In a few countries, selection for emerging or non-conventional livestock species and breeds has been implemented (the grasscutter in Benin and buffalo in Egypt). Community-based breeding programmes (CBBP) have been run in various locations across the continent. Community-based breeding programmes are considered as pathways to participatory genetic improvement of livestock in Africa.

To set up conservation programmes, countries often consider mainly the genetic uniqueness, the cultural or historical importance, the production traits and the risk of extinction of the breeds. Conservation practices are limited in most African countries, with in vivo conservation as the most common and readily available option. Most conservation programmes are initiated either by the governments or research institutions. In vivo conservation is also practised by pastoralists and small-scale farmers who keep the breeds. Currently, the practice of ex situ conservation is quite low due to lack of appropriate

technology and expertise. Only 12 countries reported that they participate in vitro conservation activities. Efforts have been made by the African Union and countries to establish and operate regional and continental gene banks.

Institutional policy and legislative frameworks

Few African countries have stand-alone livestock policies. Most of the countries have their livestock policy embedded in the general agricultural policy. Some countries have policies and legislation directly formulated and designed for the management of FAnGR. However, the legislation mainly relates to prohibition or control of imports and exports of FAnGR. This narrow focus on trade and health-related issues emanate from the fear of spreading animal and zoonotic diseases, and does not provide conducive environments for the development of the wider FAnGR sector. There are no clear policies and legislation targeting transboundary FAnGR, yet many of those FAnGR transcend borders of various countries. Almost all countries in Africa do not have formal policies and legislation targeting crossbreeding.

Several countries have identified the existence of gaps in the development and implementation of the FAnGR policies and legal instruments. Subsequently, 30 of them have addressed FAnGR in the National Livestock Sector Strategy Plan or Policy. Governments have established ministries and provided them with responsibilities to implement policies related to food and nutrition security. These ministries are also charged with the conception, implementation, coordination and assessment of policies in domains such as agriculture, livestock, forestry, fisheries and rural development. They have also put in place institutions with specialisation on FAnGR and breeding, and significant infrastructure to pursue their objectives. Despite the existence of numerous institutions within the ministries (Agriculture, Livestock, Fisheries Environment or Natural Resources) dealing with aspects of FAnGR, there is a general lack of focus and coordination in addressing issues related to their management. There are noticeable deficiencies of coordination among the different national institutions in various countries. Policies, where they exist, are often in different institutions; their harmonisation becomes a challenge hence reducing their effectiveness.

On the establishment of institutional mechanisms that enable the development of FAnGR, 60 per cent of the countries confirmed that such mechanisms exist. In terms of coordination mechanisms on FAnGR and on conservation objectives, 55 per cent of the countries acknowledged the existence of such mechanisms. Most of them (52 out of the 54 countries) have,

under the framework of the Global Plan of Action, established National Focal Points (NFPs). These are generally anchored in the ministries in charge of livestock. National Focal Points (NFP) are institutional structures nominated by the government to oversee the management and development of FAnGR. Many countries in Africa have not yet established and implemented their National Strategies and Action Plan (NSAPs) for FAnGR within their livestock policies. This is due to several challenges such as funding.

Africa has made efforts in the process of establishing or strengthening Sub-Regional Focal Points (S-RFP) with elected steering committees for the management of FAnGR in all the five regions. Several governments have put in place mechanisms to facilitate interactions among agencies dealing with FAnGR and within the livestock sector in general. Regional Economic Communities – Southern African Development Community (SADC), Economic Community of West African States (ECOWAS), Intergovernmental Authority on Development (IGAD) and East African Community (EAC) – have or are in the process of developing their FAnGR policies and legislative frameworks and action plans for their implementation.

In 45 per cent of the countries, breeders or farmers' associations were considered organised enough to be involved in the discussions and/or development of FAnGR. The national and regional livestock associations such as the East and Southern Africa Dairy Association (ESADA), the East Africa Farmers Federation (EAFF), the West African Shorthorn Breeders Association (WASHBA), the National Azawak Breeders Association of Burkina Faso (UNEAB), Réseau de Communication sur le Pastoralisme (RECOPA) of Burkina Faso, the Pig Farmers Association of Nigeria (PigFAN), the Coopérative TIWAT de Filingué in Niger (Breeders of the Azawak cattle), the National Association for Sheep and Goat Breeders (ANOC), the Sheep and Goat Associations of the Maghreb Union (UMAOC) and the Cattle Breeders Associations of the Maghreb Union (UMAEB) have moved forward the agenda of conservation and sustainable utilisation of FAnGR.

Capacity in the management and development of FAnGR is lagging behind for many reasons. These include the lack of specialisation among African university faculties in the area of FAnGR, and the perceived or real complexity of the course in animal breeding and genetics (biometrics and quantitative tools used).

The African Animal Genetic Resources Information System (AAGRIS) is a module hosted within the core area of animal production in the Animal Resources Information System (ARIS) of AU-IBAR and is envisioned as a

one-stop shop for FAnGR that allows a wide range of end-users, particularly policy makers, to access knowledge and data to inform decision-making processes, especially on policies and legislation. In the SADC region, the Livestock Information Management Systems (LIMS) is hosted by the SADC Secretariat. The Ethiopian Livestock Market Information System is linked to the Livestock Information Network Knowledge System (LINKS), and delivers early warnings on livestock market information.

Thirty-one (31) countries have signed the Nagoya Protocol (including Morocco) and 27 have so far ratified it. The Nagoya Protocol, being the latest of the international protocols on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation, is of special importance to Africa due to the vast diversity of the genetic resources that has attracted global interest and potential exploitation in the future.

Priority Areas for Enhanced Sustainable Management of FAnGR

The animal breeding sector is offering innovative possibilities for FAnGR improvement and conservation in Africa. Key priority areas identified and proposed for the development of FAnGR in Africa are:



List of Acronyms and Abbreviations

AAGRIS	-	African Animal Genetic Resources Information System
ADB	-	African Development Bank
ADC	-	Agricultural Development Corporation
AI	-	Artificial Insemination
ALICE	-	African Livestock International Conference and Exhibition
ANEP	-	l'Association Nationale des Éleveurs de Porcs [National Association of Pig Rearers]
AnGR	-	Animal Genetic Resources
ANOC	-	National Association for Sheep and Goat Breeders [Association Nationale Ovine et Caprine]
ANOPER	-	Association Nationale des Organisations Professionnelles d'Eleveurs de Ruminants [National Association of Professional Organisations of Ruminant Breeders]
ARC	-	Agricultural Research Council
ARDEC	-	Research Institute-Aquaculture Research and Development Centre
ARDI	-	Association Rwandaise pour la Promotion du Développement Intégré [Association for Promotion of Integrated Development in Rwanda]
ARIS	-	Animal Resources Information System
ASARECA	-	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	-	African Union
AU-IBAR	-	African Union - InterAfrican Bureau for Animal Resources
AU-PANVAC	-	African Union - Pan African Veterinary Vaccine Centre
BCC	-	Beekeeping Collection Centres
BecA Hub	-	Biosciences Eastern and Central Africa, with its Hub at ILRI
BLUP	-	Best Linear Unbiased Prediction
CAADP	-	Comprehensive Africa Agriculture Development Programme
CABI	-	Centre for Agriculture and Bioscience International
CAHWs	-	Community Animal Health Workers
CBBP	-	Community-Based Breeding Programmes

CBD	-	Convention on Biological Diversity
CBOs	-	Community-Based Organisations
CBPP	-	Contagious Bovine Pleura-Pneumonia
CCARDESA	-	Centre for Coordination of Agricultural Research and Development for Southern Africa
CEBEVIRHA	-	Commission Economique du Bétail, de la Viande et des Ressources Halieutiques Atelier [Economic Commission for Meat and Fish Resources]
CECURI	-	Centre Cunicole de Recherche et d'Information [Benin]
CGRFA	-	Commission on Genetic Resources for Food and Agriculture
CIAT	-	International Center for Tropical Agriculture [Centro Internacional de Agricultura Tropical]
CICs	-	Community Information Centres
CIRDES	-	Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide [Bukina Faso]
CMAP	-	Centre National de Multiplication des Animaux Performants
CNAG	-	Centre Nationale dAmélioration Génétique
CNERV	-	National Centre for Animal Husbandry and Veterinary Research
COP	-	Conference of the Parties
CORAF/ WECARD	-	West and Central African Council for Agricultural Research and Development
CSIR	-	Council for Scientific and Industrial Research [Ghana]
DAFF	-	Department of Agriculture, Forestry and Fisheries [South Africa]
DAHLD	-	Department of Animal Health and Livestock Development [Malawi]
DNA	-	Deoxyribonucleic Acid
DPFO	-	Developing Poultry Farmers Organisation
DRC	-	Democratic Republic of Congo
DZARC	-	Debre Zeit Agricultural Research Centre
EAC	-	East African Community
EAFF	-	East Africa Farmers Federation
EBI	-	Ethiopian Biodiversity Institute
EBVs	-	Estimated Breeding Values
ECOWAP	-	ECOWAS Agricultural Policy
ECOWAS	-	Economic Community of West African States
ECRMP	-	Eastern Cape Red Meat Project

EISMV	-	École Inter États des Sciences et Médecine Vétérinaires de Dakar
ESADA	-	East and Southern Africa Dairy Association
ET	-	Embryo Transfer
ETLMIS	-	Ethiopian Livestock Market Information System
EU	-	European Union
FAnGR	-	Farm Animal Genetic Resources
FAnGR-CIM	-	Farm Animal Genetic Resources-Characterisation, Inventory and Monitoring
FAO	-	Food and Agriculture Organisation [of the United Nations]
FARM-Africa	-	Food Agricultural Research Management in Africa
FMD	-	Foot and Mouth Disease
GCRB	-	Germplasm Conservation and Reproductive Biotechnologies
GDP	-	Gross Domestic Product
GIFT	-	Genetically Improved Farmed Tilapia
GILMA	-	Gambia Indigenous Livestock Multiplier Association
GPA	-	Global Plan of Action
GTZ	-	German Development Corporation [Gesellschaft für Technische Zusammenarbeit]
HBU	-	Heifer Breeding Units
HIC	-	Heifer International Cameroon
HLPE	-	High Level Panel of Experts [on Food Security and Nutrition]
HPI	-	Heifer Project International
IAC	-	Inter Academy Council
IAEA	-	International Atomic Energy Agency
IBRA	-	International Bee Research Association
ICAR	-	International Committee for Animal Recording
ICARDA	-	International Centre for Agricultural Research in the Dry Areas
ICIPE	-	International Centre for Insect Physiology and Ecology
ICLARM*	-	International Centre for Living Aquatic Resources Management
IGAD	-	Intergovernmental Authority on Development
ILCA	-	International Lactation Consultant Association
ILRI	-	International Livestock Research Institute
INAT	-	Institut National Agronomique de Tunisie [National Agricultural Institute of Tunisia]
InCIP	-	Indigenous Chicken Improvement Programme
INRA	-	Institut National de la Recherche Agronomique [National Institute of Agronomic Research of Morocco]
INRAA	-	National Institute of Agronomic Research of Algeria [National

		Institute of Agronomic Research of Algeria]
INRAT	-	L'Institut National de la Recherche Agronomique de Tunisie [National Agricultural Research Institute of Tunisia]
IPA	-	Instituto de Produção Animal [Institute of Animal Production-Mozambique]
IPAL	-	Integrated Project on Arid Lands
IRAD	-	Institut Régional de Recherche Agricole [Agricultural Research and Development Institute – Cameroon]
ITC	-	International Trypanotolerance Centre
KAGRC	-	Kenya Animal Genetic Resources Centre
KARI	-	Kenya Agricultural Research Institute
KCA	-	Kenya Camel Association
KDPG	-	Kenya Dual Purpose Goat
KLBO	-	Kenya Livestock Breeders Organisation
KLPA	-	Kenya Livestock Producers Association
KMFRI	-	Kenya Marine and Fisheries Research Institute
KSB	-	Kenya Stud Book
LBDA	-	Lake Basin Development Authority
LIDeSA	-	Livestock Development Strategy for Africa
LIMS	-	Livestock Information Management System
LINKS	-	Livestock Information Network Knowledge System
LITS	-	Livestock Identification and Traceability System
LMU	-	Livestock Multiplication Units
LRC	-	Livestock Recording Centre
MAS	-	Marker Assisted Selection
MGBA	-	Meru Goat Breeders Association
MINEPIA	-	Ministre de l'Elevage, des Pêches et des Industries Animales [Ministry of Livestock Fisheries and Animal Industries – Cameroon]
MLD	-	Ministry of Livestock Development
MOET	-	Multiple Ovulation and Embryo Transfer
MoU	-	Memorandum of Understanding
NABP	-	National Animal Breeding Programme
NAGRC&DB	-	National Animal Genetic Resources Centre and Data Bank
NAMC	-	National Agricultural Marketing Council [South Africa]
NAPRI	-	National Animal Production Research Institute [Nigeria]
NARS	-	National Agricultural Research System
NEPAD	-	New Partnership for Africa's Development

NFP	-	National Focal Points
NGO	-	Non-Governmental Organisation
NM-AIST	-	Nelson Mandela–African Institution of Science and Technology
NPDP	-	National Poultry Development Programme
NSAPs	-	National Strategy and Action Plans
NSBA	-	Namibian Stud Breeders Association
NWGA	-	National Wool Growers Association
NZG	-	National Zoological Gardens [South Africa]
OIE	-	Office International des Epizooties [World Organisation for Animal Health
ONBS	-	Open Nucleus Breeding Scheme
PAPEL	-	Projet d'Appui à l'Élevage
PBAA	-	Project Benino-Allemand d'Aulacodiculture
PigFAN	-	Pig Farmers Association of Nigeria
PNDHD	-	Programme National de Développement Humaine Durable
PNSO	-	Programme National de Sélection Ovine [Côte d'Ivoire]
PRA	-	Participatory Rural Appraisal
PROGEBE	-	Regional Project on Sustainable Management of Globally Significant Endemic Ruminant Livestock [Projet Régional de Gestion Durable du Bétail Ruminant Endémique]
R&D	-	Research and Development
RCA	-	Rwanda Cooperative Agency
RECOPA	-	Réseau de Communication sur le Pastoralisme
RECs	-	Regional Economic Communities
REML	-	Restricted Maximum Likelihood
REVs	-	Relative Economic Values
RFPs	-	Regional Focal Points
SADC	-	Southern African Development Community
SAPPO	-	South African Pork Producers Organisation
SBA	-	Sicilo-Sarde Breed Association
SEAFMD	-	South-East Asia Foot and Mouth Disease
SLU	-	Swedish University of Agricultural Sciences [Sveriges Lantbruksuniversitet]
SNL	-	Swazi National Land
SNP	-	Single Nucleotide Polymorphism
SODEPA	-	Société de Développement et d'Exploitation des Productions Animales
SOW-AnGR	-	State of the World Animal Genetic Resources

SR-CRSP	-	Small-Ruminant Collaborative Research Programme
S-RFP	-	Sub-Regional Focal Points
SSR	-	Single Sequence Repeat
SWOT	-	Strengths, Opportunities Weaknesses and Threats
TCP	-	Turkana Camel Project
TREMU	-	Turkana Rangeland Monitoring and Evaluation Unit
UEA	-	Université Evangélique en Afrique
UEMOA	-	Union Economique et Monétaire Ouest Africaine [West African Economic and Monetary Union]
UMAEB	-	Cattle Breeders Associations of the Maghreb Union
UMAOC	-	Sheep and Goat Associations of the Maghreb Union
UNDP	-	United Nations Development Programme
UNEAB	-	National Azawak Breeders Association of Burkina Faso
UNESCO	-	United Nations Educational, Scientific and Cultural Organisation
UNSIC	-	United Nations System Influenza Coordination
USAID	-	United States Agency for International Development
USDA	-	United States Department of Agriculture
WALIC	-	West Africa Livestock Innovation Centre
WASHBA	-	West African Shorthorn Breeders Association

CHAPTER ONE

Introduction



Magnificent horns of the Inyambo cattle of Rwanda
Photo courtesy: Ministry of Agriculture and Animal Resources, Rwanda

The African livestock sector contributes between 30 and 80 per cent of the agricultural Gross Domestic Product (GDP), and has the potential to deliver both the agricultural-led growth and the socio-economic transformation as envisioned in the June 2014 African Union (AU) Malabo Declaration on Accelerated Africa Agriculture Growth and Transformation for shared prosperity and improved livelihoods (African Union, 2014). Staal et al. (2009) reported that 81 million and 28 million people in West Africa and Southern Africa, respectively, are dependent on income generated from small ruminants. It is estimated that over 80 per cent of rural population in Africa consists of smallholder livestock keepers (FAO, 2009; Hanotte et al., 2010).

Livestock are central to the livelihoods of African communities. They contribute significantly to the continent's food and nutritional security, and economy through intra-African and global trade (Steinfeld et al., 2006a; AU-IBAR, 2015; de Haan, 2016). Livestock products such as meat and milk contribute up to 13 per cent of the world's calorie intake; they are very rich sources of protein and some essential amino acids (FAO, 2009; 2011a; Smith et al., 2013). Indeed, livestock hold the key to poverty alleviation, and contribute significantly towards food and nutritional security (Smith et al., 2013). In addition, the purposes of raising livestock go beyond their products and include other significant socio-economic and socio-cultural roles such as savings, insurance, cyclical buffering, wealth accumulation and diversification, as well as various socio-cultural and traditional roles, some related to status of their owners (Thornton, 2010). There is a rising demand for foods obtained from animal products among the expanding number of urbanised consumers, and the general increases in the standards of living in many African countries (Delgado et al., 1999; 2005; Thornton, 2010; AU-IBAR, 2015).

Farm Animal Genetic Resources (FAnGR) for food and agriculture (both terrestrial and aquatic) are extremely important for millions of people, and play critical roles in the economic, food and nutritional security of the inhabitants of Africa and other continents (FAO, 2007; 2015). They are extremely rich and are a result of various actions including migrations, introduction of new breeds into the continent and their admixture with the indigenous breeds found locally, and the recent domestication of new species which were previously in the wild (Hanotte et al., 2002; Kumar et al., 2003).

Breed development is closely correlated with economic development, such that performance specialisation, market demands and the need for

more controlled and intensive production have encouraged the widespread use of a few genetically improved species of the so-called 'conventional livestock'. Five domestic animal species contribute significantly to the daily needs of food, shelter and energy. These include cattle, sheep, goats, pigs and poultry (chicken). Because of climatic and ecological diversity, as well as the different levels of economic development in various parts of Africa, there is a large number of other animal species that are potentially suitable for domestication and commercial production. These have often been termed as 'emerging or non-conventional' species, which are sources of food and nutrition for millions of people on the continent (Hardouin, 1995). They display a wide range of Darwinian adaptations that continually evolve due to the ever-changing ecosystems. They include ostrich, ilama, donkey, horse, pony, buffalo, rabbit, hare, dromedary, deer, grasscutter, guinea pig/cavy, crocodile, giant snail, frog, bees, insects and farmed fish. Peters (1987) has provided a classification of those species.



Photo Courtesy: Ministry of Agriculture, Eritrea

Figure 1: Drought-resistant Langie goats found in Eritrea

Commercial exploitation of these non-conventional FAnGR is justified on the following grounds: firstly, they are adapted to harsh environments and can utilise natural resources that conventional stock cannot, and they are suitable for complementary production with conventional species, which enables stratified utilisation of vegetation. Secondly, integrating

them into modified or intensified production systems enables more efficient recycling of nutrients in the ecological chain. Thirdly, many of the smaller non-conventional animals are relatively easy to feed, manage and handle, and can, therefore, be raised by landless and smallholder farmers within the household (Hodasi, 1984; Vietmeyer, 1984; Mongin and Plouzean, 1984; Müller-Heye, 1984; Mensah, 1985; Pich and Peters, 1985; NRC, 1991; Hardouin, 1995; Juste et al., 1995).

The potential of the FAnGR sector in Africa has not been fully exploited in order to significantly contribute to economic and social well-being, reduce poverty, create wealth, strengthen food security and health, and accelerate economic growth (Herrero et al., 2014; ADB, 2015). The sector is facing numerous challenges. The lack of good quality animal feed is perhaps the most critical constraint to increasing FAnGR productivity. A rapid increase in some animal populations has put severe constraints on the ability of the farmers to adequately feed them in order to raise productivity per animal and per unit of land. Poor feeding has limited the ability of animals to express their genetic potential and has hindered the impact of technology interventions, including artificial insemination and oestrus synchronisation. Improving the genetic potential of the animals is one of the keys to achieving food and nutrition security, and better lives through FAnGR (ADB, 2015).

Despite the abundance of FAnGR in Africa, and the depth of research and the quantity of available technologies, there have been few sustained attempts to improve indigenous breeds through crossbreeding or selection. Even with vast improvements in the coverage and quality of animal health services in some countries in Africa, service provision remains less than satisfactory. Endemic diseases have limited FAnGRs productivity and agricultural development (ADB, 2015). Despite the potential, the FAnGR sectors in many African countries are generally characterised by the absence of an effective enabling policy and institutional environment, leading to sub-optimal levels of productivity, supply and competitiveness, and limited market orientation. A lack of policies and support facilitating private sector involvement in key areas of animal health, genetics and breeding, and land use for FAnGR-related value chains have constrained development of the sector, particularly access to land for the production of feeds and forage (Kamuanga et al., 2008; ADB, 2015).

The value of indigenous FAnGR has not attracted awareness and is not adequately understood or recognised. This has significantly contributed

to the lack of concerted efforts to ensure the survival of valuable African FAnGR. The indigenous FAnGR are a genetic treasure. They exhibit unique and rare adaptive attributes. Examples of these adaptive traits include disease resistance and tolerance found in the N'Dama and the Sheko cattle, which are trypanotolerant (Mattioli et al., 2000; Lemecha et al., 2006), the Red Maasai sheep, which are resistant to intestinal parasitic worms (Baker et al., 2003), and indicine cattle breeds, which are tick-resistant (Piper et al., 2008). These adaptive traits, developed over generations under harsh environmental conditions, are the foundation for future generations of FAnGR that can be expected to withstand emerging adversities such as climate change.



Photo Courtesy: Ministry of Food and Agriculture, Ghana

Figure 2: Flock of indigenous chickens found in Ghana

Although it is often considered that the productivity of important producers such as milk, meat and eggs is considerably lower in indigenous breeds compared to their exotic counterparts, lifetime production of these breeds under harsh production conditions experienced by most livestock keepers in Africa often makes them more productive and sustainable than exotic breeds under the same conditions. These breeds are generally more productive in environments where exotic breeds would not survive. It is, therefore, important to take the economic merits of the indigenous

breeds into consideration when making comparisons with the exotic types (Wollny, 2003).

The State of Farm Animal Genetic Resources in Africa provides a comprehensive assessment of the state of animal diversity and its management on the African continent. It is envisioned to steer the continent towards food and nutrition security, eradication of poverty and enhanced livelihoods of animal resources-dependent communities through the efficient utilisation and conservation of indigenous breeds. It highlights the diversity, the importance and the uses of other species that are important in some regions. Insights into the status of characterisation, inventory and monitoring in Africa are provided.

The publication is based on information and analysis of data collected from various sources. Some sections of the publication are largely based on the information provided in the country reports to the first global assessment on the State of the World's Animal Genetic Resources (SOW-AnGR) (Country Reports, available in June 2005) and the Second global assessment on the State of the World's Animal Genetic Resources (Country Reports available in February 2014), as well as the FAO statistical database.

In addition, a structured questionnaire was administered to all countries by AU-IBAR in order to get an update on the status of the breeds, and to seek information on the flows of FAnGR, livestock sector trends, overview of FAnGR, characterisation, institutions and stakeholders, breeding programmes, conservation, reproductive and molecular biotechnologies, and integration of the management of FAnGR within policies and legislations. A total of 44 responses were extracted and analysed. In order to corroborate the data provided by the countries and to obtain more detailed information, additional information was gathered from the wider literature or from expert knowledge. This included general development assistance planning and poverty reduction strategies, as well as sectorial strategic plans, such as National Strategies and Action Plans, published reports and documents, as well as relevant tools and guidance notes.

The publication encourages the uptake of new biotechnologies related to the development and management of FAnGR. It highlights the present threats to FAnGR in Africa and offers some recommendations to stakeholders on what actions need to be taken to address these threats. It also highlights the status of animal identification and recording, and provides information on the genetic improvement and conservation programmes that have been implemented, including on bees and fish. It describes the

state of the institutional capacities, the stakeholders and their roles in the management of genetic resources as well as outlining the present policy and legislative frameworks on FAnGR in Africa.

The document showcases the current information systems and networks on the continent and further reviews the progress made in light of various international agreements and conventions, with particular emphasis on the Nagoya Protocol on access and benefit sharing, and the move towards its adoption by the countries. Best practices are provided, with a robust set of recommendations towards the utilisation, management and conservation of Africa's rich animal heritage.



Caravan of horses
in Chad

Photo Courtesy: Ministry of Livestock, Chad

CHAPTER TWO

Animal Production Systems in Africa



Rumpless indigenous cock
Photo Courtesy: Ministry of Agriculture and Food Security, Malawi

Africa is home to diverse animal production systems, ranging from nomadic, pastoral, through to ranching and intensive systems. Similarly for fisheries, depending on whether it is capture marine, capture inland or aquaculture, the levels of sophistication in production vary from traditional/subsistence or artisanal to high technology systems. This chapter attempts to describe the various animal production systems prevailing in most parts of Africa.

Livestock production systems

Farming systems in Africa are diverse in terms of the available crop and livestock enterprises, and the agro-ecological zone (IAC Report, 2004; Dixon et al., 2001). The livestock production systems, a sub-set of the broader farming systems, are described in Seré and Steinfeld (1996), and FAO (2007; 2015). There is, however, no single system of classification of the systems that can be mapped across all the regions of Africa (Herrero et al., 2010; Robinson et al., 2011). Key factors that determine the characterisation of livestock production systems are outlined by Steinfeld et al. (2006b), Herrero et al. (2010; 2014), and FAO (2007; 2015). These include the size of the land holding on which the animals are reared, the environmental conditions and precipitation in the area in which the animals are kept, management practices, the use of the animal products and the density of livestock.

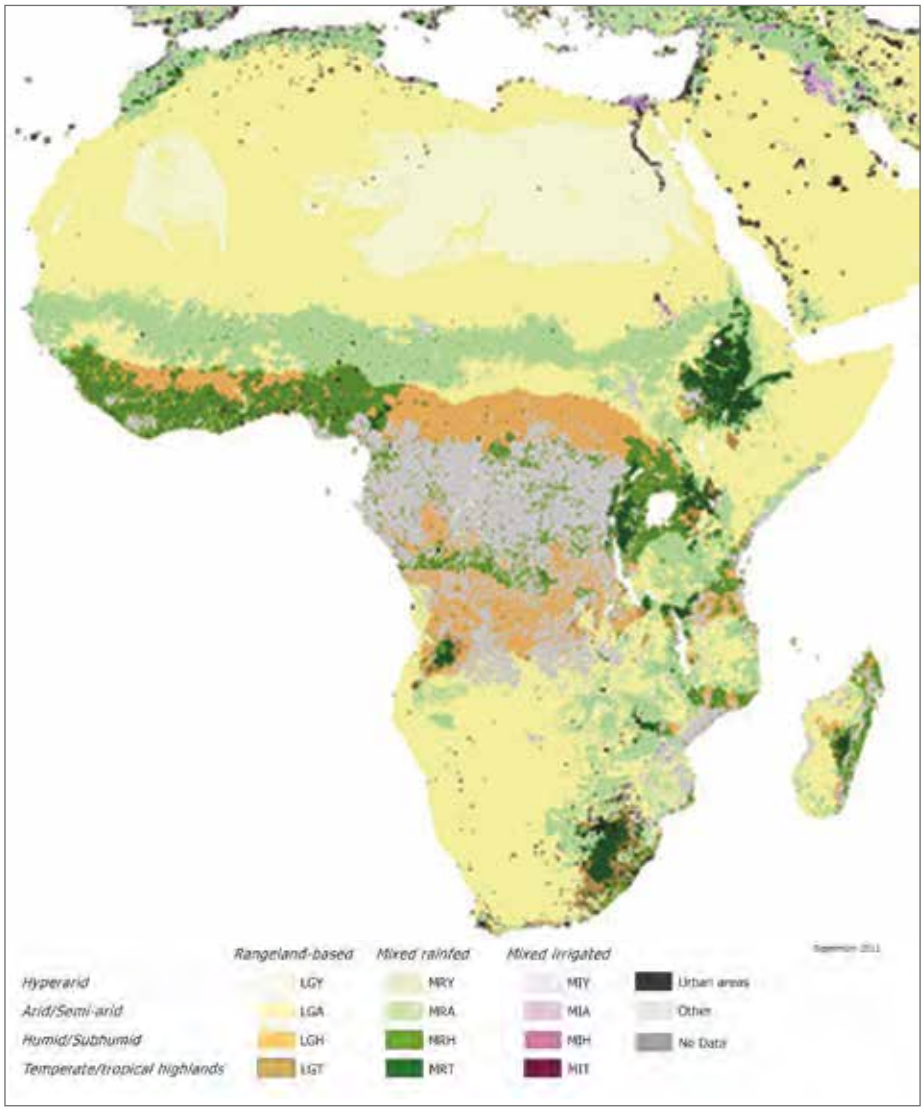
Figure 3 shows the livestock production systems in Africa, which can be broadly classified as follows: i) agro-pastoral and pastoral systems; ii) mixed crop-livestock systems; and, iii) landless systems (Herrero et al., 2010). Within these groups, livestock are reared under different management practices and scales of operation.

Agro-pastoral and pastoral systems

These types of livestock production systems consist of:

- *Large-scale extensive pastoral and transhumance systems*, which are found in arid and semi-arid areas of the continent, where potential for crop-farming is low. Livestock comprises mainly indigenous breeds of cattle, sheep, goats and camels. They are the key livelihood assets for the communities. Land is generally owned by communities rather than individuals. The systems are faced with challenges of fodder and grazing shortages,

water availability and sporadic, often devastating, disease outbreaks, frequent droughts and the fact that animals have to walk long distances in search of water and pasture. Weak policies on management of the natural resources in the arid areas and the high mobility of the livestock result in low quality products with limited access to markets.



Source: FAO/ILRI (2011)

Figure 3: Livestock production systems in sub-Saharan Africa, extended to include cropping systems

- *Large-scale extensive commercial systems (or ranching)*, which represent a relatively small but critical proportion of the production systems on the continent. Land ownership under these systems is either by individuals, commercially organised groups or government-run institutions. Livestock reared include cattle, sheep, goats, camels and buffaloes. Locally adapted exotic animals, indigenous breeds and crosses between them are reared for commercial production of meat, milk, hides and skins. In the southern region of the continent, and in some countries of East Africa, robust programmes for selective breeding and improvement of indigenous breeds are managed within these systems. This has greatly contributed to the production of specialised indigenous livestock breeds such as the Boran and Tuli cattle for beef in East and Southern Africa, local indigenous pig breeds like the Ashanti pig in Central and West Africa, the Boer goat for chevron production in Southern Africa, Barki and Beni Guil sheep for mutton in North Africa and chevron production from West African Dwarf goat in West and Central Africa.

Mixed crop-livestock systems

In mixed crop-livestock systems, livestock production is often integrated with crop production, which is usually the main agricultural activity. The systems are found in areas of the continent that have high rainfall, such as the temperate and sub-humid climates with potential for crop-farming. Production includes rearing of various species (cattle, pigs, sheep, goats and poultry) with minimal mobility. Animal nutrition is based on farmed fodder supplemented with some commercial feeds. Depending on the species, animals reared are predominantly high yielding exotic breeds or crosses with indigenous breeds. For several reasons, and the perception that exotic breeds are more productive, indigenous purebreds are rarely reared commercially. These systems can potentially play a significant role in sustainable animal conservation and improvement programmes in Africa through innovative private-public partnerships.

Mixed crop-livestock systems involve medium to large-scale intensive commercial production as well as smallholder intensive commercial systems. Smallholder farming systems are a critical contributor to food and nutritional security in Africa. They are found in areas with high human population densities and where agricultural potential is high. They provide a variety of animal and plant foods sources and are characterised by high

production potential, small land sizes, land degradation, and competition for land use. High population growth rates have resulted in increased competition on the land use. Commercial breeds of both non-ruminant and ruminant livestock, mainly exotic and crossbred types are kept. The diversity in these systems enables positive synergies between crops and livestock, such as recycling of animal waste and crop residues, and a multifunctional use of livestock. The systems are highly prioritised for national development resource allocation in many countries.

Landless systems

In landless livestock production systems, livestock are kept on small pieces of land, mainly household backyards and yards not demarcated for the keeping of livestock (Seré and Steinfeld, 1995; FAO, 2015). There are both intensive and semi-intensive landless systems. The livestock involves small stock like pigs and poultry, though cattle and other large stock can also be kept. Dairy cattle and goats, pigs and rabbits (mainly exotic and crossbreeds) are kept under intensive (stall-feeding) or semi-intensive (backyard/tethering) systems either as livestock-only or with small-scale crop production.



Photo Courtesy: Ministry of Agriculture and Rural Development, DRC

Figure 4: Roadside grazing of N'Dama cattle in DRC

Semi-landless systems may be unique to parts of East Africa. Here, grazing land is seasonally leased out for crop production, forcing the livestock keepers to graze their livestock along the roadsides until crop residues become available (Figure 4). In West Africa, the livestock keepers are also rendered landless when they move out of the Sahel into the humid cropped lands in search of pasture and water for their animals.

Table 1 gives the main characteristics of livestock production systems and the predominant species found in the different regions of the African continent.

Table 1

Main characteristics of the livestock production systems and the predominant species in the different regions of Africa

Types of livestock production systems	Main characteristics	Predominant species	Regions
Large-scale extensive system (pastoral and transhumance)	Feeding through natural grazing Main feeds are natural grazing and planted pastures Mineral supplements are used Water sources are rivers, wells and dams Livestock are mobile Livestock housed in open sheds Veterinary care provided by government and private veterinarians Low level of mechanisation	Cattle Sheep Goats Camels Donkeys	All regions
Large-scale extensive commercial system (ranching)	Feeding is through natural grazing Feeds are natural grazing and planted pastures Mineral and protein supplements are used Water sources are water pans, dams and boreholes Livestock are mobile Animals kept in open sheds Veterinary care provided by private veterinarians Medium level of mechanisation	Cattle Sheep Goats Camels	Southern, East, North and West

Table 1

Main characteristics of the livestock production systems and the predominant species in the different regions of Africa

Medium to large-scale intensive commercial system	Animals are fed in feedlots (only for a limited period in the case of ruminants, for example, when finishing animals for slaughter) Mineral and protein supplements provided Water source is mainly piped water Livestock may or may not be mobile Animals housed in roofed sheds Veterinary care provided by government and private veterinarians High level of mechanisation	Cattle Sheep Goats Poultry Buffaloes	Southern, East, North and West
Smallholder intensive commercial mixed crop-livestock system	Exclusive stall feeding with mineral supplementation Feeds obtained from planted fodder Water source is rain and piped water Livestock are not mobile Livestock housed in roofed sheds Veterinary care provided by private veterinarians High level of mechanisation	Cattle Sheep Goats Poultry Pigs Buffaloes	East, Central, Southern and North
Intensive landless system Small-scale, medium semi-landless system	Animals mainly stall-fed Commercially sourced feeds and/or kitchen waste Animals housed in roofed sheds Veterinary care provided by government and private veterinarians Low level of mechanisation	Goats Poultry Pigs	Southern, East and Central
Small to medium-scale extensive semi-landless (road-side) system	Feeding through natural grazing and provision of crop residues There is no mineral supplementation Livestock are mobile Veterinary care provided by livestock keepers Animals housed in open kraals (traditional enclosures) Low level of mechanisation	Cattle Sheep Goats Camels	North and East

Source: Adapted from Dixon et al. (2001).

Fisheries and aquaculture production systems

Appropriate production systems are essential for successful fishery and aquaculture. The systems and technologies used have developed rapidly in the last 50 years, with a number of options now available to the fish farmers. These options vary from simple facilities (for example, family ponds for domestic consumption in tropical countries) to high technology systems (for example, intensive closed systems for export production). Each of them has advantages and disadvantages; hence, there is a need to prioritise the development of systems that will significantly increase productivity. Much of the technology used in aquaculture is relatively simple, often based on small modifications that improve the growth and survival rates of the target species, such as improving food, seeds, oxygen levels and protection from predators (FAO, 2001).

Five main production systems can be identified in the fisheries sector, namely (1) the cage culture systems, (2) the pond culture systems, (3) the recirculating aquaculture systems, (4) the longlines systems, and (5) the flow-through systems (State of Victoria, 1996).

Cage culture systems

In cage culture production systems, the fish are held in floating net pens. The individual cage units come in all shapes and sizes, and can be tailored to suit the farmer's needs. However, it is also a relatively complex culture system from technological, biological, ecological, economic and social perspectives. Cages can be used in both freshwater and marine environments.

Cage culture is an established and profitable aquaculture system in many countries; it is widely used in commercial aquaculture overseas. While the financial success of cage culture has been demonstrated in Europe, North America, Latin America and Asia, it is still in its infancy in Africa, with the cage rearing of fish having been introduced in several countries in the 1970s and only a few of these early attempts were sustainable. Recurrent barriers to sustainability included, among other factors, disease problems with cultured organisms, high investment costs combined with difficult access to credit and/or necessary materials for cage production, unavailability of cost-effective high quality fish feeds, concerns regarding the use of cages in areas considered as public domain and challenges in marketing of cage-reared products.

Although there were some intermittent efforts to introduce small-scale cage culture activities in African countries, the first major private sector-led operations were established in the lagoons of Côte d'Ivoire in the 1980s and 1990s (ICLARM and GTZ, 1991; Halwart et al., 2006). They demonstrated the technical and economic feasibility of an otherwise problematic culture system. The operations were followed by a large capital venture in cage culture on Lake Kariba in the late 1990s. Over the past several years, these reportedly lucrative enterprises have flourished and become targets for would-be investors. There are now serious candidates for medium and large-scale cage culture operations on Lakes Victoria and Malawi as well as interest in expanded production on Lake Kariba and in Côte d'Ivoire. Additionally, Burkina Faso, Cameroon, Madagascar, Mozambique and Nigeria have expressed varying degrees of interest in initiating cage culture.

Cage culture is now a serious option for aquaculture investors in Africa, with the potential of producing large quantities of fish for export and domestic markets (Halwart et al., 2006). Species grown using the system are predominantly Nile tilapia (*Oreochromis niloticus*).



Photo Courtesy: Jerome Mulumbu

Figure 5: Cage culture in the DRC

Pond culture systems

Pond aquaculture is the use of earthen impoundments, with or without drainage infrastructure incorporated, to grow fish and crustaceans. Ponds (dams) are the most widely used structures for commercial aquaculture production and are generally static (limited water exchange). Intensive

systems with higher stocking density and feed rates as well as regular water exchange (irrigation dams or flow-through systems) are also utilised. Species grown using pond culture systems include Nile tilapia, African catfish, the carps and ornamentals such as goldfish.

Pond culture is not a traditional farming practice in most parts of Africa. Introduced after World War II, there was an initial spectacular development with about 300,000 ponds being operational by the end of 1950s, mainly rearing tilapia in about 20 African countries (ICLARM and GTZ, 1991). Since then pond culture has not made much progress, and has in many cases declined, resulting in the abandonment of fish ponds by discouraged farmers.

The failure to advance fish production has been attributed to the following factors:

- Harvesting of too many small and stunted tilapia from overpopulated ponds because of poor husbandry techniques;
- Dependency on subsidised extension services and fingerling distribution centres;
- Misjudgement of the motivation of the rural fish farmers by policy makers and the creation of the myth that rural farmers will willingly take up fish farming for food security or as a source of protein for their families; and,
- Failure to apply adequate resources (which may be naturally limiting) such as water and feed.

By the end of the 1960s, a reorientation to increase aquaculture production was proposed and it included the following considerations:

- A modification of the farming technique for tilapia (in which seed production and out-growing to marketable-sized fish are separated), and the introduction of monosex tilapia culture; and,
- Identification of new suitable species for aquaculture.

Recirculating aquaculture systems (RAS)

In recirculating aquaculture systems (RAS), water exchange is limited (typically up to 10% per day) and the culture water is reused. Mechanical and biological water treatment is used to maintain water quality.

RAS generally requires less area and water than conventional aquaculture, allows higher stocking densities, and provides greater control over the culture environment. The choice of fish species to be cultured in RAS is very important for the success of the venture, which largely depends on the culture fish conditions, its feeding habits, availability of seeds for stocking, acceptability of artificial feed and market value (Schmittou et al., 1997; Heinecken, 2017). Species grown using recirculating aquaculture systems include Nile tilapia and African catfish.

RAS provides a biosecure environment and offers fish producers a variety of important advantages over open pond culture. These advantages include the following: a method to maximise production on a limited supply of water and land; nearly complete environmental control to maximise fish growth year-round; the flexibility to locate production facilities near large markets; complete and convenient harvesting; and, quick and effective disease control.

RAS can be of various sizes ranging from large-scale production systems to intermediate-sized systems, and to small systems (Ebeling and Timmons, 2012). They can be used as grow-out systems to produce food fish or as hatcheries to produce eggs and fingerling, sport fish for stocking and ornamental fish for home aquariums. Disadvantages of RAS include high and constant round-the-clock demand for power supply, highly technical installation, high relative maintenance and the technically skilled manpower needed.

RAS has been the technology of choice for warm-water fish farming in South Africa for about two decades. The use of RAS has always been justified in terms of the need to heat and filter water economically, and produce a high output with a small footprint. The fact that water needs to be heated for tilapia has led some to believe that tilapia culture is inappropriate for South Africa.

Longlines systems

The use of longlines is a key component in marine-based aquaculture around the world. Longlines are long ropes anchored to the sea floor at each end and suspended from the water surface by floats and buoys. They are generally used for the culture of shellfish.

Shellfish that are cultured in Africa include mussel, shrimps, crabs and oysters attached to droppers suspended from the longline, and abalone

suspended from longlines in cages. Submerged longlines are those that are suspended below the surface of the water to avoid wave action (Buck and Buchholz, 2004; Kapetsky et al., 2013).

Suspended surface systems in South Africa use rafts based on the Spanish raft design and surface longlines using plastic floats. The first raft in the country was constructed for mussel culture in Port Elizabeth and was launched in 1986. Subsequently, longline systems were used both in Port Elizabeth and in Saldanha Bay to cultivate mussels and oysters. The advantages of these longlines were that they were less expensive in respect of capital than rafts. However, they did not provide a stable platform to work on and also required significantly more maintenance than rafts (Sales and Britz, 2001).

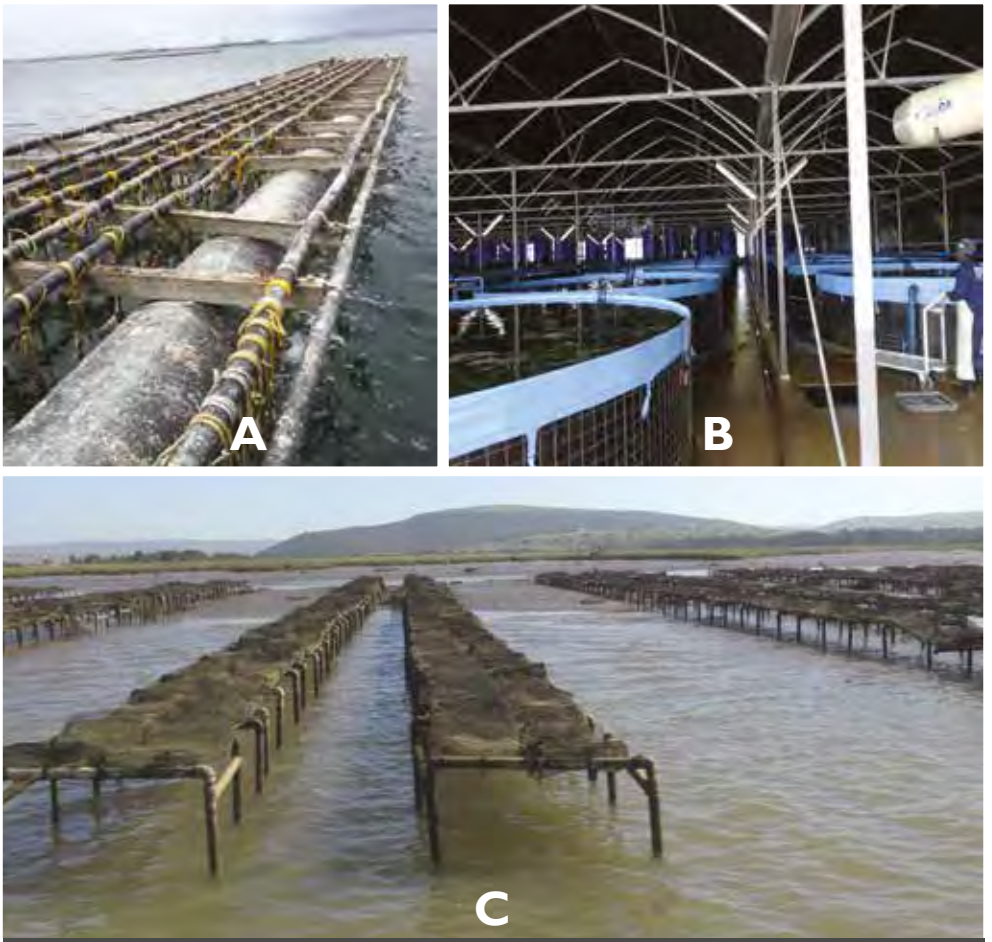


Figure 6: Mussel rafts in South Africa – (A) Masiza Mussels Farm in Saldanha Bay, (B) Oceanwise-Dusky Kob Farm in East London and (C) Oyster racks in Hamburg, South Africa



Figure 7: Masiza Mussels Farm in Saldanha Bay, South Africa

Flow-through systems

Flow-through systems are generally used for the intensive production of salmonids and for land-based abalone production. A flow-through system may include earthen ponds, tanks or raceways. They require considerable quantities of water to be pumped or gravity-fed from an adjacent waterway or marine environment, passed through the earthen ponds, tanks or raceways, and then discharged back into the source environment with little or no treatment (Bovendeur et al., 1987; Brummett et al., 2008). Species grown using flow-through systems are rainbow trout, tilapia, carps and ornamentals.



Photo Courtesy: Nembwe Fish Farm, South Africa

Figure 8: Flow-through tank culture in Nembwe Fish Farm, South Africa

Emerging or non-conventional species production systems

The production systems of emerging or non-conventional animals can be classified into commercial or subsistence, depending on production objectives. In the subsistence production system, the primary purpose is to meet family needs. It involves little or no commercial exchanges, and little or no investment is made into the feeding or health care of the animals; they scavenge for most of their feed requirements, though sometimes the feed is supplemented with household kitchen waste, as and when available (Charbonneau, 1988; Huss and Roca, 1982; Ngou Ngoupayou et al., 1995). Performance is, therefore, poor and mortality high.

In the commercial production system, the primary purpose is to raise animals for sale as well as for domestic consumption. Depending on the size of the enterprise, such commercial concerns are either smallholder or large-scale (Never, 2014).

Beekeeping production systems

Africa is endowed with water resources and various honeybee flora, which create fertile ground for the development of beekeeping. Honey hunting and beekeeping are practised for the exploitation of honey. In places where wild colonies of bees living in hollow trees are found, honey hunting is still

a common practice. Currently, bee husbandry has been exercised in the following systems:

- *Migratory beekeeping*, where hives are systematically migrated for honey production and for crop pollination. Migration of hives is often a profitable way of extending the honey flow period, provided transport facilities are available. For maximisation of honey production and efficient utilisation of resources, migratory beekeeping can be exercised in areas where honey forage provides rich honey flows in succession, and where modern hives, which are easier to move about, are in use.
- *Traditional beekeeping,* which is the oldest system and the richest practice, having been carried out for years. Several million bee colonies are managed using the same old traditional methods in almost all parts of the continent (Mammo, 1973; Fichtl and Admasu, 1994). Traditional beekeeping is of two types, namely forest beekeeping whereby a number of traditional hives are hung on trees, and backyard beekeeping, which is relatively better managed. Traditional hives are characterised by honey combs that are fixed on a solid hive body, such that access to the combs is only possible by breaking the ones that are before them. The hives are mostly made from woven twigs, grass, hollowed-out logs and soil. The lifespan of the hives is shorter than that of the improved ones. Natural forage is the major source of feed for the honey bees (Kugonza, 2009).



Photo Courtesy: http://academia.edu/23712432/Beekeeping_practices_in_Ethiopia

Figure 9: Traditional beekeeping in Ethiopia

- *Transitional system* is the intermediate between traditional and modern beekeeping methods. It mainly uses transitional hives such as the top bar hives in which combs are individually built on tightly-fitting wooden bars that are easily separated during hive inspection and harvesting. The use of such hives makes it easier to monitor the honeybee colonies' performance, though the freely hanging combs can easily break when the hives are moved about. Forage is provided from naturally existing flowering plants and natural water resources.
- *Modern beekeeping* consists of methods that aim to obtain the maximum honey crop, season after season, without harming bees (Nicola, 2002). They mostly use modern box hives, of which the Langstroth hives are dominant on the continent. In many modern apiaries, the box hives are used alongside top bar hives. The scale of operation varies from a few to hundreds of hives, either single or in multi-locations. Forage is from flowering food crops, plantation crops and/or trees, and in some cases, from managed natural forests (Kugonza, 2009).



Photo Courtesy: AU-IBAR

Figure 10a: Improved Langstroth CAB hive, modern design for the African Bee



Photo Courtesy: AU-IBAR

Figure 10b: A group of farmers from Nzaui in Kenya preparing their smokers for honey harvesting



Red Maradi goat

Photo Courtesy: Ministry of Livestock, Niger

CHAPTER THREE

Farm Animal Genetic Resources (FAnGR) in Africa

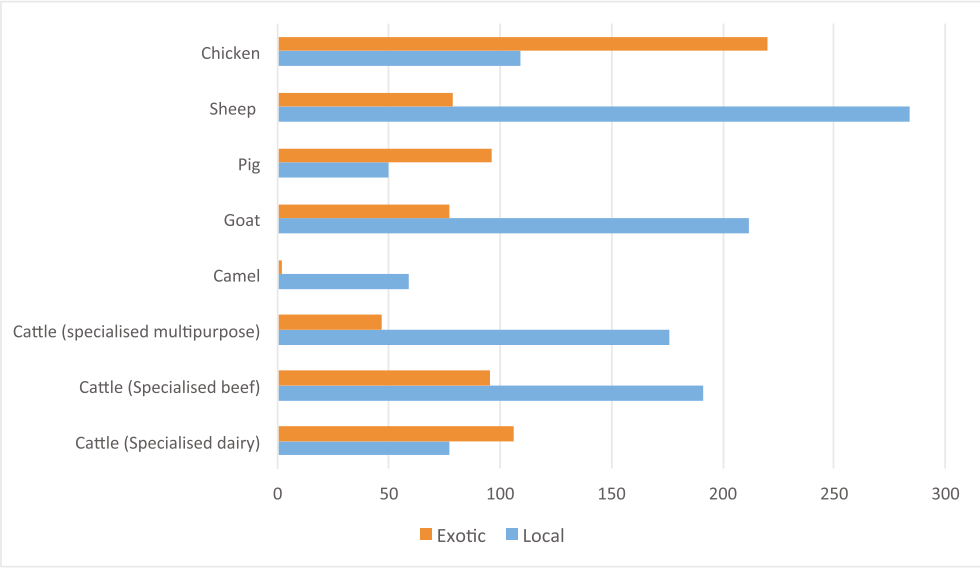


A Sudan horse with a jockey in a racing competition
Photo Courtesy: Ministry of Livestock, Niger

Africa is endowed with a rich diversity of animal genetic resources which have been developed over centuries in the various regions of the continent. This chapter discusses the extent of diversity, on a regional basis, both in terms of species and breeds, in addition to some of the unique adaptive characteristics of these breeds. It highlights the status of various African FAnGR breeds, including those adapted to Africa, as well as exotic breeds.

Diversity and adaptive characteristics of African FAnGR

Africa's FAnGRs are renowned for their adaptability and the majority of countries have at least one livestock breed that is considered well adapted to the local environment challenges, such as heat stress, diseases, parasites and limited availability of feed and water. Consequently, lifetime productivity of indigenous breeds is generally higher than that of exotic breeds due to superior adaptability, fertility and longevity, ability to walk long distances and survive long periods without water. Figure 11 shows the number of locally adapted and exotic breeds within the species in Africa, while Table 2 summarises the main characteristics of locally adapted breeds in the five regions of the continent.



Source: Country Reports, 2014

Figure 11: Number of locally adapted and exotic breeds for the main livestock species in Africa

Table 2

Main characteristics of selected animal breeds, by species and region

Region (Africa)	Species	Milk production	Growth and production	Disease resistance, tolerance and hardiness	Rough feed and water usage	Mobility and thriftiness in arid environments	Good meat quality (tenderness, juiciness and low cholesterol)
West	Cattle	White Fulani	Sokoto Gudali	N'Dama		Zebu-Gobra	
	Sheep		Nungua Black Head Sahelian	West Africa Dwarf (Djallonké)	West Africa Dwarf (Djallonké)		
	Goats	Rousse de Maradi	Sahel	West Africa Dwarf Goat	West Africa Dwarf Goat		
	Pigs		Large White	Ashanti Black	Ashanti Black		
	Poultry – Broiler		Cobb Ross Novagan	Local Chicken	Local Chicken		
	Poultry – Layer		ISA Brown Lohman Brown and White	Local Chicken	Local Chicken		
	Camelin					Dromadaire	
East	Cattle	Long horn Ankole	Short horn Zebu (Nganda) and Orma Boran	Barka Butana, Kenana, Nuba Mountains, Small East African Zebu Kenya Boran and Orma Boran	Arebo	Barka Arebo, Baggara, Butana, Kenana, Nuba Mountains, Small East African zebu and Kenya Boran	Long horn Ankole
	Sheep			North Reverie, Tagger and Red Maasai	Desert	Arid upland	Arid upland
	Goats		Mubende	Small East African Goat and Somali Goat (Galla)	Denkalia goats and Nubian	Denkalia goats, Desert Nubian, Small East African Goat and Somali Goat (Galla)	
	Camelin				Eritrean Camel, Kabashi and Shanabali	Eritrean Camel and Anafi Bishar	

Table 2

Main characteristics of selected animal breeds, by species and region

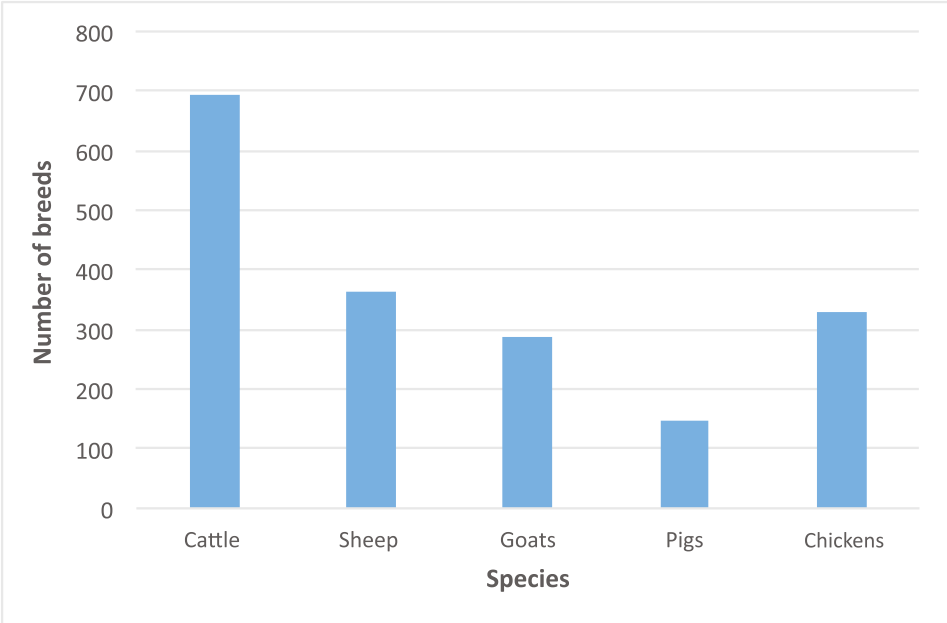
Region (Africa)	Species	Milk production	Growth and production	Disease resistance, tolerance and hardiness	Rough feed and water usage	Mobility and thriftiness in arid environments	Good meat quality (tenderness, juiciness and low cholesterol)
Central	Cattle			N'Dama, Dahomey and Lagune			Lugware
	Sheep			Djallonké			
	Goats			West Africa Dwarf Goat			
	Poultry		Bandundu	Poule Batéké			
North	Cattle	Zebu Maure and Zebu peulh		Zebu Maure			
	Sheep			Maure poil ras Maure poil long Mouton peulh	Maure poil ras, Mouton peulh		
	Goats	Chèvre du Sahel, Chèvre Gouera and Chèvre Djouguer	Chèvre du Sahel and Chèvre Djouguer	Chèvre du Sahel, Chèvre Gouera and Chèvre Djouguer		Chèvre du Sahel and Chèvre Gouera	
	Poultry	Poule locale			Poule locale		
	Camelin	Dromadaire de l'Aftout	Dromadaire de l'Aftout	Dromadaire de l'Aftout and Dromadaire Rguibi		Dromadaire de l'Aftout	Dromadaire Rguibi
Southern	Cattle		Landim	Angoni, Barotse, Tonga, Baila, Boran, Africander, Tuli and Mashona		Landim, Angoni, Barotse, Tonga, Baila, Boran, Brahman, Africander and Tuli	All Sanga breeds
	Sheep		Landim	Kumumawa, Chipepo and Sabi		Landim, Kumumawa, Chipepo and Blackhead Persian	
	Goats		Landim	Sinazongwe, Plateau, Gwembe		Landim, Sinazongwe, Plateau, Gwembe Matebele	
	Pigs		Landim	Mkota		Landim	
	Poultry			Zambi chicken, Zambi Naked-Neck, Zambi Short-Legged and Zambi Frizzle-Feathered		Kumumawa, Zambi chicken, Zambi Naked-neck, Zambi Short-Legged, Zambi and Frizzle-Feathered	

Source: AU-IBAR questionnaires, 2014

There are 1,158 indigenous breeds and 722 exotic breeds. Crossbreeding is practised mainly in specialised dairy cattle, pig and chicken breeds. The numbers of local specialised beef cattle, specialised multipurpose cattle, camel, goat and sheep breeds are substantially higher than those of exotic breeds, while exotic dairy cattle, pig and poultry breeds outnumber indigenous types. African countries are home to local specialised beef and multipurpose cattle, with potential to make a substantial contribution to the world beef trade.

Distribution of livestock species and breeds

Livestock included here consist of animals raised to produce food and fibre, the most common of which are cattle, sheep, goats, pigs and poultry. Each of these species is raised differently depending on the region in which it is reared. Figures 12 to 14 provide a general overview of the distribution of species and breeds in the different regions of Africa. The breed diversity represented in the different figures was derived from data for both indigenous and exotic breeds. The total number of breeds for all species in the continent was found to be 2, 250; 1, 819 for conventional (cattle, sheep, goats, pigs and poultry) breeds and 431 for emerging or non-conventional breeds of limited distribution.

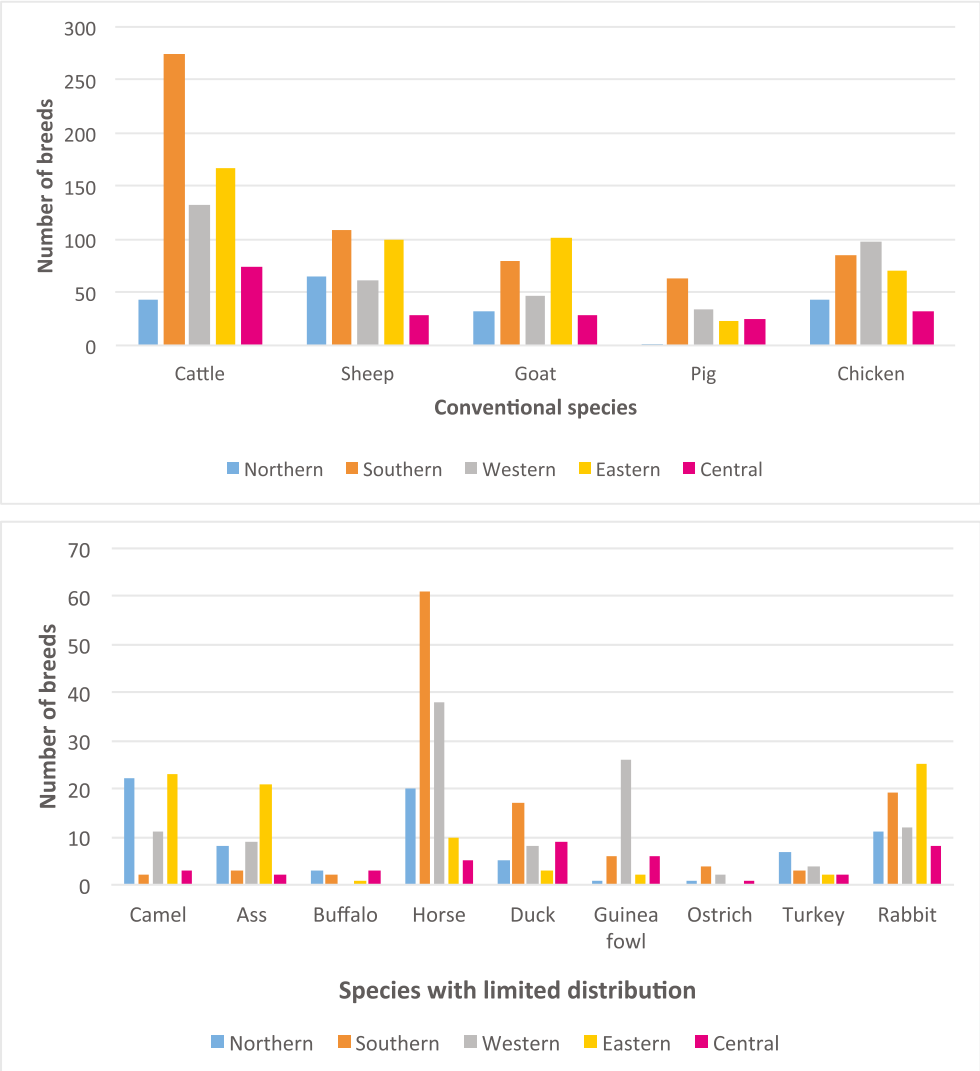


Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 12: Distribution of breeds among the main livestock species

The results from Figure 12 above confirm that of the five main species, cattle have the highest number of breeds (692 breeds), followed by sheep (363), goats (289), pigs (146) and chickens (329) in Africa.

As Figure 13 shows, Southern Africa reported the highest diversity with 729 breeds, followed by Eastern Africa (548), Western Africa (483), Northern Africa (263) and Central Africa (227). For cattle, the Southern African region recorded the highest number of breeds (275) followed by the Eastern African region (167). The Northern African region reported the lowest number of cattle breeds (43). Northern Africa is made up of the following countries: Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia.



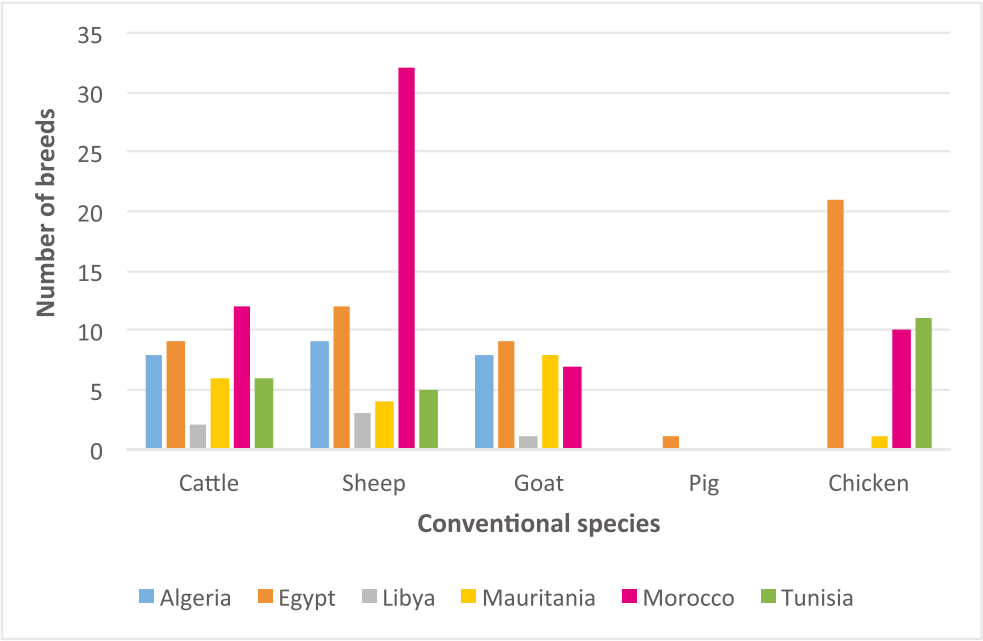
Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

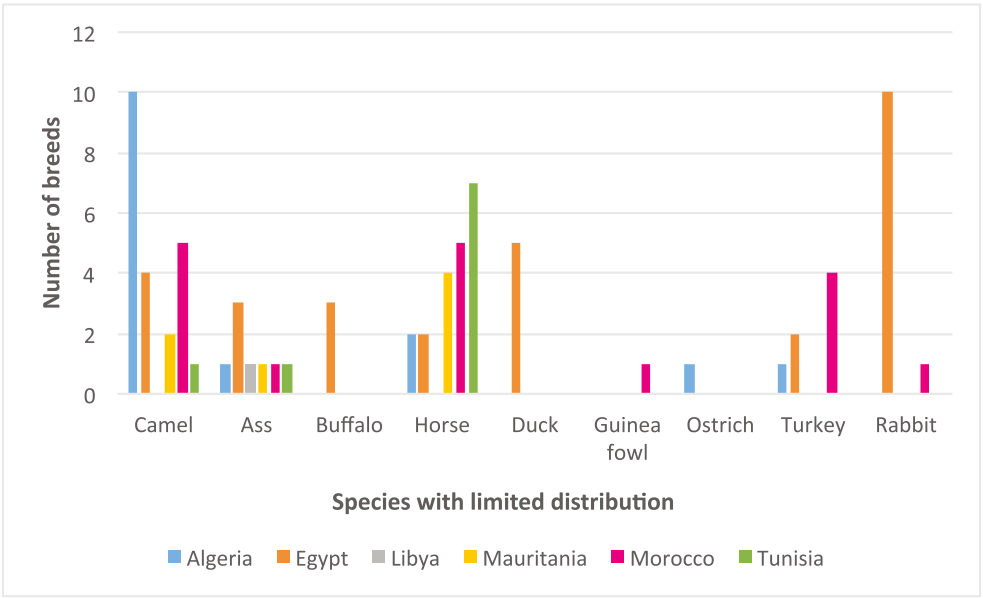
Figure 13: Regional distribution of livestock breeds among species in Africa

For sheep, 363 breeds were recorded across the continent, most of them originating from Southern Africa (109), followed by Eastern Africa (99), Northern Africa (65) and Western Africa (62). The Central African region recorded the lowest number of sheep breeds (28). For goats, the highest number of breeds was recorded in Eastern Africa (101), followed by Southern Africa (79), Western Africa (47), Northern Africa (33) and Central African region (29). For pigs, the Southern African region recorded the highest number of breeds (64), followed by Western Africa (34), Central Africa (24), and Eastern Africa (23). Expectedly, due to cultural and religious reasons, the Northern African region reported only one locally adapted pig breed, found in Egypt. For chickens, the highest number of breeds was reported in Western Africa (97), followed by Southern Africa (85), Eastern Africa (71), Northern Africa (43) and Central Africa (33 breeds).

Figure 14 shows the distribution of animal breeds in the Northern African region indicating that it has the lowest breed diversity with 43 cattle breeds recorded. Morocco recorded the highest number of breeds (12). The highest breed diversity for sheep was found in Morocco (32) followed by Egypt (12). The diversity of goat breeds was distributed across the countries as follows: Egypt (9), Algeria (8), Mauritania (8) and Morocco (7), while a total of 43 chicken breeds were reported, with 21 of them found in Egypt.

Figure 15 shows the distribution of livestock breeds among the countries of Southern Africa, namely Angola, Botswana, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Zambia and Zimbabwe. Information for Réunion is also included. South Africa holds the highest number of sheep (46) and goat (15) breeds. The highest number of chicken breeds are found in Zimbabwe (13), Namibia (13) and Malawi (10). The region is endowed with many indigenous African beef cattle breeds, such as the Afrikaner, Angoni, Barotse, Boran, Mashona, Nguni, Tswana and Tuli. However, these breeds are threatened by increased uncontrolled crossbreeding with exotic genotypes. South Africa and Namibia have the highest number of cattle breeds, 80 and 30 breeds, respectively (Figure 15). The large proportion of cattle breeds in the region, especially in South Africa, is evidence of the region's emphasis on commercial beef production.

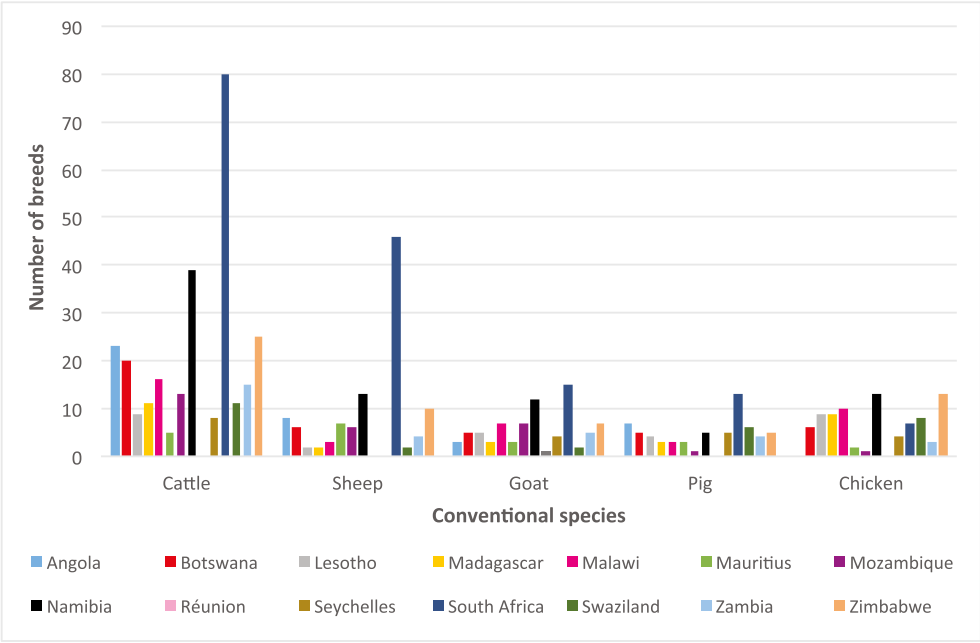


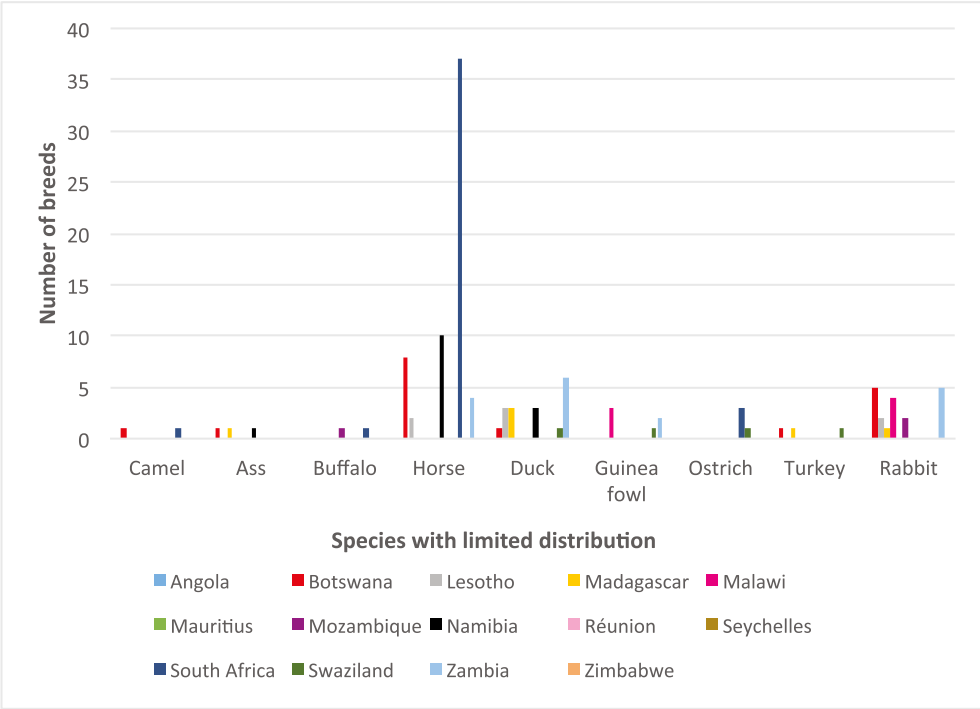


Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 14: Distribution of livestock breeds among countries in North Africa

Figure 16 shows the distribution of livestock breeds among the countries that comprise Eastern Africa, namely Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, South Sudan, Tanzania, Uganda and Somalia. In Eastern Africa, Kenya is home to a wide range of cattle genotypes and has the highest number of exotic dairy cattle. Improved

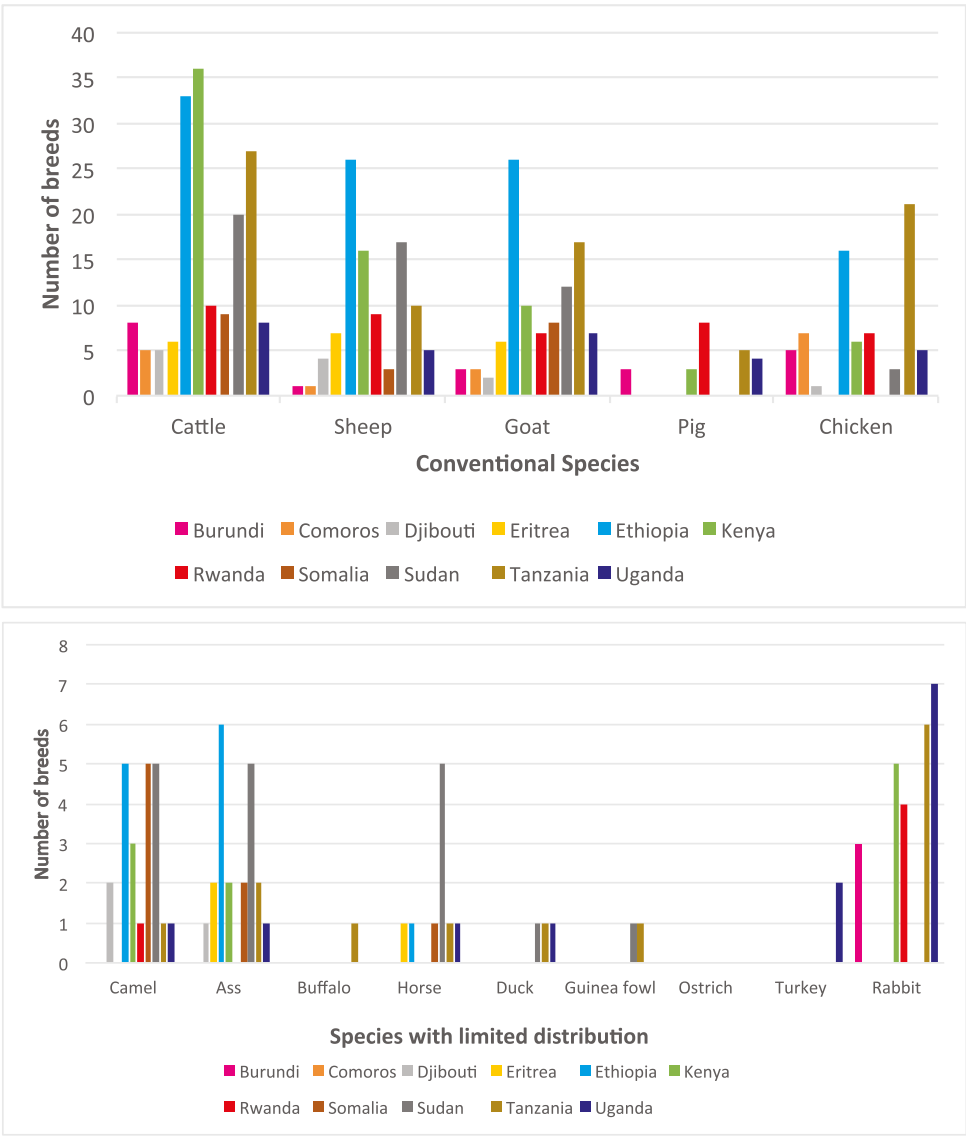




Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 15: Distribution of livestock breeds among countries of Southern Africa, including Réunion

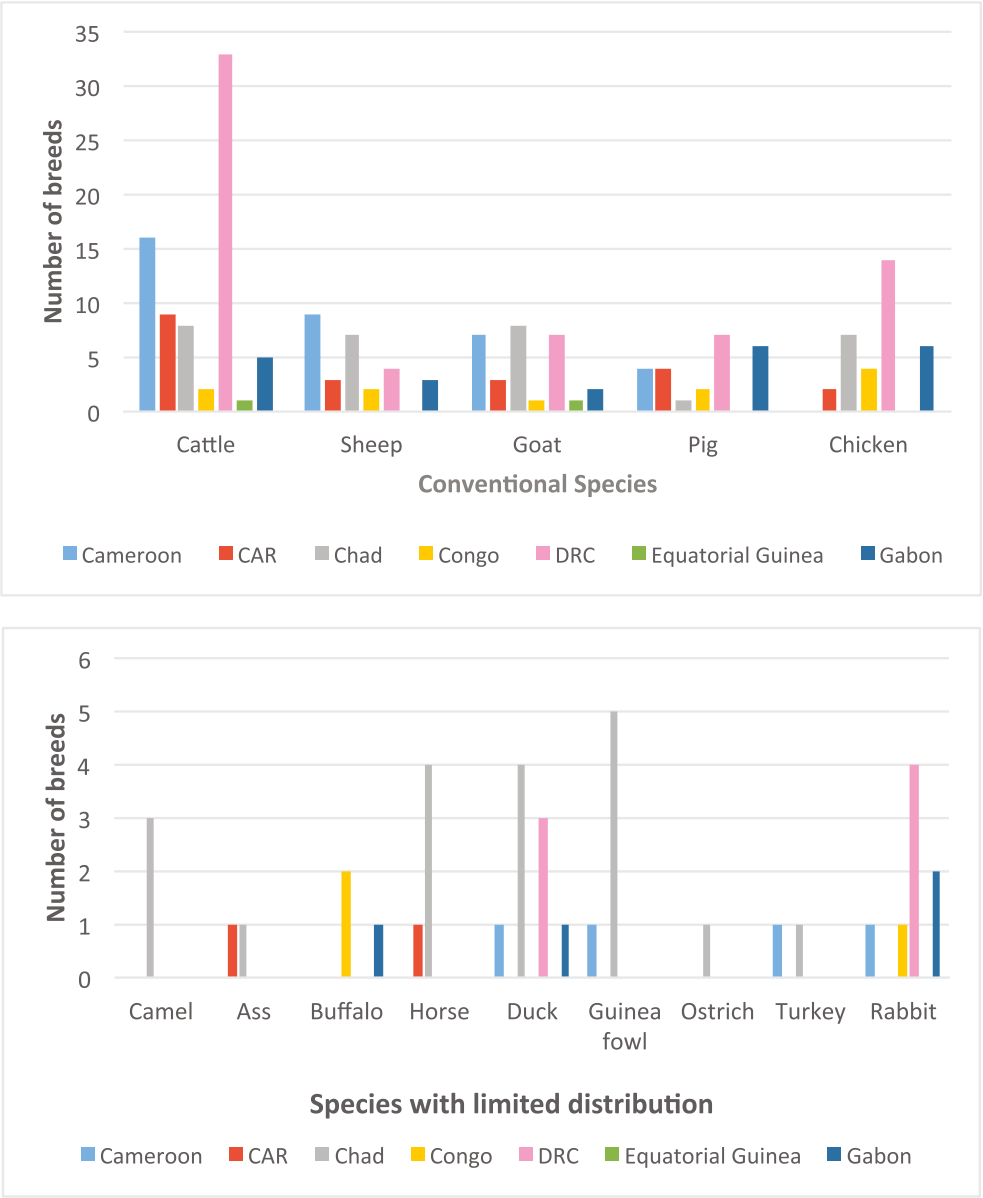
dairy cattle breeds account for 23 per cent of the total cattle population in Kenya. Eastern and Southern Africa account for 75 per cent of dairy cattle in Africa. Imported breeds in Uganda and Ethiopia account for only 3 and 1 per cent respectively, of the cattle/dairy cattle populations. Most of the sheep breeds in Eastern Africa are in Ethiopia (26), Sudan (17), Kenya (16) and Tanzania (10). The highest number of goat breeds was recorded in Ethiopia (26) followed by Tanzania (17), Sudan (12) and Kenya (10).



Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 16: Distribution of livestock breeds among countries of Eastern Africa

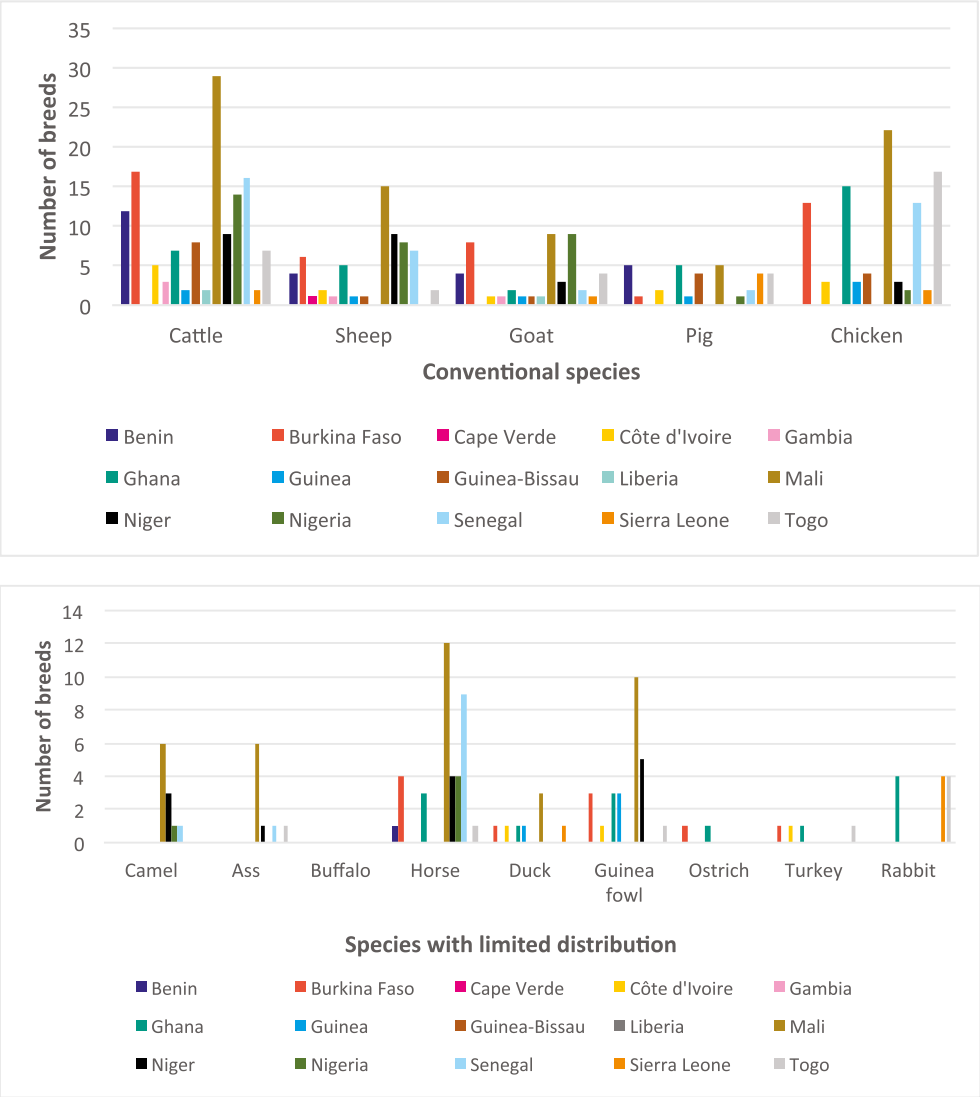
Twenty-three (23) pig breeds were reported, most of them found in Rwanda (8), while 71 chicken breeds were reported, most of them found in Tanzania (21) and Ethiopia (16).



Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 17: Distribution of livestock breeds among countries of Central Africa

A majority of the cattle breeds in Central Africa are of the specialised beef types; therefore, a common plan of action for their sustainable conservation and improvement is feasible. Figure 17 shows the distribution of livestock breeds in Central Africa, which is made up of the following countries: Cameroon, the Central African Republic (CAR), Chad, the Republic of Congo, the Democratic Republic of Congo (DRC), Equatorial Guinea, Gabon, and São Tomé and Príncipe. DRC has the highest number of cattle breeds (33).



Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 18: Distribution of livestock breeds among countries in West Africa

Cameroon and Chad reported 9 and 7 sheep breeds, and 7 and 8 goat breeds, respectively. DRC and Gabon recorded 7 and 6 pig breeds respectively. Thirty-three (33) chicken breeds were recorded in the region, with DRC alone having 14 breeds.

In West Africa, a common feature observed across all countries was the occurrence of local multi-purpose cattle breeds, indicating their relative value in the region. Figure 18 shows the distribution of livestock breeds in the West African countries consisting of the following: Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Mali, Burkina Faso, Senegal, Nigeria and Benin have the highest number of cattle breeds: 29, 17, 16, 14 and 12 breeds, respectively. Mali also has the highest number of sheep breeds (15). A total of 47 goat breeds were recorded in West Africa, with both Nigeria and Mali having the highest number at 9 breeds each. Similarly, 34 pig breeds were reported in the region, with most of them found in Ghana, Benin and Mali. The highest number of chicken breeds is found in Mali (22), followed by Togo (17), Ghana (15), Burkina Faso (13) and Senegal (13).

The dromedary, also called the Arabian camel (*Camelus dromedarius*), is present mainly in the desert zone of North Africa (Algeria, Egypt, Libya, Mauritania, Morocco and Tunisia), in West Africa (Burkina Faso, Mali, Niger, Nigeria and Senegal), in Central Africa (Chad), in Southern Africa (Botswana and South Africa) and in Eastern Africa (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan and Uganda). Four camel population types are generally recognised; namely Sudani, Maghrabi, Falahi (also known as Fellahi, or Baladi) and Mowalled. In general, however, types of camels are not as differentiated and classified as breeds. In most camel rearing societies, breed or type classifications are based on names of the ethnic group, clan as well as the geographical localities where they are raised, rather than the phenotypical characteristics. A total of 61 camel breeds or types have been reported in Africa. Table 3 summarises the camel types and their local names in different countries in Africa.

Table 3

Distribution of the main African camel breeds by types and names

Country	No. of Types	Names
Algeria	8	Berberi, Chaambi, Chameau De La Steppe, L'ait Khebbach, L'ajjer, Ouled Sid Cheikh, Targui and Ddromadaire Méhari
Botswana	1	Botswana Camel
Burkina Faso	2	Abzin and Touareg
Chad	3	Gorane, Le Chameau du Kanem and Mahamid
Egypt	3	Fellahi, Mowalled and Sudani
Eritrea	1	Dankali
Ethiopia	3	Afar, Borena and Ethiopian Dromedary
Kenya	3	Rendille and Turkana, Somali
Libya	4	Alarabia, Almahare, Altebesty and Alsertawiya
Mali	5	Bérabiche, Chameau De L'azaouad, Chameau Du Hodh, dromadaire de l'Adrar des Ifoghas and dromadaire du Tibesti
Mauritania	1	Aftout
Morocco	4	Guerzni, Jebli, Khaouri and Marmouri
Niger	4	Azarghaf, Azawak, Dromadaire de l'Aïr and Yoria
Nigeria	1	Dromedary camel
Somali	3	Mudugh, Guban and Hoor
South Africa	1	Dromedary
Sudan	7	Kababeish, Shanabla, Nyalawei, Albishari, Rashaidi, Arabi and Red Sea Hills
Tunisia	6	Ourdhaoui Médenine, Ourdhaoui Tataouine, Guiloufi, Gueoudi, dromadaire Châambi and Merzougui
Uganda	1	Camel
Regional transboundary		
Ethiopia, Kenya and Somalia	1	Somali
Djibouti, Somalia and Sudan	1	Arabi
Ethiopia and Sudan	1	Anfi
Algeria, Mali, Mauritania, Morocco, Senegal and West Sahara	1	Rgueïbi

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 19 shows the Somali camel, a regional transboundary breed found in the Horn of Africa – Ethiopia, Kenya and Somalia.



Photo Courtesy: Ministry of Agriculture, Livestock and Fisheries, Kenya

Figure 19: Resilient Somali camel, a transboundary breed found in Ethiopia, Kenya and Somalia

Distribution of other livestock species

Some countries raise a variety of farm animals not commonly found in the other regions of the continent. These species include donkeys, horses, ducks, geese, turkeys, rabbits and bees.

Donkeys

The African wild ass or African wild donkey *(Equus asinus africanus)* is a wild member of the horse family, *Equidae*. This species is believed to be the ancestor of the domestic donkey, which is usually placed within the same species. Previously found in North Africa, from the Moroccan Atlas Mountains to Somalia, donkeys are now found all over the continent. Their primary habitat are deserts, arid and semi-arid bushland and grassland. Figure 20 shows the African wild donkey, which is an endangered species.



Photo Courtesy: Ministry of Animal Resources and Livestock, Burkina Faso

Figure 20: African wild donkey, a soon endangered species

There are two recognised subspecies, namely the Nubian Wild Ass *(Equus asinus africanus)* and the Somali Wild Ass *(Equus asinus somaliensis)*. Somali asses may be the only surviving African Wild Ass, and seem to be closely related to domestic donkeys (Anon, 2011). A total of 32 African donkey breeds/types have been reported. Table 4 shows the geographical distribution of donkeys and summarises their types and the local names in different countries in Africa.

Table 4

Distribution of the main African donkey breeds by types and country

Country	No. of Types	Breed names
Algeria	1	Algerian
Botswana	1	Tswana
Egypt	5	Masri, Saidi, Egyptian, Egypt Baladi and Hassawi
Eritrea	1	Kassala
Ethiopia	3	Abyssinian donkey, Jirnrna and Sennar
Libya	1	Libyan

Table 4 *Continued...*

Distribution of the main African donkey breeds by types and country

Madagascar	1	Âne locale
Mali	5	Âne du Gourma, Âne du Miankala, Âne du plateau Dogon, Âne du Sahel and Âne du Yatenga
Morocco	1	Moroccan
Niger	1	Asin
Sudan	5	Sudanese Pack, Toposa, Riffawi, Etbai and Dongolawl
Tanzania	1	Muscat
Togo	1	Ânes
Tunisia	1	Tunisian
Regional transboundary		
Mali, Mauritania, Senegal	1	Native of North Africa
Central African Republic and Chad	1	Âne Africain
Djibouti, Kenya and Somalia	1	Somali
Kenya, Tanzania and Uganda	1	Maasai

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Horses

Horses *(Equus caballus)* are found throughout the continent and have served a variety of purposes in different communities throughout history. It is believed that different wild horses gave rise to the different breeds of domestic horses. Currently, there are approximately 59 horse breeds in Africa as shown in Table 5, which illustrates the rich genetic diversity and geographical distribution of horse breeds. Their adaptability has enabled them to survive in different environments over time, and to develop distinct characteristics. The breeds were developed into different types depending on the character (cold-blood, warm-blood and thoroughbred), the nature of work (riding, draft, military parade, war, racing, and so on), the type of horse (light, heavy or pony) and genotype (purebred or crossbred).

Table 5

Distribution of the main horse breeds in Africa

Country	No. of Types	Breed names
Botswana	1	Tswana
Burkina Faso	3	Bobo, Mossi and Yagha
Chad	2	Bahr-El-Ghazal and Poney du Logone
Egypt	1	Baladi Egyptian
Ethiopia	1	Abyssinian
Ghana	2	West African Pony
Lesotho	1	Basotho Pony
Mali	8	Beledougou, Cheval de Nioro, Dombi, Sahel, Songhoï, Hodh, Bandiagara and Hausa
Mauritania	1	Hodh
Niger	4	Bandiagara, Hausa, Djerma and Torodi
Nigeria	4	Hausa, Bhirum Pony, Bornu and Sulebawa
Senegal	4	Fleuve, Fouta, M'Par and M'bayar
Somalia	1	Somali Pony
South Africa	13	Boerperd, Nooitgedachter, Calvinia, Cape Harness, Cape Horse, English Halbblut Horse, European Warmblood, Namaqua Pony, Namib Horse, SA Miniature Horse, SA Sporting horse, SA Warm Blood and Vlaamperd
Sudan	3	Sudan Country-Bred, Tawleed and West Sudan Pony
Tunisia	3	Hamdani, Le poney des Mogods and Nefza Pony
Regional transboundary		
Botswana and South Africa	1	Boerperd, Nooitgedachter
Algeria, Chad, Ghana, Mauritania, Senegal and Tunisia	1	West African Barb
Algeria, Mali, Mauritania, Morocco and Senegal	1	Barb
Benin and Togo	1	Koto-Koli Pony
Central African Republic and Sudan	1	West African Dongola
Eritrea, Chad, Mali and Sudan	1	Dongola

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)



Photo Courtesy: Ministry of Rural Development, Mauritania

Figure 21: Barbe horse breed found in Mauritania

Ducks, geese and turkeys

In the past 50 years, there has been considerable progress in the development of breeds for intensive commercial poultry production. This trend is noticeable in ducks, geese and turkeys. The breeds are widely distributed and are reared in all countries in Africa, even in the most remote villages. The different breeds of ducks, geese and turkeys have generally been bred either for meat, egg or dual purpose production. In Africa, there are 21 main duck types and 13 main goose types as Table 6 shows. Figure 22 (A) and (B) shows smallholder farms of ducks and geese in Niger and

Madagascar respectively.

Table 6

Distribution of the main African duck and goose breeds by country

Country	No. of Types	Names
Duck		
Burkina Faso	1	Burkina Faso Domestic Duck
Cameroon	1	Canard du Cameroun
Chad	3	Local Duck of Gredaya and Massakory, Local Duck of Guelateng and Local Duck of Moulkou and Bongor
Côte d'Ivoire	1	Local Duck of Côte d'Ivoire
Democratic Republic of Congo	2	Canard and canard de Barbarie
Egypt	3	Domiati, Shersheer and Sudani
Ghana	1	Local Ghanaian Duck
Guinea	1	Canard
Lesotho	2	Muscovy and Pekin
Madagascar	2	Canard Domestique and Mulard
Mali	1	Malian Duck
Namibia	1	Muscovy
Sudan	1	Sudanese Muscovy Duck
Swaziland	1	Lidada
Goose		
Burkina Faso	1	Burkina Faso Domestic Goose
Cameroon	1	Oies du Cameroun
Chad	2	Local Goose of Karal and Massakory, and Local Goose of Mandelia
Côte d'Ivoire	1	Local Goose of Côte d'Ivoire
Egypt	3	Masri
Madagascar	2	Oie de Guinée and Oie de Lande
Swaziland	1	Likewu
Tanzania	2	White-footed Goose and Greyleg goose

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

The local African turkeys *(Meleagris gallopavo)* are found throughout Africa, but in limited numbers. Only 10 types were reported. The distribution estimates are presented in Table 7. Figure 23 (A) and (B) shows commonly



Photos Courtesy: Ministries of Livestock, Niger and Madagascar

Figure 22: Smallholder farms of (A) ducks and (B) geese in Niger and Madagascar respectively

found black turkey and the white turkey of Benin and Madagascar respectively.

Table 7

Distribution of the main African turkey breeds by country

Country	No. of types	Names
Burkina Faso	1	Burkina Faso Turkey
Cameroon	1	Dindon du Cameroun
Chad	1	Local Turkey of Mandelia
Côte d'Ivoire	1	Local Turkey of Côte d'Ivoire
Egypt	2	Egypt Baladi and Mahalla 85
Ghana	1	Local Ghanaian Turkey
Madagascar	1	Dinde locale
Swaziland	1	Turkey Ingalukhuni



Photos Courtesy: Ministries of Livestock, Benin and Madagascar

Figure 23: Commonly-found black turkey of Benin (A), and the white turkey of Madagascar (B)

Tanzania	1	Mallard

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Rabbits

The domestic rabbit *(Oryctolagus cuniculus)* is a descendent of wild rabbits of Southern Europe and North Africa. Rabbits are generally classified according to size, weight and type of pelt. In most countries in Africa, local strains are used, although most of the species are not indigenous. The most popular breeds for meat production are the New Zealand and the Californian. These breeds are common because they combine white fur and



Photo Courtesy: Ministry of Livestock, Madagascar

Figure 24: Madagascan local rabbits

good growth characteristics. In Africa, there are 28 reported distinct types as Table 8 shows. Figure 24 shows the local rabbit breeds in Madagascar.

Table 8

Distribution of the main rabbit breeds found in Africa

Country	Breed
Botswana, Cameroon, DRC, Congo, Kenya, Malawi, Mozambique, Lesotho, Sierra Leone, Ghana, Rwanda, Togo, Gabon	New Zealand
Botswana, Cameroon, DRC, Kenya, Mozambique, Sierra Leone, Ghana, Rwanda	Californian
Botswana, Kenya, Lesotho, Ghana	Chinchilla
Cameroon, Chad, DRC, Kenya, Ghana, Rwanda, Togo	Flemish
Chad, Congo, Togo, Gabon	Fauve de Bourgogne
Chad, DRC, South Sudan, Kenya	Bunyoro rabbit
Congo, Mozambique, Togo	Butterfly
Egypt	Baladi, Bauscat, Gabali, Giza White
Algeria	Kabyle
Morocco	Tadla, Zemmouri
Cameroon	Tachetée, Mankon rousse, Mankon noire, Rousse
Congo	Largentine de Champagne, Noire and Provence de France
South Africa	Riverine rabbit
Kenya	French lop, Dutch, Checkered Giant, Angora and Rex
Rwanda	Blanc de Tormonde

Source: FAO (2000); Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

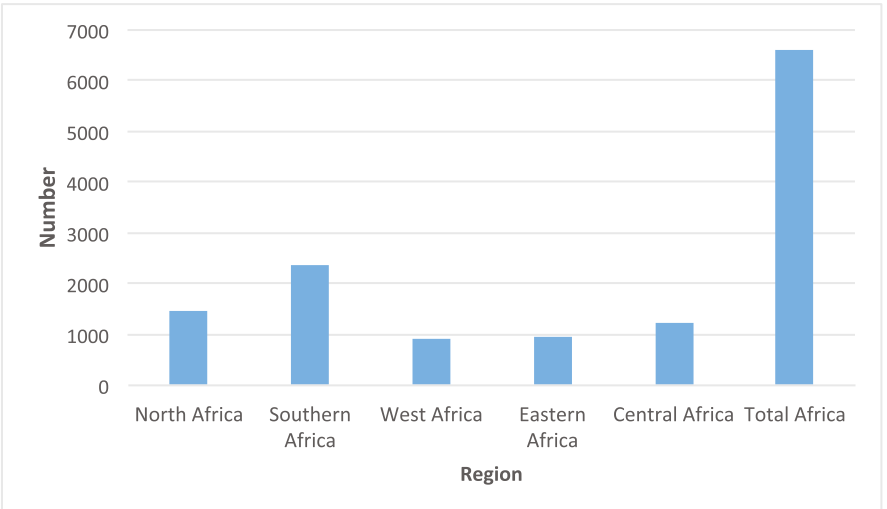
Honeybees

A summary of honeybee classification and distribution has been well documented by Hepburn and Radloff (1997). There are about 6,591 breeds of bees in Africa. The bee fauna can be described as moderately diverse with six of the seven bee families found in Africa, recognised by Michener (2007). At a generic level, this suggests reasonably high diversity. The most

species genera in Africa are *Lasioglossum* (about 260 species) and *Megachile* (about 322 species) (Pasteels, 1965). Figure 25 gives the approximate numbers of bee species per region in Africa.

According to Figure 25, the Southern African region has the highest bee diversity followed by North Africa, Central Africa, Eastern Africa and West Africa. Africa's bee diversity is largest in the winter rainfall area of South Africa. This area is species-rich for all families except *Andrenidae* (Michener, 2007). Southern Africa has a few endemic genera that occur in both the dry winter rainfall areas in the west and the wetter summer rainfall areas in the east. A few genera are diverse in the *Palaearctic* and recorded in Southern Africa from only a few rare species such as *Aglaoapis Cameron. Fidelia Friese* has its centre of diversity in Southern Africa with a relic species in Morocco. Neither of these genera has any known species in the tropical regions of Africa. *Meliturgula Friese* has its maximum diversities in Southern Africa and the Sahara Desert yet one species, *Meliturgula scriptifrons* (Walker), occurs in East Africa. The *Anthidiini* and *Osmiini,* which are largely cosmopolitan, have their centres of diversity in the south-west region of Africa (Connal et al., 2009).

Africa is home to the honeybee *Apis mellifera Linnaeus* (Stringer and Andrews, 2005). A recent review of *Apis mellifera* shows 22 honeybee races worldwide and 10 valid geographical races in Africa (Engel, 1999). The races include *Apis mellifera adansonii*, *A. m. scutellata*, *A. m. litorea*, *A. m. monticola*, *A. m. unicolor*, *A. m. lamarkii*, *A. m. major, A. m. jemenitica*, *A. m. capensis*, and *A. m. intermissa*. These subspecies have been found to



Source: World Bee Diversity

Figure 25: Number of bee species per region in Africa

have specific behavioural and morphological characteristics (Ruttner and Kauhausen, 1984; Hepburn and Radloff, 1997). Table 9 shows 10 valid races of *Apis mellifera* and their distributions in Africa.

Table 9

The Apis mellifera species and their distribution in Africa

Species	Distribution
Apis mellifera adansonii	West Africa
Apis mellifera capensis,	South Africa
Apis mellifera intermissa	North Africa, from Libya to Morocco
Apis mellifera jementica	Somalia, Uganda, Sudan
Apis mellifera lamarkii	Egypt and Sudan along the Nile Valley
Apis mellifera littorea	Kenya to Mozambique
Apis mellifera monticola	Tanzania and Kenya
Apis mellifera sahariensis	North Africa
Apis mellifera scutellata	East Africa and South Africa
Apis mellifera unicolor	Madagascar

Apiconsult (2013)

The honeybee is the only managed pollinator in Africa, and its numbers and distribution have increased with its domestication and the introduction of exotic plants like *Eucalyptus spp.* (Eardley, Gikunyu and Schwarz, 2009). The recent movement of the Cape Honeybee into Gauteng Province of South Africa, and the introduction of honeybee diseases such as Varroa have reduced honeybee numbers over the past two decades. East Africa has several unique melittid genera (Michener, 1981). Six of the 10 species of *Nomada Scopoli* are found in Ethiopia. In Uganda, honeybees at higher altitudes in the west of the country have been found to be more aggressive than those found in other areas of the country (Corner, 1984).

Climate change and drought, less biodiverse forage for bees, lack of genetic diversity and danger from exotic species have contributed to a decline in pollinator bees in Africa. This is evident from the fact that bee diversity and abundance is greater on crops in areas surrounded by natural vegetation than in ecosystems that have been widely transformed by agricultural practices. Political and infrastructural circumstances make bee biodiversity research very difficult in many regions of the continent, and are major impediments to assessing the basic elements of bee diversity in much of tropical Africa and the Horn of Africa (Connal et al., 2009).



Photo Courtesy: AU-IBAR

Figure 26: A swarm of African worker bees on a honey comb

Fish diversity and distribution

African harbours have a rich biological diversity of native fish resources with more than 2,608 unique freshwater species and 842 unique marine species (Pullin et al., 2001). While it is estimated that about 500 aquatic animal species are either farmed or experimented, information is generally lacking on the total number of farmed fish breeds.

Knowledge of the genetic characteristics of farmed aquatic animal species is still way behind that of farmed livestock. Lévêque (1997) recorded 76 families in Africa with the freshwater fauna dominated by *ostariophysans* (1,159 species) many of which are typically riverine; however, several families are represented by only a few species (Boxes 1 and 2). The *Cyprinidae* (475 species) form the greatest proportion of *ostariophysans* and *Characiformes* are also well represented by the *Alestidae* (109 species) and *Distichodontidae* (90 species).

The *Siluriformes* (catfishes) include numerous species of *Mochokidae* (176 species), *Claroteidae* (98 species) and *Clariidae* (74 species). Among the *non-ostariophysan* groups, *Cichlidae* is the most species-rich family with at least 870 species. According to Lévêque (1997), most of these are represented

by species endemic to the lakes of East Africa. Other families with large numbers of species include the former *Cyprinodontidae* killifish (at least 243 species are currently classified in *Nothobranchiidae* and *Poeciliidae*) and the *Mormyridae* (elephantfishes) with 198 species.

Box 1: Distribution of the subgenus Clarias

The large African species which are of interest for aquaculture belong to the subgenus Clarias. The species are:

- *Clarias anguillaris*
- *Clarias senegalensis*
- *Clarias lazera*
- *Clarias mossambicus*
- *Clarias gariepinus*

Clarias gariepinus and *Clarias anguillaris* remain the two catfish species most farmed in Africa, even though more than 100 species populate African waters. *Clarias gariepinus* is commonly referred to as African Catfish, Sharptooth Catfish, Catfish, Common Catfish, Mudfish, Barbel, Sharp-toothed Catfish and North African Catfish. In Africa, the *C. gariepinus* species is native to the following countries: Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; The Democratic Republic of Congo (DRC); Egypt; Eritrea; Ethiopia; Ghana; Guinea; Kenya; Libya; Malawi; Mozambique; Namibia; Niger; Nigeria; Rwanda; Senegal; Somalia; South Africa; Sudan; Swaziland; Tanzania, United Republic of Togo; Uganda; Zambia and Zimbabwe, while the *C. anguillaris* has restricted distribution mainly found in Mauritania, in most West African basins and in the Nile.

Source: de Graaf and Janssen (1996)

Box 2: The Tilapia genus

The genus *Tilapia* is among the cichlid endemic to the freshwater habitats of sub-Saharan Africa and the Nile River System into Israel. Tilapia are typically opportunistic herbivores and are substrate-spawners that guard their brood. Africa's commonest Tilapia species are T. *sparrmanii,* A. Smith; T. *rendalli* Boulenger; T. *zillii* (Gervais) and *T. cabrae,* Boulenger (Trewavas, E. 1982. **Tilapias: Taxonomy and Speciation**, p. 3-13 in R.S.V. Pullin and R. H. Lowe-McConnell (eds). **The Biology and Culture of Tilapias**. ICLARM Conference Proceedings 7, 432 p. International Centre for Living Aquatic Resources Management, Manila, Phillippines).

In Southern Africa, Lake Malawi has the greatest number of species. This region has an estimated 800 species, most of which are endemic. The Lake Tanganyika Basin harbours an estimated 470 species of fishes, 287 of which had been formally described from the lake itself at the time these numbers were reported by Thieme, M.L. et al. (2005). From Lake Tanganyika, some of the species have been introduced to other African lakes; for instance, the Tanganyika sardine (*Limnothrissa miodon*) of the

Clupeidae family was introduced into Lake Kivu in 1959 and Lake Kariba in 1967 (Carvalho and Pitcher, 1994), where they are currently thriving and contributing strongly to livelihoods.

In East Africa, estimates for the total number of species in Lake Victoria are variable, although Thieme et al. (2005) noted that there may be more than 600 endemic species. In Central Africa, more than 858 fish species have been identified for the Congo Basin (Stiassny et al., 2011). This number is certainly an underestimate and many of these regions are poorly explored or not explored at all (Stiassny et al., 2011). An excellent case in point is the Lefini River, from which virtually no species were known until recently when, after a thorough exploration of its lower reaches, it was found to harbour 140 species (Ibala-Zamba, 2010). In the equatorial location, the large size, the relative longevity and the climatic stability of the forested moist tropical regions of Central Africa contribute to the high levels of species richness in this area (Kamdem Toham et al., 2006; Thieme et al., 2008).

Although the species richness observed in the Congo Basin and the East African Rift Valley lakes exceeds that observed in any other part of Africa, there are several other regions that have a relatively large number of species distributed over large areas. This is particularly noticeable over large parts of coastal rivers of West Africa. Most sub-catchments of the Lower Guinean province have between 50 and 100 species. West Africa comprises 17 freshwater eco-regions where there are 584 species of fresh and brackish water fishes distributed throughout the region. The greatest numbers of species in West Africa are found in the Niger Delta eco-region (152 species have been assessed). A total of 107 species have been assessed in the Ogun River basin in the region of the Lagos Lagoon. Several catchments and sub-catchments of West Africa have more than 70 species, particularly those in the Upper Guinea province (covering parts of southern Guinea, Sierra Leone and Liberia), the Upper Niger and Inner Niger Delta eco-regions (in Guinea and Mali) and some coastal catchments from Côte d'Ivoire to south-west Nigeria. The Volta eco-region (including Lake Volta) has between 160 and 185 species (Lalèyè and Entsua-Mensah, 2009). Some 105 fish species are present in the lake itself. While several river basins in West Africa have a relatively large number of species, the region is less uniformly rich in species than the Lower Guinea province of Central Africa. More than 550 species have been reported from Lower Guinea (Stiassny et al., 2007a; b). In Central Africa, the most species-



Photo Courtesy: Logose Perose

Figure 27: A woman sun-drying silver cyprinid fish on racks. The fish is found across East Africa, and is known locally as *dagaa*, *omena* or *mukene*

rich drainages are the lower part of the Sanaga (Cameroon), the Ogowe (Gabon), the upper Ngounie (Gabon and Congo) and the lower Kouilou systems (Congo).

Other parts of Africa have lower species numbers compared to West Africa, Lower Guinea, the Congo and the Rift Valley lakes. In North Africa, while the Nile River is the longest in the world (Revenga and Kura, 2003), not more than 30 species are recorded and assessed for most of its length. Forty-seven (47) species from Lake Nasser formed by the Aswan Dam have been recorded and assessed. In Eastern Africa, the greatest numbers of species (where 40 to 50 species have been assessed) are found upstream from Khartoum in the Blue Nile system and in the wetlands around Gambela National Park (in the west-most part of Ethiopia) that drain into the White Nile. Most of the East Coast provinces south of the Ethiopian Highlands and the eastern part of the Nilo-Sudan province have a relatively small number of species. Twenty-nine (29) species are recorded and assessed for the Tana River basin in Kenya, 39 in the Ruvu and Rufiji river basins in Tanzania, and 25 in the Ruvuma River on the border between Tanzania and Mozambique. Otherwise, most of the East Coast basins have fewer than 20 species. Southern Africa encompasses the Quanza Zambezi and Cape ichthyofaunal provinces. South Africa has fewer than 10 species. The highest number is found in parts of the Zambezi basin, upstream from Lake Kariba (more than 50 species are recorded).

The major centres of freshwater aquatic animal species diversity and endemism (including fish, molluscs and crustacean) are located in the upper Guinea River region, mainly in Guinea and Liberia, in the Democratic Republic of Congo, and in the eastern region of Madagascar. This is further heightened by diversification of *Cichlidae* species in the Great Lakes. Congo Basin is ranked number 2 after Amazon Basin in terms of the number of fish species (McGinley, 2009).

Species of limited distribution

African farmers have the potential to invest in a wide array of emerging livestock species that were in the wild and have undergone the process of domestication to produce food. These species include buffaloes, guinea fowls, ostriches, grasscutters, giant snails, guinea pigs and crocodiles.

Buffaloes

African buffaloes are found in a variety of habitats, including open savannah, woodlands and rainforests. The African buffalo or Cape buffalo *(Syncerus caffer*) is a large bovine and there are five identified subspecies (IUCN SSC Antelope Specialist Group, 2008; Groves and Leslie, 2011). *Syncerus caffer caffer* (Cape buffalo or southern savannah buffalo) is the typical subspecies, and the largest one. It is peculiar to South and East Africa. *S. c. nanus* (African forest buffalo or dwarf buffalo) is the smallest subspecies. The dwarf buffalo is common in forest areas of Central and West Africa. This subspecies is quite different from the standard species. Some researchers consider it a separate species, *S. nanus*. Hybrids between the typical subspecies and dwarf are common.

S. c. brachyceros (Sudanese buffalo) is, in morphological terms, intermediate between the above two subspecies. It occurs in West Africa. *S. c. aequinoctialis* (Nile buffalo) is confined to the savannah region of Central Africa. It is similar to the Cape buffalo, but somewhat smaller. This subspecies is sometimes included in the Sudanese buffalo. *S. c. mathewsi* (mountain buffalo or Virunga buffalo) is not universally recognised (Groves and Leslie, 2011). It lives in mountainous areas of the Democratic Republic of the Congo, Rwanda and Uganda. Depending on the subspecies, African buffaloes range from dark-brown or black (in savannah-living races) to bright-red (forest buffalo) in colour.

Guinea fowls

There are several subspecies of guinea fowl (*Numida meleagris*) on the African continent. The most common species are the Numidian type (*Numida meleagris meleagris*) or the helmeted guinea fowls, found in regions ranging from Chad to Ethiopia via Democratic Republic of Congo, Uganda and Kenya. The Saby type (*Numida m. sabyi*) is mainly found in Morocco. *Numida m. galeata* has a fairly large distribution area covering Mauritania, Senegal, The Gambia, Chad, Democratic Republic of Congo and Angola. The Somali type (*Numida meleagris somaliensis*) is found in Ethiopia, Somalia and Kenya. *Numida m. reichenowi* is found in Kenya. *Numida m. mitrata* is one of the most abundant type, ranging from Kenya, Tanzania, Mozambique and Zambia to Angola, Botswana, Zanzibar and Tumbatu (Tanzania). The Marungu type (*Numida meleagris marugensis*) is found in regions covering Congo, Angola and Zambia. The Damara type (*Numida damarensis*) is found in Angola, Botswana and Namibia. *Numida meleagris coronata* is found in South Africa (BirdLife International, 2012; Gill and Donsker, 2017).

Numida meleagris belongs to the family *Phasianidae* and the subfamily *Numidinae* and is one of the six guinea fowl species found only in Africa. Within the helmeted guinea fowls, nine (9) different subspecies are known, including *Numida ptilorhyncha*, which carries a collarette of feathers on the upper part of the neck. The subspecies is common in Madagascar, both in the domestic and the wild state. The guinea fowls live in semi-open habitats such as the savannah or semi-deserts, while some, such as the black guinea fowl, mainly inhabit forests. Figure 28 shows the helmeted guinea fowls.



Photo Courtesy: Ministry of Livestock and Fisheries, Mali

Figure 28: A flock of helmeted guinea fowls

Ostriches

Ostriches formerly occupied West, East, Central, North and Southern Africa. The ostrich or common ostrich (*Struthio camelus*) is a large flightless bird native to Africa. Ostriches prefer open land and are native to the savannah and the Sahel, inhabiting the semi-desert or true desert. Four living subspecies of ostriches are recognised (Roots, 2006; Thiollay, 2006; Clements, 2007; Sahara Conservation Fund, 2010; BirdLife International, 2016):

(a) North African ostrich (*S. c. camelus*), also called the red-necked ostrich or Barbary ostrich, lives in North Africa. Historically, it was the most widespread subspecies found in Ethiopia, Sudan, Senegal, Mauritania, Egypt and Morocco. The subspecies is considered critically endangered.

(b) The South African ostrich (*S. c. australis*), also commonly known as black-necked ostrich or southern ostrich, is found in Angola, Botswana, Democratic Republic of the Congo, Namibia, South Africa, Zambia and Zimbabwe.

(c) The Masai ostrich (*S. c. massaicus*), also known as the pink-necked ostrich or East African ostrich, is found in Eastern Africa in Burundi, Ethiopia, Kenya, Rwanda, Somalia, Tanzania and Uganda, and in Central Africa in the Democratic Republic of the Congo and Chad.

(d) The Somali ostrich (*S. molybdophanes*), also known as blue-necked ostrich, is found in Djibouti, Eritrea, Ethiopia, Kenya and Somalia.



Photo Courtesy: Ministry of Livestock, Niger

Figure 29: Ostriches at a farm in Aïr, Niger

Grasscutters

The greater cane rat or grasscutter (*Thryonomys swinderianus*) is one of the animal species that have gained popularity and a notable rise in population in Africa (Woods and Kilpatrick, 2005; Hoffmann, 2008a). *Thryonomys* is a genus of rodents, the only member of the family *Thryonomyidae*. The grasscutter's contribution to the supply of animal products is still very small, even though it has potential for demand by urban markets. It is a delicacy in western Africa.

Grasscutters are found in several countries in Africa, but the distribution is patchy and discontinuous. They only occur where there is suitable habitat. The lesser cane rat, *Thryonomys gregorianus*, is generally recorded from Central Africa, Eastern Africa and northern parts of Southern Africa, although the geographic range of this species remains poorly defined. The core area of their range appears to be centred in Eastern Africa, from extreme southern Sudan, Uganda and western Kenya southwards through Tanzania, most of Zambia and Malawi to Zimbabwe. However, there are also isolated records from Cameroon, Chad, the Democratic Republic of Congo and Ethiopia, suggesting that the distribution range may be much wider and more continuous than currently thought (Ansell and Dowsett 1988; Woods and Kilpatrick, 2005; Hoffmann, 2008b). Figure 30 shows a grasscutter from West Africa (Ghana).



Photo Courtesy: Ministry of Agriculture and Food, Ghana

Figure 30: The cane rat or grasscutter, a delicacy in Western Africa

Giant African snails

The giant African snail (*Achatina fulica*) belongs to the family *Achatinidae*, which is represented by about 200 species in 13 genera (Raut and Barker, 2002). Several species of *Achatinidae* have attained pest status within their native range when the habitat has been anthropomorphically modified as a crop system including *A. fulica* (Raut and Barker, 2002). Within the *Achatinidae*, four species are classified as giant African snails, namely *Achatina achatina, A. fulica, Archachatina marginata* and *Limicolaria aurora* (Smith and Fowler, 2003; Venette and Larson, 2004). Figure 31 shows the giant African snails that are ready for sale.

The snail originated from the coastal areas and islands of Eastern Africa. It inhabits countries ranging from Mozambique in the south, to Kenya and Somalia in the north. It has also been introduced in many other countries such as Ghana, Côte d'Ivoire, Guinea, Liberia, Sierra Leone, Nigeria and Morocco. West Africa is home to the largest species of land snail in the world (Global Invasive Species Database, 2017).



Photo Courtesy: AU-IBAR

Figure 31: Reared Giant snails ready for the market

The snail is not a migratory species and has, therefore, been introduced to countries outside Eastern Africa, possibly through agricultural transportation, commerce, trade, vehicle attachment, smuggling, and other accidental and purposeful ways (Cowie, 2010; Egonmwan, 2007; Stokes, 2006; Vogler, et al., 2013).

Guinea pigs

Guinea pigs (*Cavia porcellus*) are generally not covered by livestock statistics; therefore, their full extent in Africa is virtually unknown (Nuwanyakpa et al., 1997; Perry et al., 2002). *C. porcellus* in Africa is kept as livestock in Benin, Burkina Faso, Cameroon, the Republic of Congo, Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Nigeria, Senegal, Sierra Leone, Tanzania and Togo (Ngou Ngoupayou et al., 1995). In the Democratic Republic of Congo, they can be found both in peri-urban environments as well as in rural regions, such as in South Kivu. They are also frequently held in rural households in the Iringa Region of southwest Tanzania.

Guinea pigs are not original to Africa. They were brought in from South America. The strain or line of guinea pig breeds found throughout West Africa is presumably of indiscriminate genetic origin. In the northwest province of Cameroon, the guinea pig is characterised by a tri-coloured coat pattern; black and red pigmentation with varying degrees of white spotting (Lukefahr, 1984). On some farms, the pelage variation gives the smooth or rough-haired coat pattern.



Photo Courtesy: Drs Félix Meutchieye & Ayagirwe Rodrigue, Univeristy of Dschang, Cameroon

Figure 32: Polychrome-coat patterned guinea pigs

Crocodiles

Genetic analysis of Africa's crocodiles has revealed that there are at least seven distinct species. Historically, only three species of crocodiles were recognised in Africa, namely Nile crocodiles (*Crocodylus niloticus*), dwarf crocodiles (*Osteolaemus tetraspis*) and the slender-snouted crocodile (*Crocodylus cataphractus*). Several recent studies have revealed that there is more depth to these creatures.

A study published by Eaton (2010) revealed that there are actually three species of dwarf crocodile – *O. tetrapis, O. osborni* and a third currently unnamed species. This discovery was followed by a study by Hekkala, et al. (2011) which reported that the Nile crocodile is actually two very divergent species. A latest study by Shirley, et al. (2013) has reported that what was thought to be a single species of slender-snouted crocodile is actually two. The species is composed of a central African population (*Mecistops cataphractus*) and an unnamed West African population.

The Nile crocodile is quite widespread throughout Africa and lives in different types of aquatic environments such as lakes, rivers and marshlands. The crocodiles are widely found in Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Egypt, Ethiopia, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Côte d'Ivoire, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Mauritania, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, the DRC, Zambia and Zimbabwe (Fergusson, 2010). Isolated populations also exist in Madagascar. Figure 33 shows the Nile crocodile in Zimbabwe.

The substantial variation seen within *C. niloticus* across its enormous range has resulted in the naming of seven subspecies, namely (1) *C. n. africanus* (informally named the East African Nile crocodile), (2) *C. n. chamses* (or the West African Nile crocodile), (3) *C. n. corviei* (the South African Nile crocodile), (4) *C. n. madagascariensis* (Malagasy crocodile), (5) *C. n. niloticus* (Ethiopian Nile crocodile), (6) *C. n. pauciscutatus* (Kenyan Nile crocodile), and (7) *C. n. suchus* (Blake and Jacobsen, 1992; Schmitz et al., 2003).

The dwarf crocodile's distribution ranges across tropical lowland regions of West and Central Africa. Such a distribution greatly overlaps with that of the slender-snouted crocodile, which is native to freshwater habitats in Central and West Africa. West African populations of the reptile do not



Photo Courtesy: Binga Crocodile Farm

Figure 33: Nile crocodiles at the Binga Crocodile Farm in Zimbabwe

share the same genetic information or specific physical features as Central African populations. In West Africa, the species is found in Côte d'Ivoire, Gambia, Ghana, Guinea, Liberia, Nigeria, Senegal and Sierra Leone. It is likely *expatriated* from Benin, Burkina Faso, Guinea-Bissau, Mali and Togo. In Central Africa, the species occurs in Cameroon, Central African Republic, the Democratic Republic of Congo, Gabon, Republic of Congo and Tanzania. It is likely *expatriated* from Angola, Chad, Equatorial Guinea and Zambia (Waitkuwait, 1989).

Population trends in FAnGR

Livestock population trends

Table 10 shows an increase in the populations of virtually all the livestock species in Africa over a 14-year period, while subsequent pages illustrate population trends over the same period in the different regions. The livestock involved include cattle, sheep, goats, pigs and camels.

Overall, the number of cattle reared for human consumption increased by 37 per cent between 2000 and 2014, from 226.6 million to 310.2 million respectively. During the same period, the goat population grew by 0.54 per cent and reached 364.3 million in 2014. The sheep population reached 340.5 million, while the pig population grew by 58 per cent to reach 34.5 million.

Table 10

Population trends of the main livestock in Africa from 2000 to 2014

	Cattle	Sheep	Goats	Pigs	Camels
2000	226,623,962	246,505,821	236,852,594	21,823,023	16,495,847
2001	230,417,007	252,494,057	246,916,924	21,654,951	17,109,201
2002	234,628,128	258,033,109	254,870,038	22,932,270	17,558,601
2003	239,912,715	261,845,100	261,681,158	22,717,813	18,043,708
2004	242,372,136	270,181,300	272,066,228	23,764,620	18,818,682
2005	250,492,301	276,586,689	280,487,138	24,899,243	18,730,533
2006	255,295,950	280,883,688	282,358,153	25,681,830	18,674,586
2007	267,527,147	294,956,982	308,160,173	26,968,901	21,541,795
2008	276,301,005	297,892,772	320,307,897	28,538,486	22,471,528
2009	280,491,930	303,473,514	323,648,218	29,650,523	21,974,851
2010	286,068,809	309,936,196	330,646,650	31,510,950	22,656,897
2011	291,031,537	316,997,768	335,622,246	31,394,718	22,849,397
2012	300,331,293	324,529,497	350,377,570	32,984,128	22,816,099
2013	303,913,049	333,361,940	364,374,570	33,814,276	23,249,678
2014	310,277,515	340,502,679	364,338,248	34,536,408	23,554,306
Growth %	37	38	54	58	43

East Africa is endowed with a rich resource of locally adapted livestock breeds; this diversity is exemplified by the presence of some unique breeds. The livestock population is made of 156.5 million cattle, 91 million sheep, 134.8 million goats, 11.6 million pigs and 11 million camels. The majority of these cattle (95 per cent) are indigenous, with an estimated 60 per cent found in the arid and semi-arid uncultivable zones that comprise 70 per cent of East Africa's ecosystems. Sudan and Ethiopia are among the countries with the highest cattle populations. Figure 34 shows the Sheko breed, which is considered endangered in the world.

Figure 35 shows the changes in livestock population in East Africa with the number of cattle, goats and sheep having increased considerably. The number of cattle increased by 62 per cent from 98 million to 156 million.



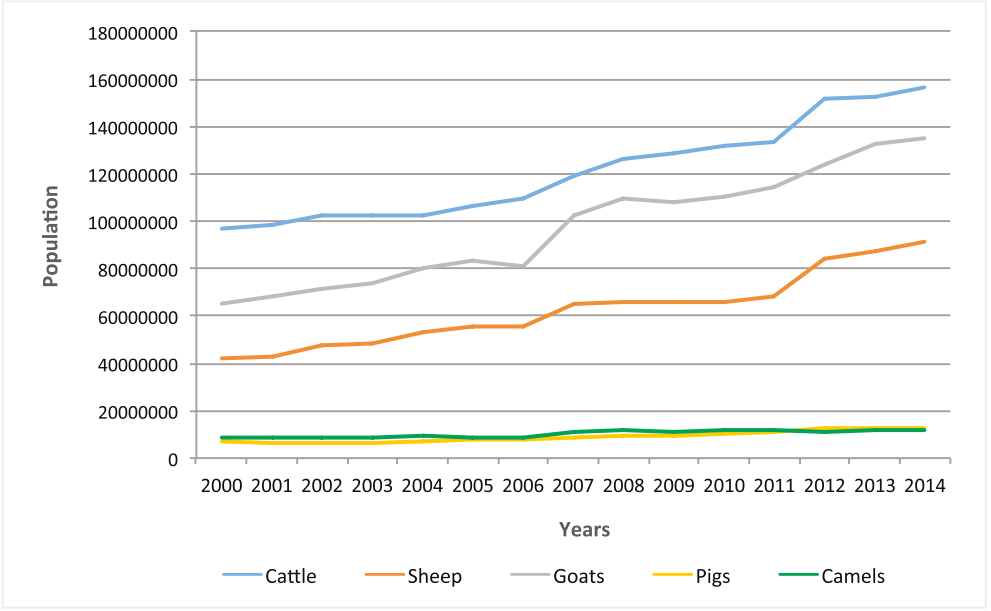
Photo Courtesy: AU-IBAR

Figure 34: An Ethiopian livestock keeper with a Sheko bull, one of the endangered cattle breeds in the world

During the same period, the sheep and goat population grew by 38 per cent and 54 per cent respectively.

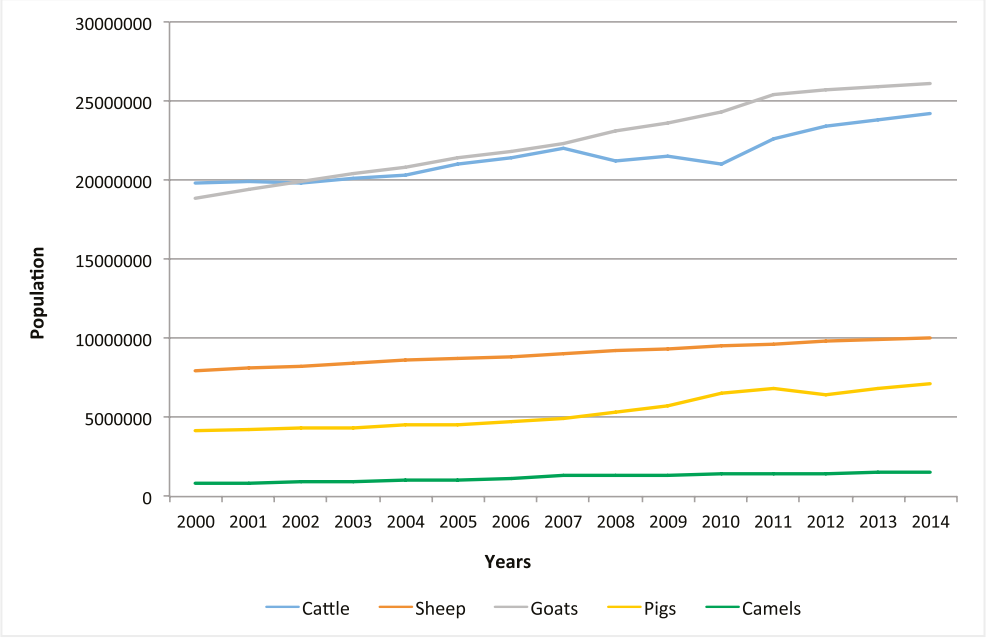
In Central Africa, the livestock population is made up of about 24 million head of cattle, 10 million sheep, 26 million goats, 7 million pigs and 1 million camels. Cattle represent 35 per cent, small ruminants 52 per cent, pigs 10 per cent and camels 2 per cent of the total population. Figure 36 shows that cattle and goats are the most common species and are present in all the countries. They are followed by sheep and pigs, while camels are less common.

As Figure 36 shows, livestock numbers have been continuously evolving for each species since 2000, though the trend has been slow for sheep, pigs and camels. The region has significant pig populations with reported figures for pigs and camels in 2014 being 7 million and 1.5 million respectively. Figure 37 shows the Kuri cattle, which is considered an endangered breed in the world.



Source data: FAO statistical database

Figure 35: Livestock population trends in East Africa between 2000 and 2014



Source data: FAO statistical database

Figure 36: Trends in livestock populations in Central Africa between 2000 and 2014



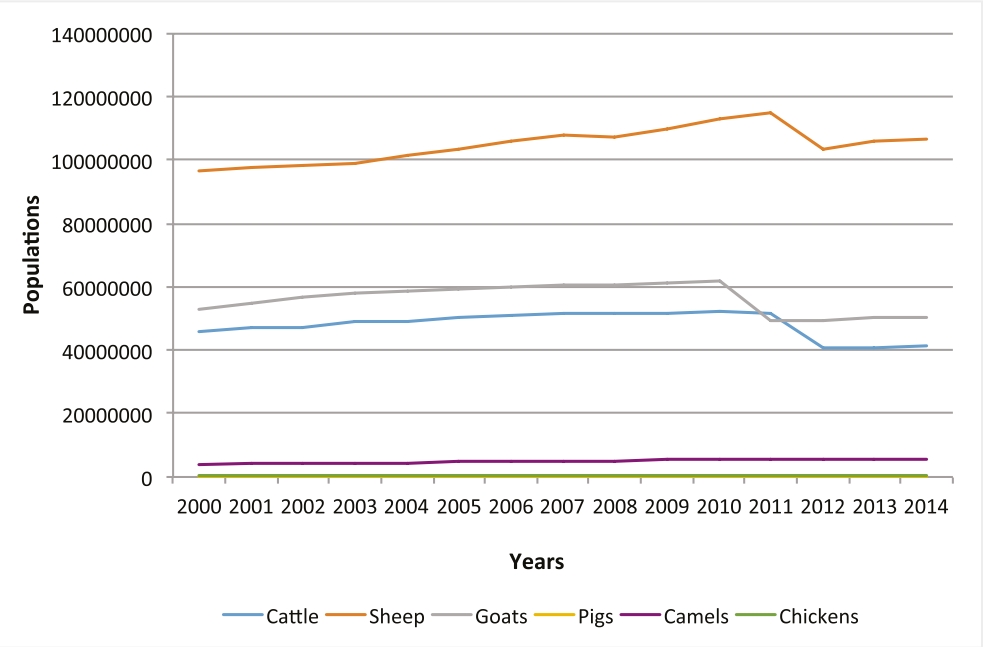
Photo Courtesy: Ministry of Pastoral Development and Animal Productions, Chad

Figure 37: A pastoralist with his Kuri bull, one of the endangered cattle breeds in the world

North Africa recorded the largest sheep population with approximately 106.4 million head, followed by goats at 50.5 million head, cattle 41.1 million head, camels 5.7 million head and pigs 29,000 head. Pig production is low to nearly non-existent in North Africa. As Figure 38 shows, the livestock sectors, except for the sheep production, in most of the countries have stagnated for a long time. Cattle, sheep and goats did not show any particular trends in their numbers from 2000 to 2014.

The figure further indicates that livestock populations in North Africa (cattle, sheep and goats) initially increased. The sheep increased to 114.8 million, the goats to 61.8 million and cattle 49.4 million until the period 2010-2011, and thereafter declined to 106.4 million, 50.6 million and 41.1 million, respectively, in 2014.

Southern Africa is endowed with a diversity of livestock and their population estimates are as follows: 48 million for cattle, 31 million for sheep, 35 million for goats, 12 million for pigs and 88 head for camels. Camels are the least among the mammalian species as Figure 40 shows.



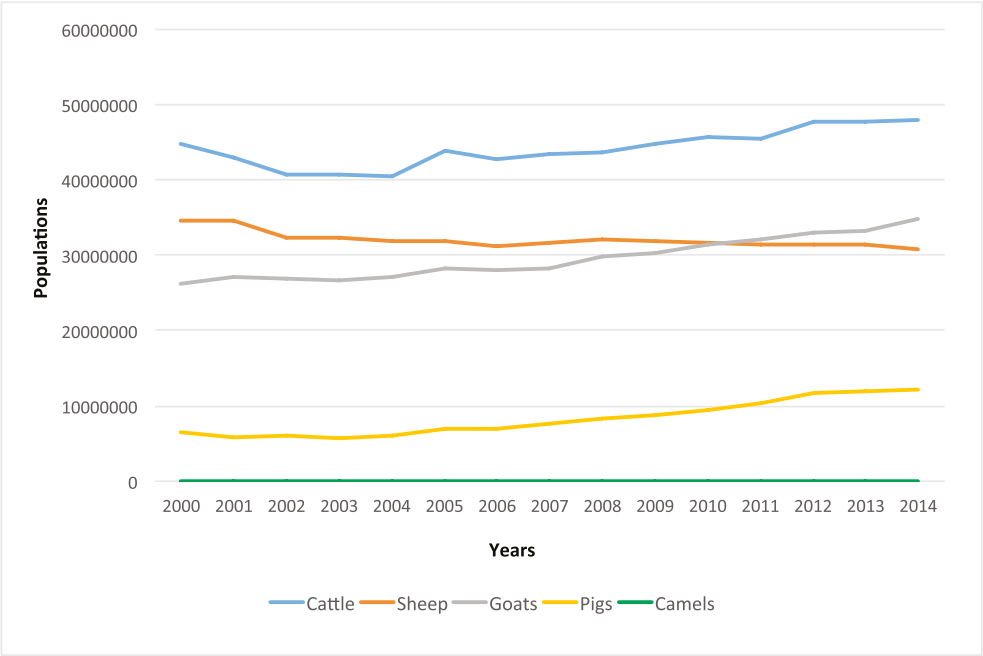
Source data: FAO statistical database

Figure 38: Trends in livestock populations in North Africa between 2000 and 2014 (In North Africa, the number of chickens is negligible.)



Photo Courtesy: Ministry of Rural Development, Mauritania

Figure 39: A thin-tailed hair Peulh sheep in Mauritania



Source data: FAO statistical database

Figure 40: Trends in livestock populations in Southern Africa between 2000 and 2014 (In Southern Africa, the number of camels is negligible.)

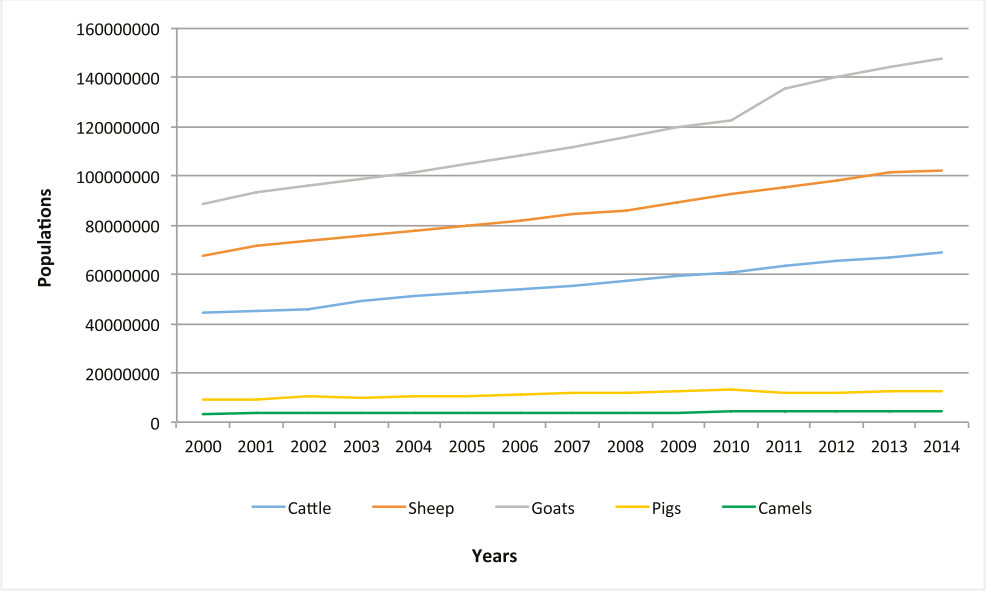
Although Southern African countries have a large livestock pool, the numbers in most of the countries have stagnated for a long time. Small ruminants showed declining trends from 2000 to 2014. Growth pattern of sheep and goats showed a negative growth rate of 8 per cent and 53 per cent per annum, respectively. The number of cattle did not change during the same period (from 2000 to 2014). Figure 41 shows the Angora goat, known for wool and mohair.

In West Africa, the main species numerically are goats and sheep, followed by cattle, as Figure 42 shows. The figure also shows an increase in the populations of virtually all the species from 2000, with the number of cattle increasing by 55 per cent, from 44.3 million in 2000 to 68.5 million head in 2014. During the same period, the goat population grew by 67 per cent and reached 147.3 million in 2014. The sheep population reached 102.4 million, while the pig population grew by 43 per cent to reach 12.6 million. With this growth in the different livestock species, this is an exceptional region for livestock rearing.



Photo Courtesy: Ministry of Agriculture and Food Security, Lesotho

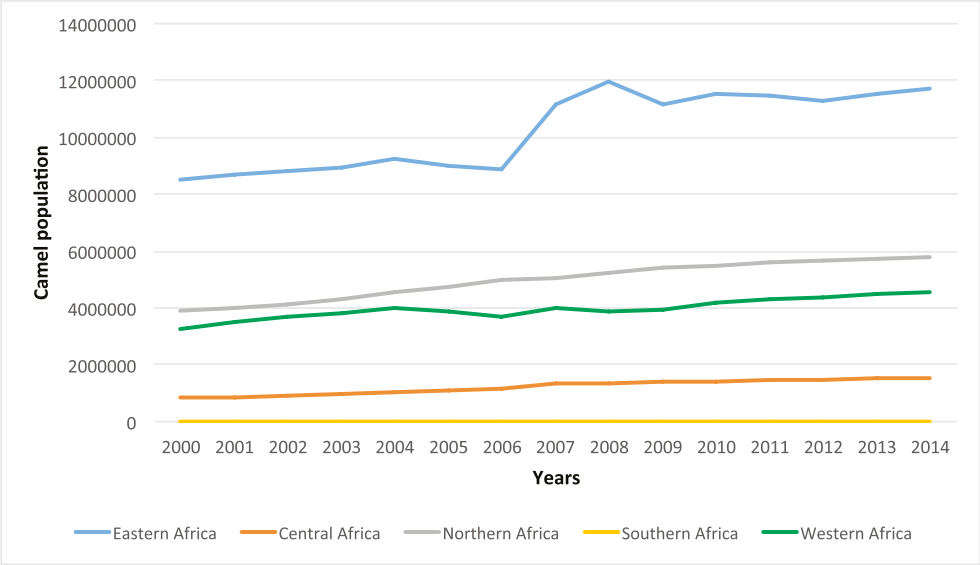
Figure 41: Angora goat, which is known for wool and mohair production in Lesotho



Source data: FAO statistical database

Figure 42: Trends in livestock populations in West Africa between 2000 and 2014 (In West Africa, the number of camels is negligible.)

As Figure 43 shows, the African camel population is increasing regularly. In 2014, there were approximately 23.5 million camels in Africa. The growth rate (43%) was not similar for all the regions. In Eastern and Western Africa, the populations increased slowly (37% and 40%, respectively) whereas in other regions like Northern and Central Africa, the growth was significant at 48 per cent and 87 per cent, respectively. Approximately 11.7 per cent of camels are in the arid areas of Africa, particularly in Eastern Africa (Somalia, Sudan, Ethiopia and Kenya).



Source data: FAO statistical database

Figure 43: Trends in camel population in Africa by regions between 2000 and 2014 (In Southern Africa, the number of camels is negligible.)

All the regions of Africa recorded substantial growth in chicken population from 2000. As Table 11 shows, the chicken population increased by 56 per cent, from 1.19 billion in 2000 to 1.8 billion in 2014. North Africa is one of the most important regions on the continent in terms of chicken populations.

Table 11

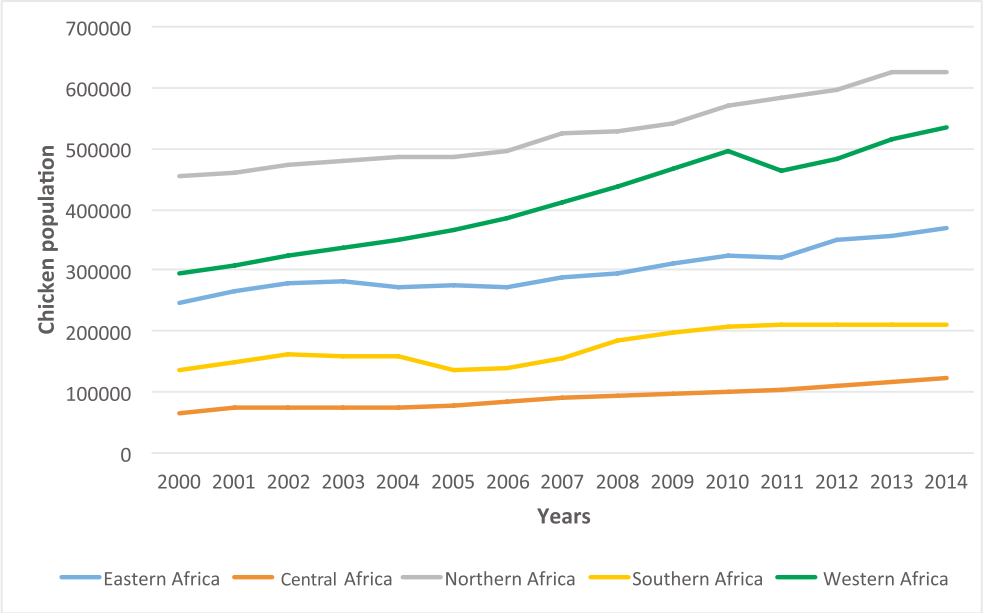
Trends in chicken populations (×1000 head) in Africa by regions between 2000 and 2014

	East Africa	Central Africa	North Africa	Southern Africa	West Africa	Africa
2000	246,451	65,230	454,664	137,100	293,519	1,196,964
2001	267,125	73,551	461,237	149,950	307,996	1,259,859
2002	278,528	73,007	473,000	160,600	324,051	1,309,186
2003	280,681	73,410	481,000	157,300	337,877	1,330,268
2004	272,748	73,940	485,000	158,300	351,464	1,341,452
2005	273,969	78,275	485,000	134,800	366,141	1,338,185
2006	270,981	84,850	495,000	139,840	384,982	1,375,653
2007	287,319	89,528	524,724	154,793	410,039	1,466,403
2008	295,188	94,344	526,902	183,505	437,726	1,537,665
2009	310,390	96,878	539,899	198,871	465,840	1,611,878
2010	323,535	100,382	569,816	207,863	495,449	1,697,045
2011	321,902	104,654	583,600	210,834	463,548	1,684,538
2012	349,789	109,629	595,600	210,580	482,237	1,747,835
2013	355,871	116,082	624,167	210,631	516,393	1,823,144
2014	368,660	122,225	626,252	210,600	535,335	1,863,072
Growth %	50	87	38	54	82	56

Figure 44 indicates that the chicken industry in Central Africa and West Africa in particular has been rapidly expanding in recent years, while the populations from Central Africa and West Africa grew faster at 87 per cent and 82 per cent respectively, to reach 122.2 million and 535.3 million in 2014, respectively.

Population trends in other livestock species

The other species include bees, donkeys and horses, and rabbits and hares. Bee products, including honey and wax, can be collected from the wild, but these have been largely backyard activities. In East and Southern Africa, farmers are being assisted by the International Centre for Insect Physiology and Ecology (ICIPE) to take up apiculture. National and international outlets for the marketing of high-quality honey have been established and



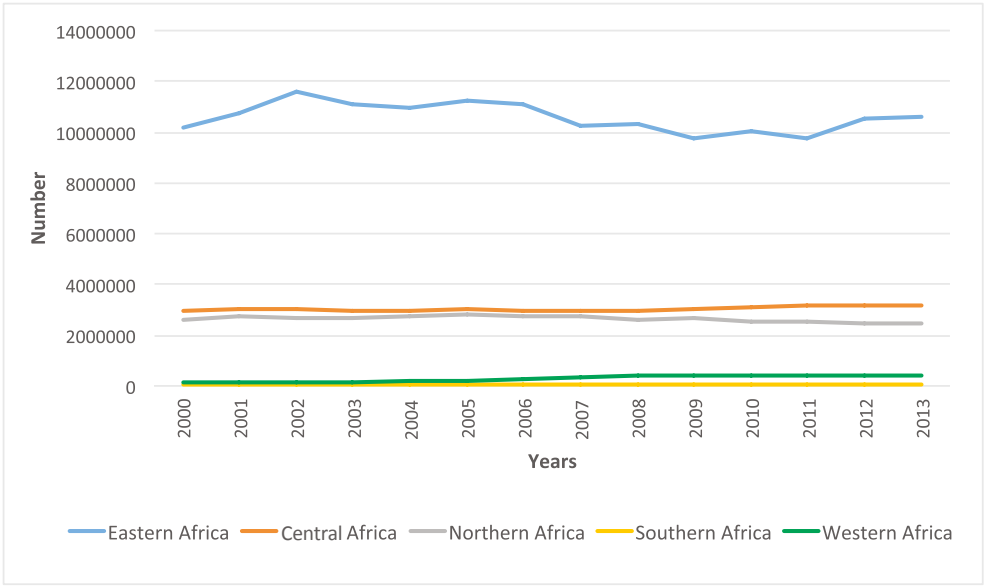
Source data: FAO statistical database

Figure 44: Trends in chicken population in Africa by region between 2000 and 2014

over 3, 500 individual farmers from Uganda, Tanzania, Kenya, Ethiopia and Eritrea have received training in improved beekeeping techniques from ICIPE. In Uganda, beekeeping is becoming a particularly popular activity among women, with several organisations providing advice on management of bees and marketing of honey (Mujuni et al., 2012). There are national research and extension programmes promoting beekeeping in most countries on the continent, and promoting the honey and hive product value chain has been done by several local and international non-governmental organisations, as well as AU-IBAR's apiary programme.

According to Figure 45, there were about 10.6 million managed hives in East Africa in 2013. Estimates of managed hives in Central Africa and North Africa were 3.1 million and 2.4 million respectively. Based on the studies done, there has been no comprehensive assessment of the status and trends of pollinators and pollination services in Africa (Martins et al., 2009; Gemmill-Herren et al., 2014; Melin et al., 2014); hence, the current status of almost all wild pollinator populations is unclear and difficult to assess due to the lack of data.

Beekeeping is unique in Africa as it is the only region that has the presence of large populations of native honeybees still existing in the wild (Pirk et al., 2014). It should be noted that there are inherent difficulties in determining



Source data: FAO statistical database

Figure 45: Trends in the number of beehives in Africa by region between 2000 and 2013 (The number of beehives in Southern Africa is negligible.)

trends in the number of honeybee colonies for biological and sociological reasons, and these trends are often confounded with rates of colony mortality. Specifically, it is difficult to determine the number of honeybee colonies in a geographic locality in Africa for the following five reasons:

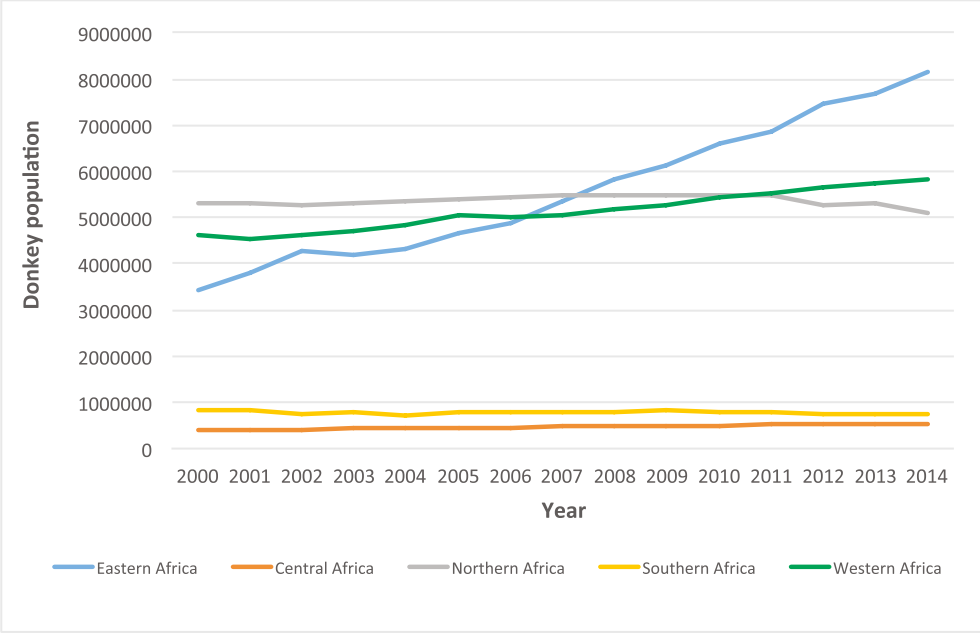
1) Unlike other livestock, a honeybee colony can be divided by a beekeeper into two or more parts during the active season to multiply colony numbers and, conversely, colonies can be united into one in periods of flower dearth or cold temperatures;
2) An entire honeybee colony may depart (abscond) or be acquired as a passing swarm;
3) Beekeeping is a labour-intensive activity and colonies are often not registered;
4) There are unknown numbers of wild honeybee colonies in Africa; and,
5) There is variation across nations in how data on colony numbers are collected and interpreted.

These factors contribute to the distortion of reports on colony numbers (the total number of colonies at any one point in time) and annual rates of colony mortality (the proportion of colonies that die in one year)

(Johannsmeier, 2001 and Dietemann et al., 2009). However, in most countries, an estimate of the number of colonised beehives and the number of beekeepers does give a fair indication of the scale of operation, economic role and production levels of the enterprise (Kugonza, 2009). Nevertheless, many beekeepers simply give the number of sited beehives, which is grossly erroneous due to the high mobility of the species.

The total African donkey population was 20.3 million in 2014, as Figure 46 illustrates. The population change per year (39%) has not taken place evenly over the continent. Most of the increase has been in the semi-arid areas, notably in East (137%) and Central (34%) Africa. The large population estimates in North Africa remained fairly constant over the years, while the population estimates in Southern Africa seem to be particularly low and have also stagnated. There are very few donkeys in the humid, forested areas of Central Africa. In the East African region, the number of donkeys has nearly tripled from 3.7 million in 2000 to 8.14 million in 2014.

In 2014, there were about 6 million horses in Africa. Most of them are found in Eastern Africa (2 million) followed by Western Africa (1.9 million). Figure 47 illustrates the estimates of horse populations in all

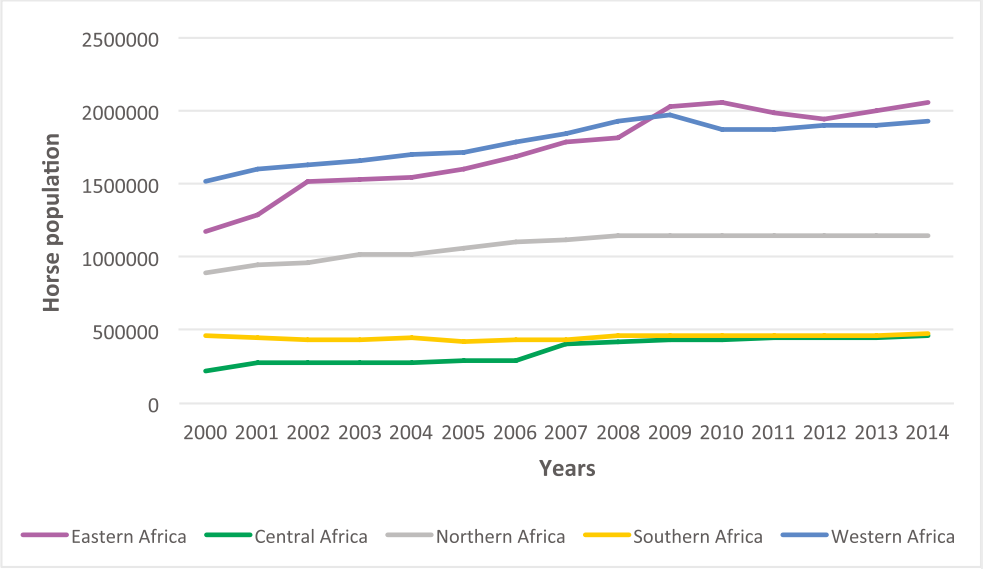


Source data: FAO statistical database

Figure 46: Trends in estimated donkey population in Africa by region between 2000 and 2014

the regions of Africa from 2000 to 2014. As the figure shows, the horse population has gradually increased since 2000. However, the population changes have not taken place evenly over the continent with much of the increase having been in Western Africa (27%) and Eastern Africa (76%).

African rabbits are found throughout the continent. They are particularly favoured for poverty reduction programmes on account of their low investment and early benefits, and subsistence on renewable resources for feeding, housing and general management.

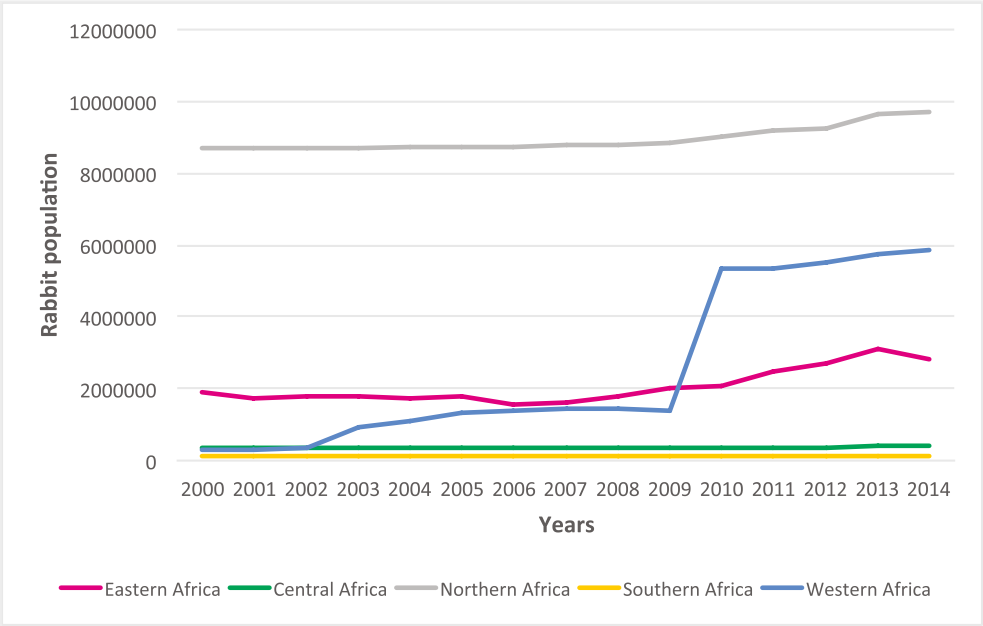


Source data: FAO statistical database

Figure 47: Estimates of the horse populations in Africa by region between 2000 and 2014

Several countries, among them Ghana, Kenya, Malawi, Mauritius, Mozambique, Nigeria, Sudan, Tanzania, Togo and Zambia, now have national rabbit-raising programmes.

The total number of rabbits was approximately 18.8 million in 2014, as Figure 48 shows. The population trend of rabbits in Southern and Central Africa was low and stable from 2000 to 2014. The population was static in Northern Africa until 2010 and increased slightly thereafter. A similar trend was observed in Eastern Africa, while Western Africa has seen the population double between 2009 and 2010.



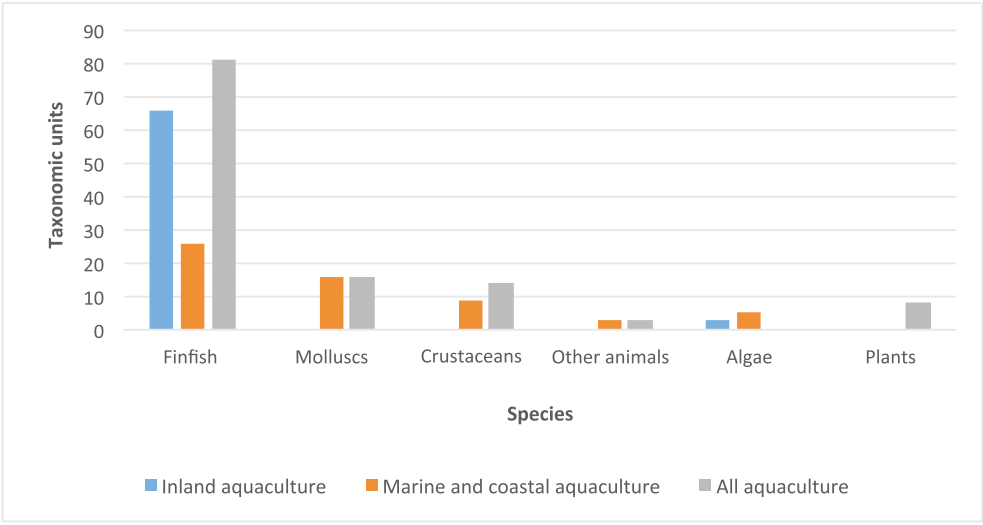
Source data: FAO statistical database

Figure 48: Trends in rabbit populations in Africa between 2000 and 2014

Population trends of fish and aquaculture

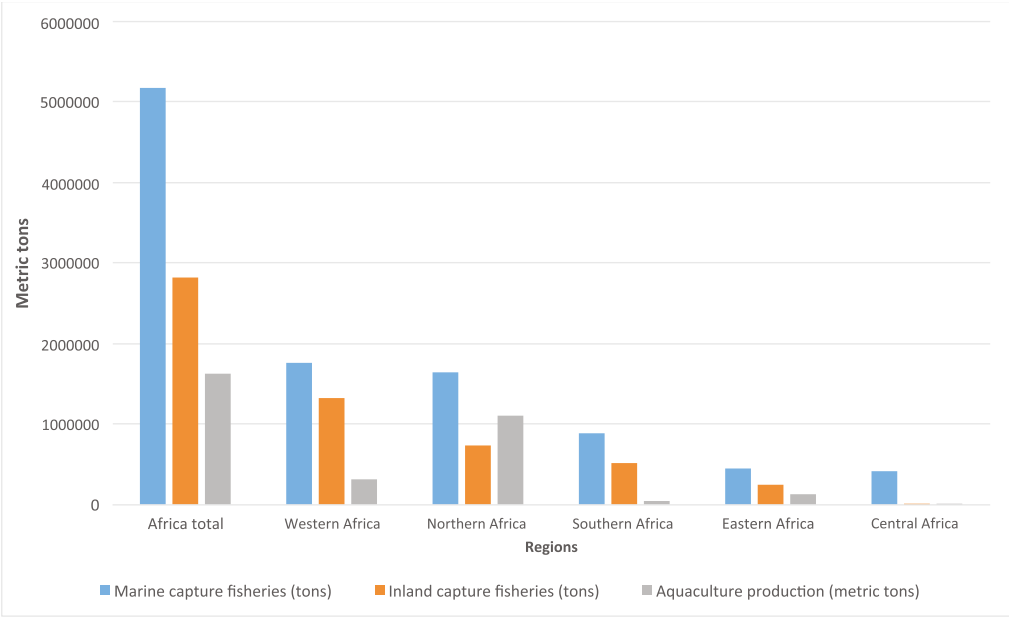
Reliable data and statistics on continental fisheries in Africa are lacking, making the biomass difficult to assess (FAO and WorldFish Centre, 2008). Most countries do not have effective data collection systems that can be considered useful in collecting aquaculture production statistics. The presence data collection systems is critical for monitoring, evaluating the performance and justifying the allocation of resources to the sector. This is in part due to the low priority given to the sector and the complexity of collecting data from dispersed rural farmers (Machena and Moehl, 2001). Figure 49 gives the number of taxonomic units that countries have reported to FAO for the production of the first report on the State of the World's Aquatic Genetic Resources for Food and Agriculture. For marine and coastal aquaculture, 59 taxonomies were reported, while 69 were reported for inland aquaculture.

The relatively few fish species farmed in Africa in relation to the size, habitat diversity of the continent and the potential number of species available for farming demonstrates the potential for further use of aquatic genetic resources in African aquaculture (FAO, 2016). Figure 50 shows recorded production of all fish by region in 2013, broken down by marine and inland capture fish and aquaculture.



Source data: FAO (2016)

Figure 49: Aquaculture taxonomic units in Africa as reported to FAO

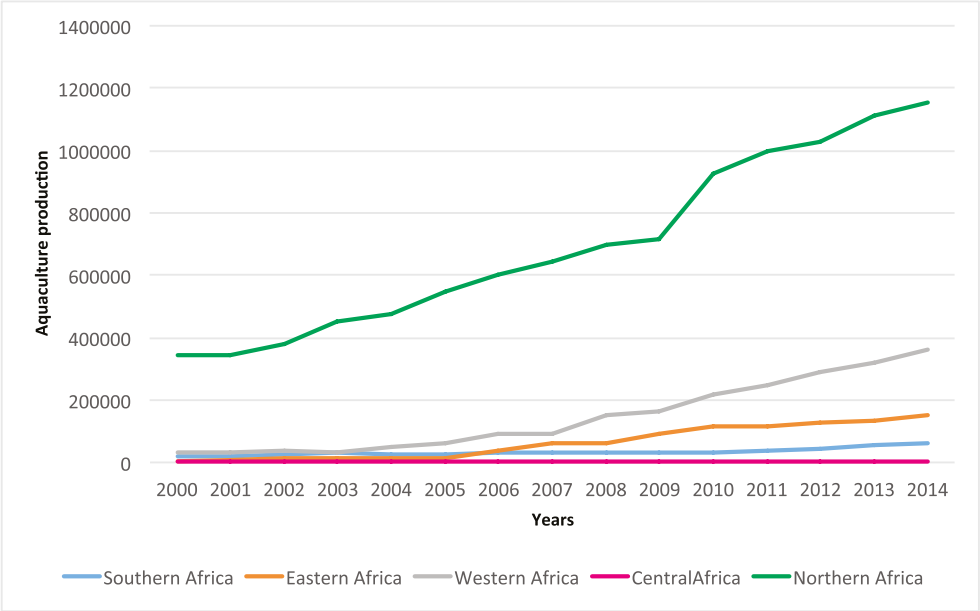


Source data: FAO (2016); World Bank (2016)

Figure 50: Production of marine and inland capture fisheries and aquaculture in Africa by region, 2013

According to the figure, Western Africa had the largest production of marine and inland capture fish (1,763,872 and 1,318,114 metric tons, respectively). For aquaculture, the largest production was recorded in Northern Africa (1,112,919 metric tons).

Figure 51 shows that, over the period 2000 to 2014, aquaculture production grew rapidly in Western and Northern African regions. In all the other regions, the production has remained stagnant.



Source data: World Bank (2016)

Figure 51: Trends in aquaculture production in Africa by region between 2000 and 2014 (Aquaculture production in Central Africa is negligible.)

Eight countries account for the majority of the production of aquaculture, namely Egypt (1,137,091 tons), Nigeria (313,231 tons), Uganda (111,023 tons), Ghana (38,545 tons), Kenya (24,098 tons), Zambia (19,281 tons), Madagascar (16,833 tons) and Tunisia (11,279 tons).

Improving the efficiency and sustainability of Africa's marine and inland fisheries will help boost the overall production. Only in the last decade has aquaculture gained popularity with overall production rising. However, this is still only a small fraction of the continent's total fish output. Even in countries where production is still very low, the sector is receiving greater attention. The market for African catfish in the continent is developing. Demand for fish is continuously increasing, and most major producing countries are substantial importers of fish to meet their population needs. The market will certainly expand through the development of new fish products and value-added processing.

Population trends in species of limited distribution

The rearing of emerging or non-conventional livestock species is expanding throughout Africa (Vietmeyer, 1984; Pich and Peters, 1985). As the human populations grow and farms get smaller, the protein requirements of many rural people will have to increasingly be met by small, short-cycle livestock species. Non-conventional animal species are currently not utilised to their full potential. Awareness and scientific understanding of non-conventional livestock is increasing and the development of this sector has been shown to be sustainable by not only fulfilling nutritional and income-generating requirements, but also serving to protect the environment.

Grasscutter

The Government of Ghana and NGOs have been promoting grasscutter production in the Brong Ahafo region of the country since 2007 (Box 3). Lack of breeding stock is the main constraint though. Most of the local breeds originating in the wild adapt well to captivity, reproduce very quickly, require minimal care and have good resistance to disease. This is helping to promote peri-urban and even urban farming of the grasscutter. In countries bordering the Gulf of Guinea, commercial grasscutter farms, each with more than 1,000 animals, are achieving high productivity levels (*West Africa Trends Newsletter, 2014*).

Box 3: Specialised veterinary officers in charge of grasscutter care in Ghana

To support the fledgling industry, the Government of Ghana has created a sub-sector, under the Ministry of Agriculture, with specialised veterinary officers in charge of grasscutter care. It has also developed programmes to assist prospective grasscutter farmers with grants and loans at 2 per cent interest. As a result of such interventions, Benin is now the leading producer of grasscutters in the world, with some very successful farmers able to house 7,000 animals, compared to 150 for the most successful farmers in Ghana.

The private sector is also very active in promoting grasscutter farming, with a number of farms and consultants offering technical expertise and supplying breeding stock to those entering the industry. There have been promising results where interventions have been implemented. In one district in Ghana, intervention through the German Development Cooperation has seen 20 poor farmers increase the stock from 5 to 15 within two years, with women constituting about 30 per cent of the farmers trained. One of Heifer's Project's most successful grasscutter farmers makes at least US$1,400 per year from his grasscutter operation alone, which is about double the average annual income of other Ghanaians. The prospects for grasscutter farming look good. One important area for research in grasscutter farming is the development of docile breeds of animals to enhance domestication efforts. Research to develop the sector, market for both fresh and production needs investment in addition to extension services for appropriate technology transfers to small-scale farmers. Benin provides good examples of how to go about this. Emerging private sector initiatives also need support and strengthening as an alternative model.

Source: West Africa Trends Newsletter, 2014

The taste of the grasscutter is well appreciated and so the demand for it is high irrespective of the availability of conventional meats. Additionally, grasscutter is central to the livelihood of many poor rural dwellers who consume and trade in it. Approximately 80 million grasscutters are hunted each year in West Africa (Bolton, 2012). Part of the popularity of the grasscutter is due to its perceived superior nutritional value. The relatively low fat and cholesterol content makes grasscutter a meat of choice for an emerging health-conscious middle class population in the region. The steady growth of this population is an indication that demand is likely to increase rapidly in future (*West Africa Trends Newsletter, 2014*).

Giant African snails

For hundreds of years, Africa has had an appetite for snails. Traditionally, most of the snails are gathered from the wild during the rainy season. Therefore, snails handpicked from the bush have been the only way to get snails to the market. However, as Africa's human population increases and the forests continue to be sacrificed to give way to human habitation, the (bush) supply of snails cannot cope with the demand. To promote agribusiness in Nigeria and Ghana, farmers keep snails for subsistance and export to Europe and USA.

Buffaloes

Historically, buffaloes were found throughout most of Africa. Today, their distribution is considerably reduced and in many parts of the continent, they are largely confined to game reserves. Their population is estimated at 4.8 million head, and in Eastern Africa, the buffalo population is about one million head. Although the African buffalo is not in danger of extinction, populations in the mountains of West and Central Africa are rapidly declining. About 27,000 buffaloes are found in West Africa, 133,000 in Central Africa, 3 million in North Africa and 670,000 in Southern Africa. Recent population estimates of wild buffaloes in Africa within protected

areas are presented in Table 12.

Table 12

Population estimates of wild buffaloes in African countries

Country	Population estimates
Angola	<500
Benin	>2,000
Botswana	8,050 (plus 18,840 in other areas)
Burkina Faso	1,620
Burundi	500
Cameroon	3,210
Central African Republic	19,000
Chad	1,020
Congo	39,180
Côte d'Ivoire	>8,330
Ethiopia	2,330
Kenya	> 11,630 (plus 7,930 in other areas)
Malawi	>3,150
Mali	120
Mozambique	9,570
Namibia	690 (plus 310 in other areas)
Niger	500
Nigeria	>200
Rwanda	1,200
Senegal	4,000
South Africa	28,470 (plus >2,500 on private land)
Sudan	>100
Tanzania	>245,000 (plus 97,350 in other areas)
Uganda	>20,220
Zambia	>40,090 (population for entire country)
Zimbabwe	>50,330 (population for entire country)

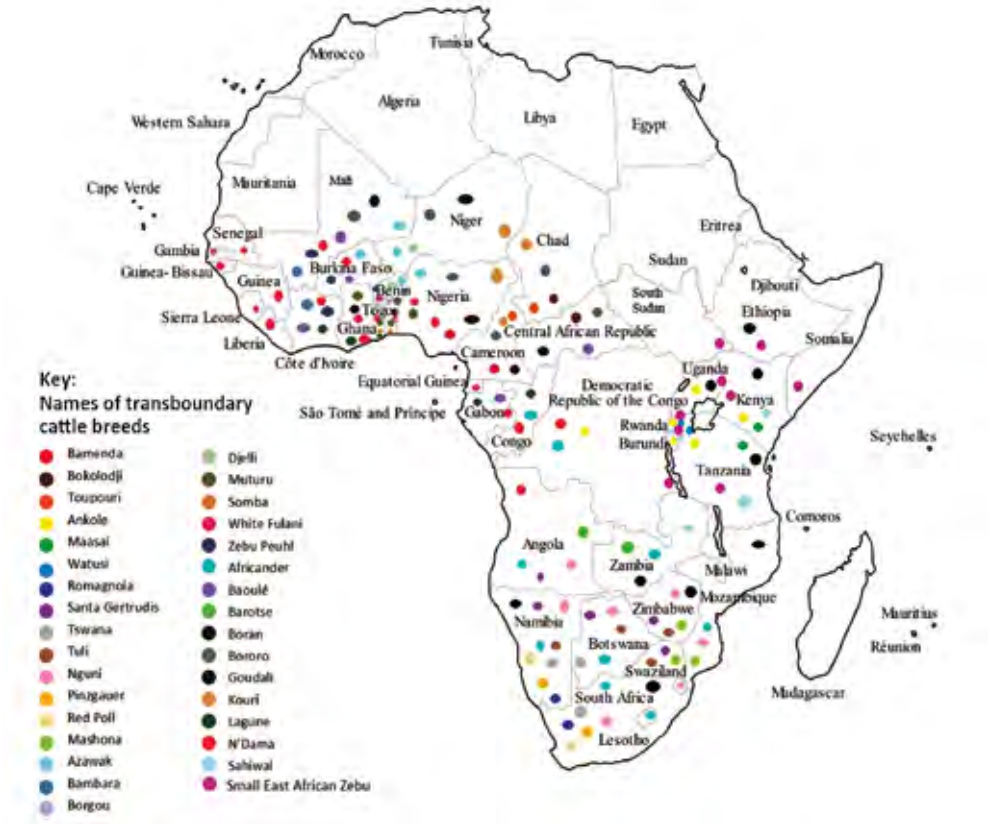
Source: San Diego Zoo (1999)

Transboundary breeds

Geographically, transboundary breeds are found throughout Africa and are not restricted to particular regions. There are significant numbers of regional transboundary breeds and this highlights the need for cooperation

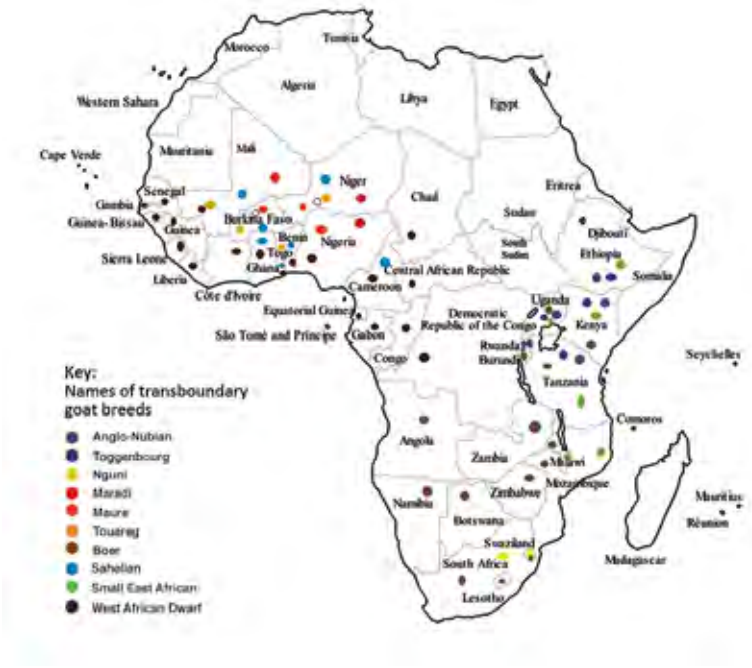
at regional or sub-regional levels in order to ensure sustainable development, utilisation, management and conservation of these genetic resources. Figures 52 through 59 give the distribution of some transboundary breeds in Africa, with pictures of some selected resources per region highlighting their specific attributes.

In Eastern Africa, the selected breeds are the Boran cattle, the Ankole cattle, the Red Maasai sheep and the small East African goat. The Boran cattle are a prized possession to many farmers in Kenya, Ethiopia and Somalia. Due to their exceptional performance, the breed has earned itself the name "God's gift to herdsmen". It is a good grazer and is heat-tolerant (Gaughan et al., 1999). The Ankole longhorn breed (Figure 55) is found in Tanzania, Burundi, Rwanda and Uganda. The breed possesses the ability to survive on poor forage without supplementary feeding; it is drought-resistant, tolerant to ticks and helminths and relatively resistant to East Coast Fever (Ndumu



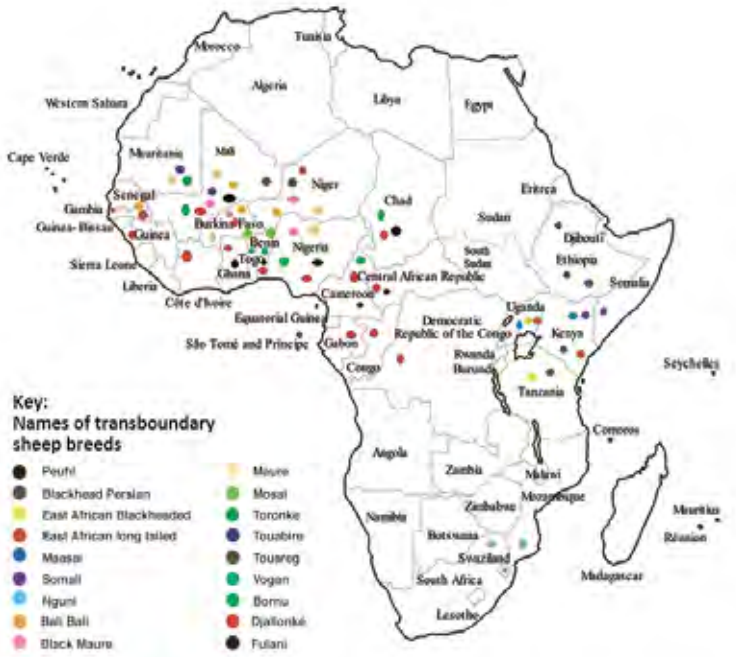
Source: Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 52: Distribution of some African transboundary cattle breeds



Source: Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 53: Distribution of some African transboundary goat breeds



Source: Country Reports, (2005; 2014); AU-IBAR questionnaires, (2014)

Figure 54: Distribution of some African transboundary sheep breeds



The Red Maasai sheep is fat-tailed and is found in the East African region. The breed is resistant to intestinal helminths (Baker et al., 1999; Baker et al., 2003) and is also drought-resistant (Kosgey, 2004).

The Boran cattle are a prized possession to many farmers in Kenya, Ethiopia and Somalia. Due to its exceptional performance, the breed has earned itself the name "God's gift to herdsmen". It is a good grazer and is heat-tolerant (Gaughan et al., 1999).





The Ankole longhorn breed is found in Tanzania, Burundi, Rwanda and Uganda. The breed possesses the ability to survive on poor forage without supplementary feeding. It is drought-resistant, tolerant to ticks and helminths, and is relatively resistant to East Coast Fever (Ndumu et al., 2008; Norval, 1992; Magona et al., 2011; Palling et al., 1991).

The Small East African goat is found in Ethiopia, Kenya, Uganda and Tanzania. The breed has good adaptive traits; it is hardy and has good browsing abilities. The breed also has cultural value. It is used in payment of bride price as well as in traditional and religious functions (Chenyambuga, Komwihangilo & Jackson, 2012).



Figure 55: Selected transboundary breeds of East Africa

et al., 2008; Norval, 1992; Magona et al., 2011; Palling et al., 1991). The Red Maasai sheep, which is fat-tailed, is resistant to intestinal helminths (Baker et al., 1999; Baker et al., 2003) and is also drought-resistant (Kosgey, 2004).

The Small East African goat is found in Ethiopia, Kenya, Uganda and Tanzania. The breed has good adaptive traits; it is hardy and has good browsing abilities. It also has cultural value and is used in payment of bride price as well as in traditional and religious functions (Chenyambuga, Komwihangilo & Jackson, 2012).

In North Africa, the selected breeds are the Margherbi camel, Arabian horse, D'Man sheep and Baladi cattle. The Margherbi camel breed is found in parts of Egypt, Tunisia and Morocco. The breed exhibits unique physiological characteristics that include heat tolerance, drought resistance and ability to thrive in harsh topography and poor or scarce vegetation (Kadim et al., 2008). The Arabian horse, commonly known as Arabe, is found in Tunisia, Egypt and Algeria. It is traditionally used as a source of transport as well as for draught power (Mason, 1996). The D'Man sheep is found in parts of Algeria and Morocco. The breed is highly prolific, producing all year round. It is well adapted to harsh environments, making it suitable for the Sahelian conditions (Boubekeur et al., 2015). The Baladi cattle are found in Egypt and Tunisia. The breed provides good draught power. It is renowned for its hardiness and disease resistance as well as the ability to survive under harsh climatic conditions (Shabtay, 2015).

The selected breeds for Southern Africa are the Nguni cattle, Boer goat, Damara sheep and Dorper sheep. Nguni cattle are found in Botswana, Mozambique, Namibia, South Africa, Swaziland, Zimbabwe and Angola. The breed is highly fertile, hardy and heat-tolerant. It also exhibits high levels of tick and tick-borne disease resistance (Bester et al., 2001). The Boer goat is a breed that was developed in South Africa in the early 1900s for meat production. It has a fast growth rate and excellent carcass qualities, making it one of the most popular breeds of meat goats in the world (Mason, 1996). The Damara sheep is found in Botswana, Mozambique, Namibia, South Africa and Zimbabwe. The breed is known to be highly prolific, has high survivability, is drought-resistant and has good browsing ability (Namibia, 2013). The Dorper sheep was developed in South Africa from the Dorset Horn and the Blackhead Persian breeds. It is widely spread in



The Margherbi camel breed is found in Northern Africa in parts of Egypt, Tunisia and Morocco. The breed exhibits unique physiological characteristics that include heat tolerance, drought resistance and ability to thrive in harsh topography and poor/scarce vegetation (Kadim et al., 2008).



The Arabian horse, commonly known as Arabe, is found in Tunisia, Egypt and Algeria. It is traditionally used as a source of transport as well as for draught power (Mason, 1996).



The D'Man sheep is found in parts of Algeria and Morocco. The breed is highly prolific, producing all year round and it is well adapted to harsh environments, making it suitable for the Sahelian conditions (Boubekeur et al., 2015).

The Baladi cattle are found in Egypt and Tunisia. The breed provides good draught power and is renowned for its hardiness and disease resistance as well as ability to survive under harsh climatic conditions (Shabtay, 2015).



Figure 56: Selected transboundary breeds of North Africa

Africa. The breed is highly prolific and well adapted to the arid regions of Southern Africa. The Dorper's thick skin offers protection against harsh weather conditions (Buvanendran et al., 1992).

In West Africa, the select breeds include the N'Dama humpless longhorn cattle, the Red Fulani cattle, the West African Dwarf goat, the Sahelian goat, the Djallonké sheep and the Bali Bali sheep. The N'Dama is a humpless longhorn cattle breed found in Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Senegal, Sierra Leone and Togo. The breed is trypano-tolerant and tick-resistant (Mattioli et al., 1995). The Red Fulani or Bororo breed is found in Nigeria, Burkina Faso, Chad



Nguni cattle are found in Botswana, Mozambique, Namibia, South Africa, Swaziland, Zimbabwe and Angola. The breed is highly fertile, hardy and heat-tolerant. It also exhibits high levels of tick and tick-borne disease resistance (Bester et al., 2001).

The Boer goat is a breed that was developed in South Africa in the early 1900s for meat production. It has a fast growth rate and excellent carcass quality, making it one of the most popular breeds of meat goat in the world (Mason, 1996).





The Damara sheep is found in Botswana, Mozambique, Namibia, South Africa and Zimbabwe. The breed is known to be highly prolific, has high survivability, is drought-resistant and has good browsing ability (Namibia, 2013).

The Dorper sheep was developed in South Africa from the Dorset Horn and the Blackhead Persian breeds. It is widely reared in Angola, Botswana, Malawi, Mauritius, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. The breed is highly prolific and well adapted to the arid regions of Southern Africa. The Dorper's thick skin offers protection against harsh weather conditions (Buvanendran et al., 1992).



Figure 57: Selected transboundary breeds of Southern Africa

and Cameroon. It is a hardy, disease and parasite-resistant breed that adapts well to harsh climatic conditions (Mason, 1996). The West African Dwarf (WAD) goat is found in Benin, Togo, Central African Republic, Senegal, Côte d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Gabon, Gambia, Chad, Congo, Ghana, Guinea, Liberia, Mali, Nigeria, Sierra Leone and Burkina Faso. The breed is known to be helminth-resistant and highly prolific (Mason, 1996). The Sahelian goat is also known as the Sahel or desert goat. It belongs to the savannah group of goats. The breed is found in Benin, Burkina Faso, Ghana, Mali, Niger and Togo. It is well adapted to arid conditions (Mason, 1996). The Djallonké sheep is found in Burkina Faso, Central African Republic, Congo, Côte d'Ivoire, Gabon, Ghana, Guinea, Mali, Benin, Gambia, Togo, Guinea-Bissau, Senegal and Cameroon. The breed is considered more or less trypano-tolerant depending on the zone and the level of challenge. It is well adapted to hot and humid climate (Mason, 1996). The Bali Bali sheep is found in Nigeria, Niger, Chad, Cameroon and Sudan. The breed is a favourite of the pastoral communities and has, as a characteristic, spirally twisted horns common in males (Mason, 1996).

The selected breeds in Central Africa are the Kuri cattle, Arab Shuwa cattle, Sokoto Gudali cattle and Arab camels. The Kuri cattle breed is



The N'Dama is a humpless longhorn cattle breed found in Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Senegal, Sierra Leone and Togo. The breed is trypano-tolerant and tick-resistant (Mattioli et al., 1995).

The Red Fulani or Bororo breed is found in Nigeria, Burkina Faso, Chad and Cameroon. It is a hardy, disease and parasite-resistant breed that adapts well to harsh climatic conditions (Mason, 1996).





The West African Dwarf (WAD) goat is found in Benin, Togo, Central African Republic, Senegal, Côte d'Ivoire, Democratic Republic of Congo, Equatorial Guinea, Gabon, Gambia, Chad, Congo, Ghana, Guinea, Liberia, Mali, Nigeria, Sierra Leone and Burkina Faso. The breed is known to be helminth-resistant and highly prolific (Mason, 1996).

The Sahelian goat is also known as the Sahel or Desert goat and it belongs to the savannah group of goats. The breed is found in Benin, Burkina Faso, Ghana, Mali, Niger and Togo. It is well adapted to arid conditions (Mason, 1996).





The Djallonké sheep is found in Burkina Faso, Central African Republic, Congo, Côte d'Ivoire, Gabon, Ghana, Guinea, Mali, Benin, Gambia, Togo, Guinea-Bissau, Senegal and Cameroon. The breed is considered more or less trypano-tolerant depending on the zone and the level of challenge. It is well adapted to hot and humid climate (Mason, 1996).

The Bali Bali sheep is found in Nigeria, Niger, Chad, Cameroon and Sudan. The breed is a favourite of the pastoral communities and has, as a characteristic, spirally twisted horns common in males (Mason, 1996).



Figure 58: Selected transboundary breeds of West Africa

distributed around Lake Chad. It is large-bodied, humpless and is noted for its variable colour (Mason, 1996). The Arab Shuwa cattle are found in Chad, Nigeria and Cameroon. They are considered good dairy animals and are used by women for riding and as pack animals (Rege and Tawah, 1999). The Sokoto Gudali is a short-horned, short-legged breed native to Sokoto State in Nigeria where the climate is semi-arid and tropical. The breed is also widely distributed throughout Central Africa and the neighbouring Sahelian countries (Mason, 1996). The Arab camels are found in Northern and Central Africa. Their ability to go for so long without both food and water, along with being able to carry heavy loads, has enabled people to



The Kuri cattle breed is distributed around Lake Chad. It is large-bodied, humpless and it is noted for its variable colour (Mason, 1996).

The Arab Shuwa cattle are found in Chad, Nigeria and Cameroon. They are considered good dairy animals and are used by women for riding and as pack animals (Rege and Tawah, 1999).





The Sokoto Gudali cattle breed is a short-horned, short-legged breed native to Sokoto State in Nigeria where the climate is semi-arid and tropical. The breed is also widely distributed throughout Central Africa and the neighbouring Sahelian countries (Mason, 1996).

The Arab camels are found in Northern and Central Africa. Their ability to go for so long without both food and water, along with being able to carry heavy loads, enables people to travel farther across the desert. They have been used for thousands of years and are a good source of milk and meat (Mason, 1996).



Figure 59: Selected transboundary breeds of Central Africa

travel farther across the desert. They have been used for thousands of years and are a good source of milk and meat (Mason, 1996).

Characterisation of FAnGR

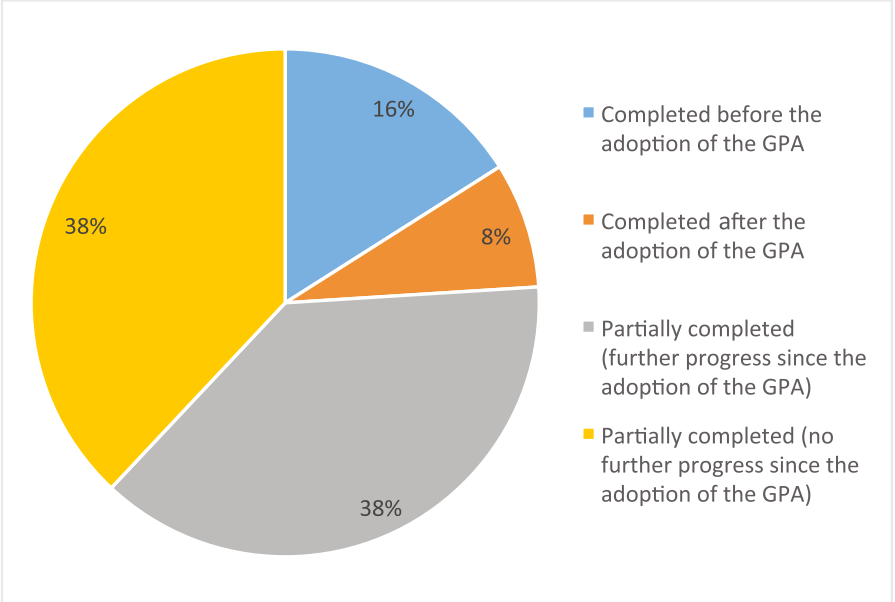
Characterisation and taking inventory of FAnGR are important for the evaluation of the resources. Characterisation contributes to the reliable assessment and prediction of genetic performance in a defined environment.

It helps to compare and contrast differences between and within breeds and populations, in addition to determining how the different FAnGR could be utilised. Proper characterisation establishes genetic attributes of animals or populations using such techniques as DNA sequencing, estimating genetic distances, heritability, genetic correlations as well as expected performance in a given production environment or system.

Characterisation also includes the indigenous knowledge that is associated with a particular FAnGR. This knowledge informs breeding strategies, conservation programmes and policy making processes (FAO, 2011b; 2012). The first State of the World's Animal Genetic Resources for Food and Agriculture report (FAO, 2007b) indicated that population sizes of over two-thirds of African breeds are unknown. The lack of this vital information places Africa's FAnGR at risk as decline in indigenous populations may remain undetected. This may result in gradual loss of ecologically-important traits or breeds.

Status of inventory and characterisation of FAnGR

Currently, most African countries integrate the collection of data on FAnGR within national censuses, but often this does not reflect the actual FAnGR status. Figure 60 presents the proportion of countries taking

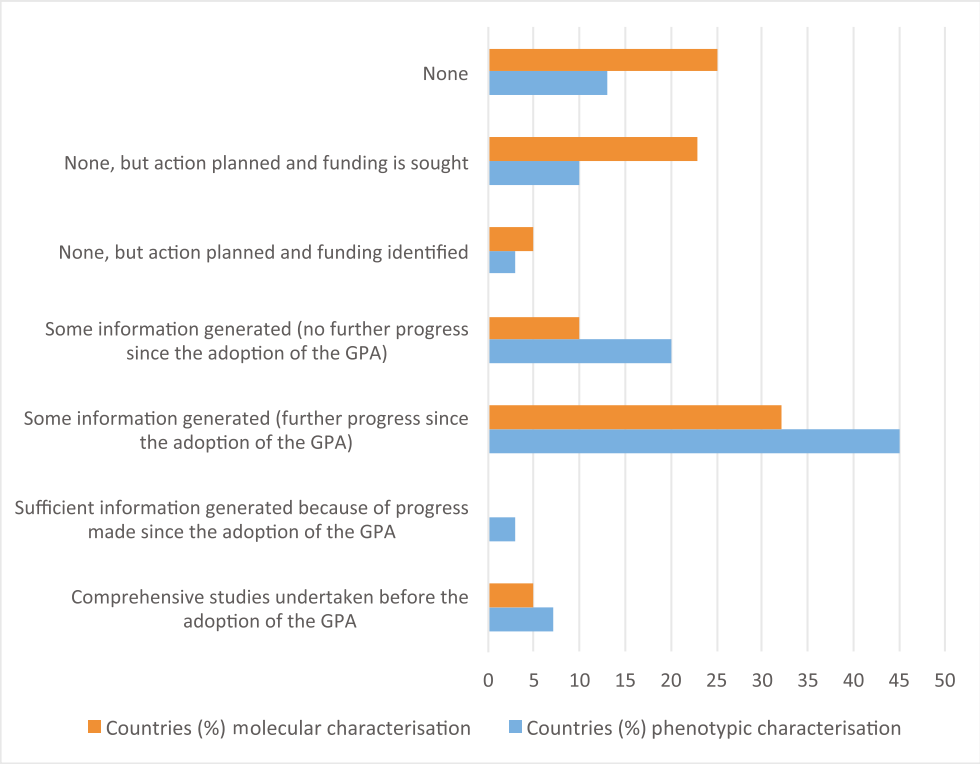


Source: Country Reports, 2014

Figure 60: Proportion of countries' progress in taking inventory of their FAnGR

inventory of their FAnGR. It shows that approximately 40 per cent of the countries reported not to have made any progress at the national level in building an inventory of their FAnGR.

The few countries that have reported having completed inventory of their FAnGR before the adoption of the Global Plan of Action (GPA) include Burundi, Cameroon, Djibouti, Ghana, Niger and South Africa. These countries reported that FAnGR inventories were currently being undertaken by the relevant line ministries. Generally, FAnGR data are collected through baseline surveys funded by national projects, case studies for research institutions and universities, and development projects for the management of FAnGR, except in Southern Africa where phase 1 of the SADC/UNDP/FAO project was influential in kick-starting the inventory processes in 2003. The common challenge reported was the financial constraints faced by national governments to conduct inventories (Breedsurv, 2003). Most of the initiatives undertaken to inventorise the populations have provided statistics on the species, but breed statistics



Source: Country Reports, 2014

Figure 61: Proportion of African countries conducting phenotypic and molecular characterisation of their FAnGR

have largely remained unavailable. There are still some countries, such as Djibouti, Guinea-Bissau, Equatorial Guinea and Mauritania that have reported no actions to undertake baseline surveys.

The status of implementation of phenotypic and molecular characterisation is presented in Figure 61. Phenotypic characterisation covering morphology, performance, location, production environments and specific features in all FAnGR of economic importance in Africa improved significantly since the adoption of the GPA. Approximately 45 per cent of the countries indicated that information was generated since the adoption of the GPA.

There are increased phenotypic characterisation activities for the different FAnGR species. In Botswana, phenotypic characterisation studies on Musi cattle were initiated. Comparisons of the performance of breeds of beef cattle, sheep and goats were conducted between 1970 and 2000 in several countries which include Botswana, Zambia, Namibia, Zimbabwe, Mozambique, Swaziland and South Africa. These confirmed the superior productivity of indigenous breeds in pure breeding systems and as maternal lines in crossbreeding programmes under ranching conditions. In Botswana, these studies led to the development of the Musi, a synthetic beef cattle breed comprising 28.24 per cent Tswana, 4.44 per cent Tuli, 26.32 per cent Simmental, 22.60 per cent Brahman and 18.40 per cent Bonsmara. The developement of this phenotype (music cattle) started in 1980 and was officially declared a breed in 2011.

In Kenya, increased activity in phenotypic characterisations of the Sahiwal cattle breed, the Alphine goat breed and some indigenous chicken breeds was reported. The Maradi Rousse and the Azawak breeds in Niger and Nigeria have also been phenotypically characterised since the adoption of the GPA. In Togo, initiatives have been undertaken to characterise the West African Dwarf goats and the Djallonké sheep using molecular genetic tools. Some countries, mainly in Southern Africa, have well-established recording schemes such as the South African Stud Book. In Namibia, the Stud Book was extensively used to phenotypically describe the livestock population. There is need to encourage the 23 per cent of countries that reported minimal to no efforts undertaken, to initiate activities to phenotypically characterise their FAnGR populations.

The introduction and utilisation of novel molecular genetic tools to characterise FAnGR has been adopted extensively in all continents except Africa due to its financial weakness, the high cost of the biotechnology

equipment, and the lack of skilled technical personnel. In Sudan, a molecular laboratory was established, but lack of skilled manpower is constraining the operations of the facility. Approximately 40 per cent of the countries reported improved molecular characterisation of FAnGR since the adoption of the GPA (Figure 65). Some of the species and breeds that have been characterised include the Malawi zebu cattle, the Zulu sheep in South Africa, the Vogan sheep in Togo, the Tankwa goat in South Africa and the Kgalagadi camel in Botswana.

In Ethiopia, phenotypic characterisation of local donkeys has been carried out. However, such activities have to be complemented with proper genetic characterisation in order to classify the donkey types found in the region and other parts of Africa. The Basotho pony was developed as a unique animal adapted to the high mountain areas of Lesotho. Characterisation of this breed was done and it has been established that the pony has different strains, with each more adapted to one area than the other (Odenya, 2003). Local or indigenous chickens probably show the highest rate of variation of population types. For the local chickens characterised so far in Nigeria, Botswana, Kenya, Malawi, Sudan and Ethiopia, variation is observed in morphological characteristics and production parameters (King'ori et al., 2007).

Studies using microsatellite markers were conducted to assess the diversity in Ethiopian, Kenyan, Ugandan, South African and Sudan chickens. The results indicated that most (97%) of the genetic variation in the populations was ascribed to within breed or population diversity, which has been shaped by subtle combinations of human and natural selection (Mwacharo et al., 2013). Molecular genetics has given more insight to these genotypes and reduced the polymorphs into three major genetic pools (Ngeno et al., 2014). Single nucleotide polymorphism (SNP) is a new molecular marker system, which offers opportunities to assess the genetic diversity in farm animal species. They could be the marker of choice for diversity studies in the future because they can be used in assessing either neutral or functional variation (FAO, 2007). SNPs are currently being employed to study genetic diversity in Kenyan local chickens. Characterisation by any means is important in understanding the genetic resources at the country's disposal.

Most of these molecular characterisation initiatives were project-driven and donor-funded, either through universities, research institutions and

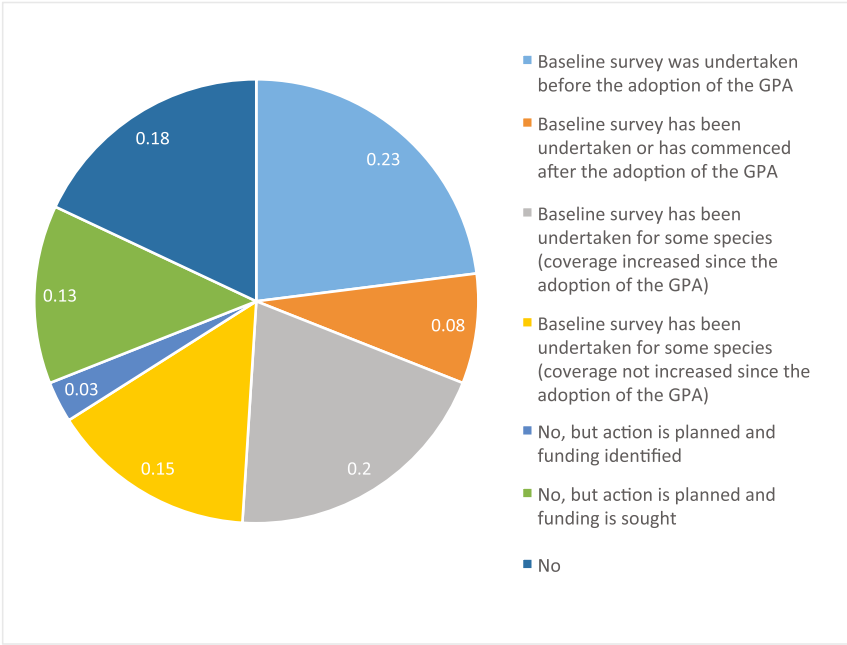
FAO-Technical Cooperation Projects/Programmes. There is need to develop strategies to adopt molecular genetics and genomics techniques in Africa as well as establish a platform that can be utilised across the regions on the continent.

Status of monitoring programmes and country-based early warning and response systems

Monitoring and conservation are the most important activities in Animal Genetics Resources (AnGR) management. They are necessary to develop early warning and response systems for proper and effective conservation of AnGR. For conservation, the most critical steps are to monitor the population of breeds over a time interval, identify breed(s) at risk, prioritise the breeds for conservation, preferably for in situ, and apply proper conservation strategies. Demographic data describe the size, structure and distribution of livestock populations and how these change over time. They are fundamental to determining the risk status of breed populations both on a national and regional scale. The best way of monitoring the population is by conducting breedwise livestock census at time intervals (preferably of five years, which should match with the generation intervals). The status indicate that 81 per cent of the countries report that baseline surveys were undertaken before and after the adoption of the GPA (Figure 62). Nineteen per cent (19%) of the countries indicate that the baseline surveys were undertaken for some species and extended coverage to include other species was not conducted. No action was taken by 18 per cent of the countries.

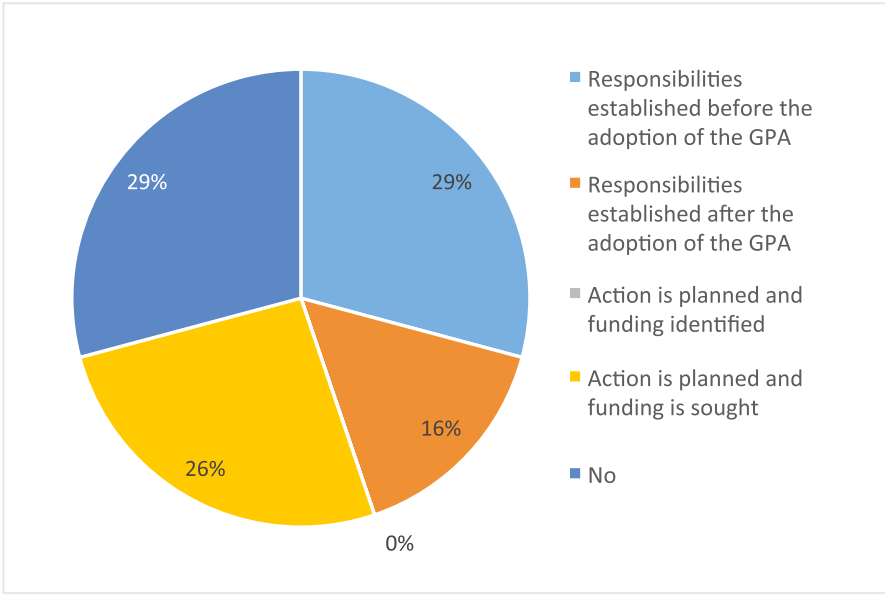
The level of engagement of institutions to monitor the FAnGR in the countries was also assessed and it shows that approximately 43 per cent of the countries have mandated key departments or national institutions to monitor FAnGR (Figure 63). For example, the animal biodiversity sub-directorate of the Ethiopian Biodiversity Institute (EBI) was mandated to undertake monitoring in the country. The Namibia Stud Breeders Association (NSBA) and the South African Stud Book monitor registered stud animals.

Approximately 25 per cent of African countries have indicated that actions to mandate institutions are planned; however, the major constraint remains lack of funding for monitoring of the FAnGR. In Ethiopia,



Source: Country Reports, 2014

Figure 62: Proportion of countries with baseline surveys, conducted or planned



Source: Country Reports, 2014

Figure 63: Proportion of countries with institutions mandated to foresee monitoring of FAnGR

the Sheko breed, a remnant of the East African taurine population, has reportedly less than 2,500 animals left despite its superior trypanotolerance (Woldu and Beyene, 2013). This has led to calls for its conservation to save it from extinction.

Adoption of characterisation, inventory and monitoring protocols

In line with one of the strategic priority areas of the GPA (characterisation, inventory and monitoring of trends in FAnGR diversity), FAO developed comprehensive guidelines for the classification of risk status and phenotypic characterisation – surveying and monitoring; molecular genetic characterisation and DNA extraction (FAO, 2007; 2011b; 2012). These guidelines continue to be the fundamental tools/protocols for characterisation inventory and monitoring used by countries, international research organisations and institutions of higher learning. These principles were primarily drafted to guide the process in developing international standards and protocols for characterisation and inventory of FAnGR.

About 76 per cent of African countries have no established protocols for monitoring FAnGR. Furthermore, there are no standardised procedures for data collection, entry, validation and analysis. Although some countries have conducted monitoring surveys, the lack of protocols remains a challenge and this has affected documentation of population status and trends. Most of the available population size trends are based on information gathered from statistics departments and national breeder associations, among others. At least 65 per cent of the countries indicate that some research is being conducted or funding sought for use in developing technical standards and protocols for phenotypic and molecular characterisation, breed evaluation, breed valuation and comparisons. Most of these research initiatives are

spearheaded by national institutions such as directorates responsible for FAnGR research. About 68 per cent of African countries have identified barriers and obstacles to their utilisation of inventory, characterisation and monitoring programmes.

Strengths, gaps and opportunities for characterisation, inventory and monitoring

Table 13 presents a summary of strengths, opportunities and gaps in the characterisation and monitoring of FAnGR programmes in Africa.

Table 13

Summary of characterisation and monitoring programmes in Africa

Characterisation and monitoring method	Strengths	Opportunities	Gaps
- **Genetic and phenotypic characterisation of animal populations**	- Adoption of characterisation, inventory and monitoring protocols	- Revision and harmonisation of characterisation, inventory and monitoring tools - Building a sound technical base	- Lack of specialised technical capacities - Slow FAnGR characterisation and monitoring efforts - Lack of relevant policies
		- Establishment of livestock monitoring committees - Formulation of comprehensive policies and legislation - Increased advocacy of the importance of FAnGR - Adoption of new biotechnology techniques, for example, genome selection, genome editing and marker-assisted selection to enhance livestock development	- Lack of available funds within national governments - Lack or scarcity of operational FAnGR committees - Lack of efficient recording systems - Poor communication channels/structure

Source: Country Reports, 2014; AU-IBAR questionnaires, 2014

Animal Genetic Resources Characterisation, Inventory and Monitoring (AnGR- CIM) Tool for Africa

Taking into consideration the opportunities and gaps mentioned in Table 13, and with a primary impetus to develop a composite, user-friendly and appropriate tool that will adequately cater to the uniqueness of African

AnGR, AU-IBAR has developed a harmonised animal genetic resources characterisation, inventory and monitoring (AnGR-CIM) tool for Africa. The AnGR- CIM tool is all-encompassing, enabling the capture of morphometric, environmental, production and reproduction, adaptive,



A B C D

Photo Courtesy: AU-IBAR

Figure 64: Use of Harmonised Animal Genetic Resources–Characterisation, Inventory and Monitoring (AnGR-CIM) Tool for Africa in Ghana

socio-economic and indigenous knowledge data. It also includes concise linear and phenotypic descriptive manuals for AnGR.

Africa has taken a bold step to embrace paperless data capture. The digitised AnGR-CIM tool will provide a robust resource of data-based evidence and information to better inform formulation of sound policies and legislations to benefit African AnGR.

Figure 64 shows a data manager interviewing a farmer and making entries into the digital AnGR-CIM (A), taking linear measurements of a grasscutter in a farm (B), doing coat colour assessment using the phenotypic descriptive manual (C) and collecting blood samples from the hind paw of the grasscutter.



Arado bull of Eritrea

Photo Courtesy: Ministry of Agriculture, Eritrea

CHAPTER FOUR

Threats and Risk Status of Africa's Genetic Resources



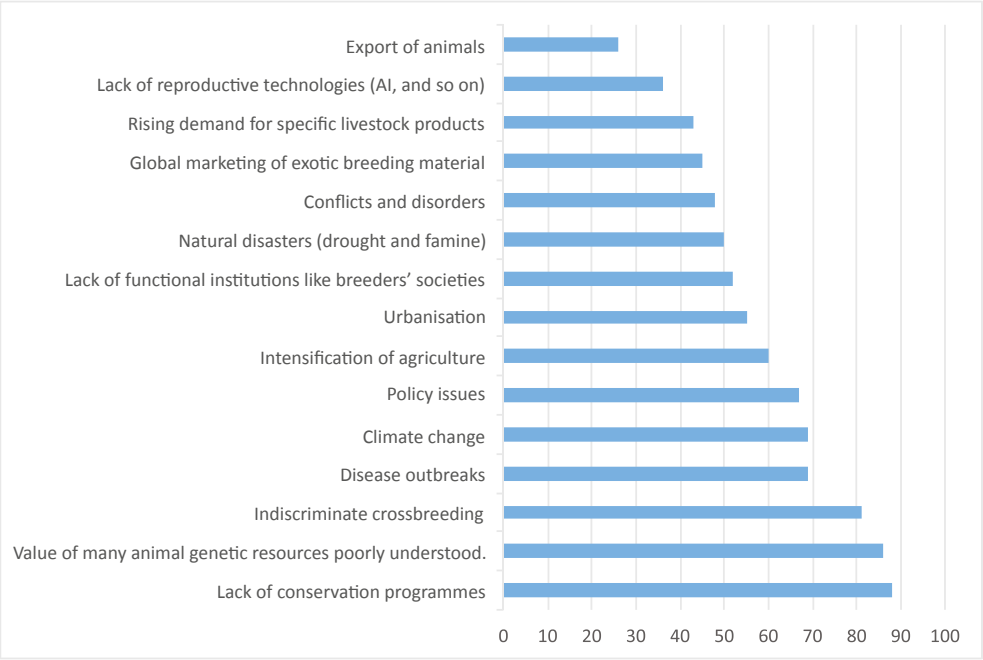
Fulani pastoralists watering their cattle
Photo courtesy: Ministry of Livestock, Chad

Threats to animal genetic resources (AnGR) have received attention in high level discussions across Africa. The impetus to these deliberations is attributed to the growing need to identify the imminent threats to AnGR following the continual loss of animal diversity. The dwindling population sizes of this rich animal heritage has resulted in certain breeds attaining various risk status (Extinct, Critical, Endangered or At risk).

Threats to Africa's Genetic Resources

Threats have been described as circumstances that cause breed populations to decrease, leading to their extinction if preventive measures are not put in place. Pilling (2010), however, emphasises that threats are not only circumstances, causes of loss or pressures, but also include actual or potential generators of negative changes in breed populations. Rege and Gibson (2003) cited various threats, such as use of exotic germplasm, shifts in producer preferences and production systems, as well as natural catastrophes. From a socio-economic perspective, some of the drivers include shifts towards perceived economically beneficial breeds resulting in breed replacement, economic globalisation and adoption of certain technologies (Tisdell, 2003). A study conducted by FAO (2009) revealed that in Africa, livestock populations are threatened by two main factors, namely changes in economic and market dynamics, and poor livestock sector policies. Other significant drivers in the loss of Africa's FAnGR in the study included loss of production environment and labour, disease outbreaks, socio-political instability, lack of functional institutions and poor conservation strategies.

Figure 65 presents the main threats associated with loss of breeds or diversity. Lack of conservation programmes is the most common threat identified by 88 per cent of the countries in Africa, followed by poor understanding of the value of many FAnGR (86%), the threat of indiscriminate crossbreeding (81%), disease outbreaks and climate change (69%), lack of appropriate policies (67%), intensification of agriculture (60%), lack of reproductive technologies (36%) and the exportation of animals (26%).



Source: AU-IBAR questionnaires, 2014

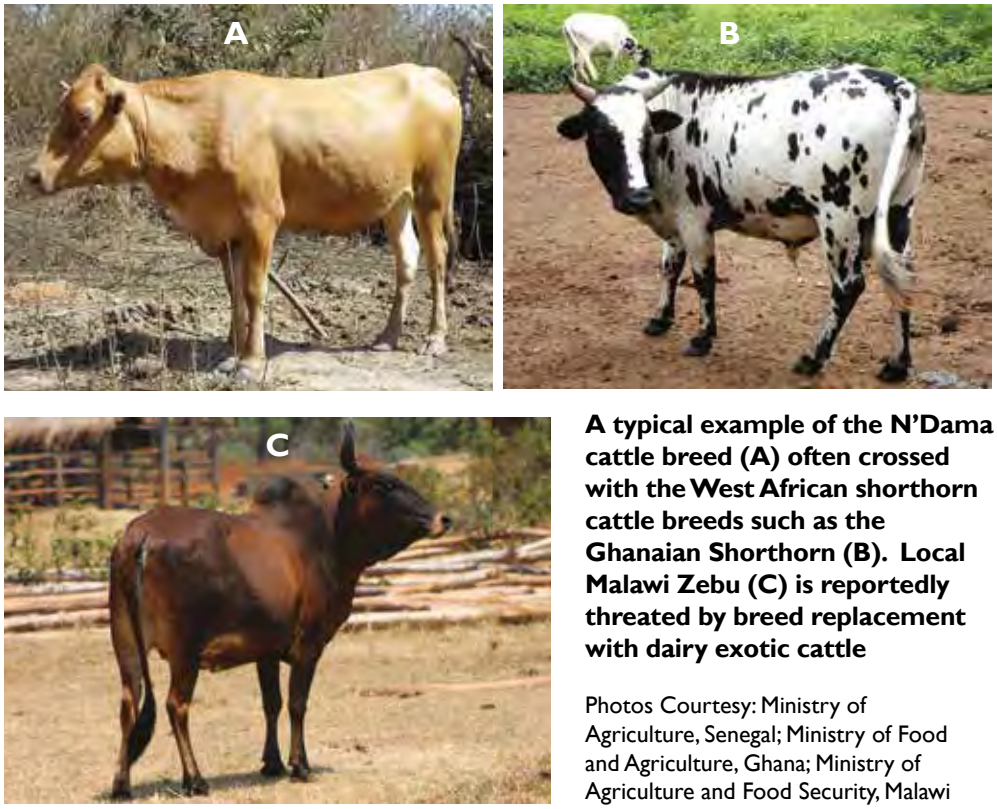
Figure 65: Overview of the main threats associated with loss of breed numbers or diversity in FAnGR

Threats associated with breeding strategies and reproductive technologies

One of the issues in Africa is indiscriminate crossbreeding and breed substitution implemented by producers with the aim of getting perceived productive benefits from exotic breeds. Indiscriminate crossbreeding and breed substitution with exotic FAnGR are a threat to indigenous livestock breeds and can lead to loss of ecologically important traits, such as disease tolerance. Unfortunately, funding tends to be readily available to support short-term crossbreeding and introduction of exotic breeds without due consideration of the negative outcomes.

Funding for genetic improvement within indigenous breeds is often limited because such improvement is, by nature, long-term and there is general lack of interest to support long-term investments. However, the benefits are more permanent and cumulative over time and guarantee the conservation of the local FAnGR compared with crossbreeding. In West

Africa, for example, sheep, goat and cattle breeds imported from the Sahel are often crossed with local Djallonké sheep and goats, and with N'Dama and West African Shorthorn cattle, respectively, to 'improve' productive traits such as meat and milk production. Local buffalo and cattle breeds are at risk in Egypt due to increased crossbreeding. Similar concerns have been recorded in Ethiopia. In Malawi, exotic dairy breeds were mainly used to replace the local Malawi Zebu. In the Kenyan highlands, Zebu cattle have been entirely replaced by exotic commercial dairy breeds, although the Nandi Zebu had very high potential. There has been an increase in the importation of exotic semen and other genetic material. Egypt and Botswana have recorded steady increases in the importation of semen over the last ten years, and undesirable impacts on the indigenous cattle populations have also been noted.



A typical example of the N'Dama cattle breed (A) often crossed with the West African shorthorn cattle breeds such as the Ghanaian Shorthorn (B). Local Malawi Zebu (C) is reportedly threated by breed replacement with dairy exotic cattle

Photos Courtesy: Ministry of Agriculture, Senegal; Ministry of Food and Agriculture, Ghana; Ministry of Agriculture and Food Security, Malawi

Figure 66: Examples of breeds involved in improvement programmes

Threats associated with change in economics and market dynamics

The growing middle class in Africa is resulting in a corresponding increase in demand for livestock products (Delgado et al., 1999; Turner and Timothy, 2002). Notable changes in diets among consumers with high disposable incomes are exerting an increasing demand for livestock food products. This demand is expected to nearly double by the year 2050 in Sub-Saharan Africa (HLPE, 2016). Favourable livestock product prices encourage production, particularly of species with high prolificacy and offtake opportunities, such as poultry and pigs.

In several countries of Africa, indigenous animals positively contribute to meeting the growing demand for animal products due to their large populations. South Africa has observed an increase in the demand for grass-fed beef and mutton (Box 4) while the demand for free range chicken in Kenya and South Africa has led to the increase in the number of farmers keeping indigenous breeds. In general, however, market preference is for the so-called more productive exotic breeds, which has resulted in the neglect, and in some cases, loss of indigenous breeds.

Box 4: Living banks – South Africa

In South Africa, the Eastern Cape Red Meat Project (ECRMP) works with emerging and communal farmers to increase their income from raising cattle, through greater and more beneficial participation in formal red meat markets. Owned by the National Agricultural Marketing Council (NAMC) of South Africa, the project was launched in the Peddie-Ngqushwa area in the Amathole District Municipality in 2005. In 2016, the project was operating at varying levels in five district municipalities within the province. Through the project, farmers are trained on the structure, operation and requirements of formal red meat marketing, and how to align the age, health and breeding of their animals more closely to the market demands. The impact realised through project activities includes increased selling price of live animals; recognition of farmers from communal production systems for producing quality beef animals, establishment, renovation and use of seven auction pens; promotion of the use of indigenous Nguni breed of cattle; and, establishment of feeding programmes and feedlots for cattle in communal systems.

Source: AU-IBAR, 2016.

In Egypt, there is a steady increase in the demand for livestock products, leading to an increase in the rearing of exotic and crossbreeds. There is also an increase in the use of exotic semen, which has adversely affected local cattle breeds such as the Damietta (FAO Country Reports, 2005; 2014). In Ethiopia, changes in chicken marketing have led to the introduction of dressed chicken products, mainly from exotic breeds, into supermarkets in the urban centres (FAO Country Reports, 2005; 2014). The changing market dynamics have positively impacted on indigenous breeds by



Photo Courtesy: AU-IBAR

Figure 67: A herd of Nguni cattle, an indigenous breed known for its outstanding beef production

improving access to markets and promoting their production. Namibia has established auction markets for indigenous breeds, leading to demand for indigenous animals (FAO Country Reports, 2005; 2014).

Threats associated with the natural and production environment

Climate change and natural disasters, such as droughts, often result in lack of sufficient feed and water, with substantial animal losses experienced widely in Africa. Botswana highlighted the recurring droughts as a major contributor to loss of FAnGR. Ethiopia reported that during the 10-year period to 2014, climate change gave rise to frequent and more severe droughts, resulting in significant animal losses, especially within the pastoralist communities (County Report, 2014). In attempts to assist the victims, poorly informed re-stocking was undertaken in which ill-adapted breeds were given to pastoralists, leading to increased vulnerability in future droughts. Zimbabwe has reported that climate change has resulted in huge losses of pastures and other feed resources. In Rwanda, a shift to zero grazing systems for ruminant livestock due to lack of adequate pastures was reported (Country Reports, 2005; 2014). Similarly, Egypt noted increasing incidence of droughts within the main grazing regions of the country's North Western Coastal Zone, which has resulted in a

significant decrease in the sizes of the sheep, goat and camel populations. This can be expected to ultimately adversely affect the diversity within these species. There is, therefore, need for African countries to put in place and adopt mitigation measures against natural disasters and the negative effects of climate change.

Climate change, however, presents an opportunity to identify and develop sustainable programmes for conservation through use of resilient and productive indigenous FAnGR in production systems and restocking programmes. Currently, in several countries, restocking programmes involve the use of the less adapted exotic animals. Such restocking strategies are counter-productive because the exotic breeds introduced are more vulnerable to subsequent droughts and climate change, resulting in more severe animal losses. Managing the natural resources in the different countries generally involves management of water, natural rangelands and arable lands (HLPE, 2016).

Land degradation through extensive logging, overgrazing, bush clearing and other negative cultural practices pose a risk to FAnGR. This has led, in extreme cases, to a change in the livestock breeds reared in some regions of the continent. In Sierra Leone, the reduction of reported livestock numbers in certain areas was due to land degradation (Country Reports, 2005; 2014). In Ethiopia, there has been replacement of small ruminants with cattle in some areas, while in Kenya camels from the northern part of the country (specifically the Somali camel shown in Figure 68) are being adopted and reared by the Maasai in the southern rangelands (Country



Photo Courtesy: Ministry of Agriculture, Livestock and Fisheries, Kenya

Figure 68: Somali camel in northern Kenya

Reports, 2005; 2014). Livestock feeds are derived mainly from annual foraging over large areas of grazing lands. The proportional contribution of these feed resources is subject to variations in agro-ecosystem, farming system and the type of animals reared.

Irreversible human activities over land surfaces including the clearing of forests, cultivation, overgrazing, settlements, and other forms of land management are causing changes in land use and land cover patterns with resultant change in feed deficits and feeding management strategies. In many areas, the traditional rangeland-based nomadic pastoral systems where livelihoods are based on extensive movements over vast areas of land, are under threat. Increased use of limited land for competing interests occasionally flares into conflicts among neighbours. As a result, changes are expected from grazing-based feed deficit management strategies (mobility, transhumance, wet and dry season grazing) as grazing resources decrease. Instances of livestock interfering with crop production due to their movements result in conflicts over land use. Such incidents have been reported in countries of the East and West African regions (Country Reports, 2005; 2014).

Threats associated with disease epidemics

The prevailing tropical climate in Africa offers a conducive environment for many pests, diseases and vectors; hence, outbreaks of livestock diseases have led to high levels of mortality and morbidity in the different countries. This hinders the growth of livestock populations. Most diseases affecting livestock populations in Africa often spread across borders with severe consequences to regional animal health and production, human health and international trade. Diseases such as Foot and Mouth Disease (FMD) and contagious bovine pleura-pneumonia (CBPP) affect not only the health of animals, but also trade in livestock and livestock products (Alonso et al., 2016). Genetic diversity studies linked with disease in Kenya have shown downward trends in some livestock populations.

Based on effective population size estimates, the East African Shorthorn Zebu (EASZ) experienced a drastic decline approximately 240 years ago (Mbole-Kariuki et al., 2013), coinciding with the great rinderpest epidemic that broke out in 1887, wiping out thousands of cattle (Spinage, 2003). Serious disease epidemics such as the African swine fever and the CBPP have had devastating effects on the livestock population in Benin (1997) and Togo (2001) (OIE, 2006). Other cattle diseases such as trypanosomiasis and East Coast Fever may also have

contributed towards the loss of genetic diversity across Africa. In Liberia, the devastating viral diseases, Newcastle and African swine fever, have resulted in the massive loss of bird and pig populations, respectively (Country Reports, 2005; 2014). In Botswana, regular outbreaks of Foot and Mouth Disease and Newcastle have resulted in periodic mass slaughtering of infected livestock, which had significant effects on trade and may also have resulted in reduced overall genetic diversity (Country



Photo Courtesy: Ministry of Agriculture, Livestock and Fisheries, Kenya

Figure 69: A herd of East African shorthorn Zebu with Duruma strain found along the coastal shores of Kenya

Reports, 2005; 2014).

Threats related to conflict situations

Wars, internal civil strife and cross-border conflicts are typically associated with detrimental effects on FAnGR and their habitats. These scenarios are often characterised by maiming and high mortality of civilians as well as livestock. Intercommunity and political conflicts have been documented as primary contributors to the disappearance of indigenous breeds as reported in South Sudan, Djibouti, Ghana, Guinea, Liberia, Sierra Leone and Sudan (Country Reports, 2005; 2014).

Threats related to policy development and institutional capacity

These threats closely relate to the effects of indiscriminate crossbreeding and breed replacements. Lack of robust conservation and genetic improvement programmes and strategies has led to loss of FAnGR in Africa. Many African countries are yet to develop and implement comprehensive policies and regulatory frameworks to manage their FAnGR. In most of the countries, the management of indigenous FAnGR by communities is not strongly supported through policies and legal instruments. The absence of laws governing FAnGR issues and the lack of relevant policies has adversely affected the effective management of FAnGR base in Africa. Most of the countries have highlighted the lack of development of sound and relevant policies. Ghana noted that FAnGR policies have been developed, but highlighted lack of implementation of the policies. Sound FAnGR policies and laws, backed by sound legislation, may encourage national governments to recognise the importance of their FAnGR.

The lack of current information on the economic and ecological merits of indigenous breeds has also contributed to the lack of awareness on the merits of indigenous breeds by policy makers. This lack of awareness has often resulted in a lack of strong justification and political will to support conservation initiatives.

Breeds at risk

The current populations of breeds that are at risk have been documented in the FAO report (FAO, 2007), though there is still very little information on the numbers of indigenous African FAnGR populations, both at phenotypic and genetic levels. Activities on molecular characterisation of African FAnGR are underway as mentioned in the previous chapter. With few exceptions, there is no data on the population sizes of the different breeds and their status, whether their numbers are decreasing, increasing or stable.

Tables 14 and 15 are based on working estimates of indigenous African FAnGR. They do not constitute the level of assessment required to make decisions on conservation and use, but they are presented here to provide justification for additional, targeted surveys. The information is incomplete and may even contradict known facts. However, it is hoped that the

publication of these results will provoke action, particularly at national levels, that will help improve the information base on African breeds.

Table 14

Examples of some of the threatened conventional breeds in Africa that are in need of conservation

Breeds	Country
Cattle	
Tswana	Botswana
Kouri	Cameroon
Namchi	Cameroon
Lagune	Congo
Butana	Ethiopia and Sudan
N'Dama	Mali, Gambia, Guinea-Bissau and Liberia
Maasai Zebu	Kenya
Duruma Zebu	Kenya
Muturu	Liberia and Nigeria
Malawi Zebu	Malawi
Nguni	Namibia and Zimbabwe
Inkuku	Rwanda
Fipa	Tanzania
Ankole	Tanzania
Mpwapwa	Tanzania
Baoulé	Côte d'Ivoire
Creole	Mauritius
Goats	
Chèvre Rousse de Guilli	Cameroon
West African Dwarf Goat	Nigeria, Gambia and Congo
Desert Goat	Ethiopia, Sudan
Small East African Goat	Kenya
East African Goat	Malawi
Chèvre Espagnole (Gouera)	Mauritania
Chèvre Naine (Djouguer)	Mauritania
Pafuri	Mozambique
Malya	Tanzania
Sonjo	Tanzania
Sheep	
Mouton Kirdi à poils ras	Cameroon

Table 14

Examples of some of the threatened conventional breeds in Africa that are in need of conservation

Hamari	Ethiopia
Djallonké	Nigeria, Gambia and Liberia
Red Maasai Sheep	Kenya and Tanzania
Breeds	**Country**
East African long-tailed	Kenya and Tanzania
Mouton à laine du Macina	Mali
Mouton maure à poil long	Mauritania
Mouton maure poil ras (Ladem)	Mauritania
Landim	Mozambique
Hamari	Sudan
Blackhead Persian	Tanzania
Urambo	Tanzania
Poultry	
Kondé	Burkina Faso
Naked Neck	Ghana and Nigeria
Frizzled feathered chickens	Ghana
Kuchi	Kenya and Tanzania
Poule locale	Mauritania
Kawaida	Tanzania
Pig	
Tswana	Botswana
Porco Preto Local	Cape Verde
Race porcine du nord Cameroun	Cameroon
Race porcine du sud Cameroun	Cameroon
Ashanti Black Pig	Ghana
Mongoose pig	Mauritius
Landim	Mozambique
Indigenous Long Snout Pig	Nigeria
Indigenous Short Snout Pig	Nigeria
Porc de Sao Tomé	São Tomé
Nsenga	Zambia
Lusitu	Zambia
Korhogo	Côte d'Ivoire
Other livestock species	

Table 14

Examples of some of the threatened conventional breeds in Africa that are in need of conservation

Goose	
Local Goose of Karal and Massakory	Chad
Local Goose of Mandelia	Chad
Breeds	**Country**
Turkey	
Local Turkey of Mandelia	Chad
Horse	
English Halbblut Horse	South Africa
Miniatures	Namibia
Saddlebred	Namibia
Pony	
Basotho Pony	Lesotho
Rabbit	
Gabali Egyptian	Egypt
Donkey	
Áne locale	Madagascar

Source: AU-IBAR questionnaires, 2014

Table 15

Some of the threatened emerging or limited distribution breeds in Africa that are in need of conservation

Breed	Country
Ostrich	
Ninningo	Burkina Faso
Chadean Ostrich	Chad
Guinea fowl	
Amssala	Chad
Local Guinea fowl of Gredaya and Massakory	Chad
Local Guinea fowl of Moulkou and Bongor	Chad
Local Guinea fowl of Port Belilé and N'djamena	Chad
Buffalo	
Menufi	Egypt

Source: AU-IBAR questionnaires, 2014

There are numerous breeds that are threatened and an urgent call to conservation has been made. Figure 70 as well as Tables 14 and 15 give an indication of threatened conventional and emerging or non-conventional breeds that are in need of conservation in Africa.



The Basotho Pony is reknowned for its sure footedness, stamina, docility and endurance. In Lesotho, the pony's population has been estimated to be between 98,000 – 112,000 (FAO, 2003).

Of grave concern is that the Kouri population is estimated at only 10,000 head. The population of this unique cattle breed is declining due to various threats including crossbreeding (ILRI, 2007).





The Ashanti Black Pig found in Ghana continues to face numerous threats, especially indiscriminate crossbreeding (Barnes and Fleisher, 1998).

Kuchi Chicken is an indigenous chicken ecotype found primarily in Lamu County's islands of Kenya (Ngeno et al., 2014) and parts of Tanzania (Msoffe et al., 2001). This bird is reknowned for its fighting prowess. It has superior adaptive and performance traits as compared to other local indigenous chickens. However, an evident lack of consumer demand has resulted in a significant decline in its population.





Malya blended goat is found in Tanzania and is a composite breed whose genetic composition constitutes Kamorai Goat of Pakistan (55%), Boer Goat of South Africa (30%) and indigenous goats (15%). The breed has excellent meat production traits. However, currently, they are only available in government breeding stations.

The Damietta or Domiati cattle are found in Northern Africa, precisely in Egypt. It is an ecotype of the Baladi cattle. This ecotype provides good draught power and is renowned for its hardiness and disease resistance as well as the ability to survive under harsh climatic conditions. This ecotype is rapidly being lost through breed replacement and indiscriminate crossing.



Figure 70: Some threatened FAnGR in need of conservation in Africa



A herd of Inyambo cattle grazing in Rwanda, the land of a thousand hills

Photo Courtesy: Ministry of Agriculture and Animal Resources, Rwanda

CHAPTER FIVE

Genetic Improvement and Conservation Programmes in Africa



Training of technicians in harvesting of genetic material in an institution in Entebbe, Uganda, by Prof. Daniel Barry
Photo Courtesy: AU-IBAR

Genetic improvement of local breeds can make a significant contribution to the conservation and utilisation of local genetic resources. A number of breeding schemes have been suggested for the improvement of local breeds, based on within-population selection, crossbreeding or a combination of these (Hickman, 1979; Cunningham, 1979). However, successful applications are limited due to social as well as technical constraints, such as lack of good infrastructure needed for recording and performance testing, small herd sizes, variability between farms and farming systems, low reproductive efficiency, absence of effective farmer organisations, and lack of sustained and cumulative genetic progress (Madalena et al., 2002; Kosgey et al., 2005; Bosso, 2006).

Status of animal identification and recording

There is an increasing interest in animal identification and recording systems in Africa (FAO, 2015). The systems are key to genetic improvement, and to better herd and flock management that will enable achievement of sustained productivity.

Livestock identification in Africa has long been associated with ownership of animals. It is an ancient practice involving traditional marking systems, which are varied in their scope from simple ear notching to branding, and other scarification methods, all with the main purpose of providing a physical identification of animals to establish ownership (Landais, 2001; Caja et al., 2004; FAO/WHO, 2004). The goal of animal identification and recording schemes is usually to provide farmers with information about individual animals for management and for breeding purposes. The objective could also be phrased as to provide an information system about the FAnGR, their use, and performance and development by both farmers and national authorities. The importance of animal identification and recording for genetic improvement purposes needs, therefore, to be demonstrated and promoted in order to encourage participation. Governments are the most involved with identification of livestock species.

Other key players include breeders' associations and a few individual commercial farmers. The same trend is apparent for animal recording. Ideally, individual commercial farmers should be the most important stakeholders in identification and recording schemes. The poor participation by the majority of farmers in livestock identification and recording schemes is exacerbated

by shortage of trained personnel in government departments, which are responsible for running the schemes (Hoffmann et al., 2009). Adoption of identification and recording systems by farmers also depends on the benefits, which must exceed the cost of the systems used (Edwards, 2003).

Apart from the initiatives by individual livestock breeders and institutions, a number of countries on the continent, as indicated in Table 16, have established or are in the process of establishing national performance recording schemes or breeding centres. These centres receive performance records from individual farmers' herds or flocks, analyse the data centrally and the results are returned to the farmers for their selection and management decisions.

Table 16

Countries reporting to have established or are in the process of establishing national performance recording schemes or breeding centres

Country	National performance recording schemes or breeding centres
Algeria	The livestock identification programme that has been implemented appears to be getting under way, and should provide more precise statistics than were previously available.
Botswana	In 1999, the country started the national Livestock Identification and Traceability System (LITS) to trace the origin of beef in order to meet the EU beef import requirements. This system can be used to collect useful information to monitor cattle breed information. This computerised system is at a fledgling stage, currently focusing on cattle.
Burundi	A national registration system and monitoring software for breeding males is being initiated using the Internet.
Cameroon	Breeding programmes with recording systems have been implemented for decades now for cattle, goats and pigs.
Egypt	In 2014, the Minister for Agriculture implemented a legislation to record all or some of the animals in designated areas.
Ethiopia	There is an advanced plan to transform the National Artificial Insemination Centre into Animal Improvement Institute. The transformation is meant to create the necessary organisational structure for breeding programmes and to put in place recording systems. A pilot project for recording dairy cattle is underway around Addis Ababa.
Kenya	The Livestock Recording Centre was established and is able to carry out genetic evaluation of breeding stock (Box 5).
Lesotho	Although there were attempts to get an identification system underway on a number of occasions, an official, nationwide identification system apparently never really materialised. The marking of animals was in operation in Lesotho in the past and is still being done by some farmers.

Table 16

Countries reporting to have established or are in the process of establishing national performance recording schemes or breeding centres

Country	National performance recording schemes or breeding centres
Namibia	Identification of animals is compulsory on commercial farms. Communal farmers do not have to brand their animals, but should they wish to sell an animal, or send it to the abattoir, it must be branded first. Individual communal farmers use the brand issued to a particular community and not that of the individual owner.
South Africa	The branding and tattooing system to identify animals has been in operation since the late 1800s.
Swaziland	Livestock identification is compulsory only for commercial farmers on and with title deed. There is no system in place for communal farmers on the Swazi National Land (SNL). Commercial farmers may not sell any animal unless they are branded according to the legislation.
Tunisia	An identification system using plastic ear tags has been introduced since 2002. This was done to ensure a bigger coverage of national livestock through identification and to improve quality of recording of zootechnical and health aspects, and to get a database for traceability.
Zambia	It is compulsory to brand all cattle. Stud breeders may, however, get exemption from this requirement.
Zimbabwe	The Livestock Identification Trust manages the identification of livestock. It is known that Zimbabwe also has a system of district and individual brands. It is compulsory to brand all cattle in Zimbabwe.

Source: Country Reports, 2014

Box 5: The Kenya National Sahiwal Stud

The Kenya National Sahiwal Stud was started in 1962 to develop the breed for use as a dual-purpose animal (beef and milk) suitable for the semi-arid environments and to develop appropriate management systems for the breed. A breeding plan for a closed herd was drawn up in 1965 and implemented in 1968. The herd consisted of 400 to 500 cows plus followers, a total of 1,300 head, managed in a fairly extensive system. Records analysed to monitor the programme included: cow, service sire and calf identifications; dates of birth or calving, service and conception, and weaning; birth weight; age at 125 kg; lactation milk yield; and days in milk. Female selection involved eliminating 50 per cent of heifers on the basis of first lactation milk yield and a further 50 per cent at the end of the second lactation. The heifer herd was used for progeny testing of bulls. Ten test bulls were pre-selected from a total of 75 bull calves at two years of age on an index which included: first lactation milk yield of their dams and their paternal half-sisters, and own live weight at the end of a two-year performance testing period on pasture. At the end of the progeny testing period, two out of the ten bulls were selected each year. The breed is now about 800,000 head spread to much of southern Kenya and into Tanzania.

Source: Ntombizakhe Mpofu and Edward Rege (2002) Monitoring Sahiwal and Friesian cattle genetic improvement programmes in Kenya

Although most of the countries reported activities on identification and recording, these figures largely reflect what is happening in breeding stations

and a few commercial farms, with little or no recording taking place in the smallholder sub-sector. The identification and recording systems used are low cost traditional methods and in most cases, data is recorded manually.

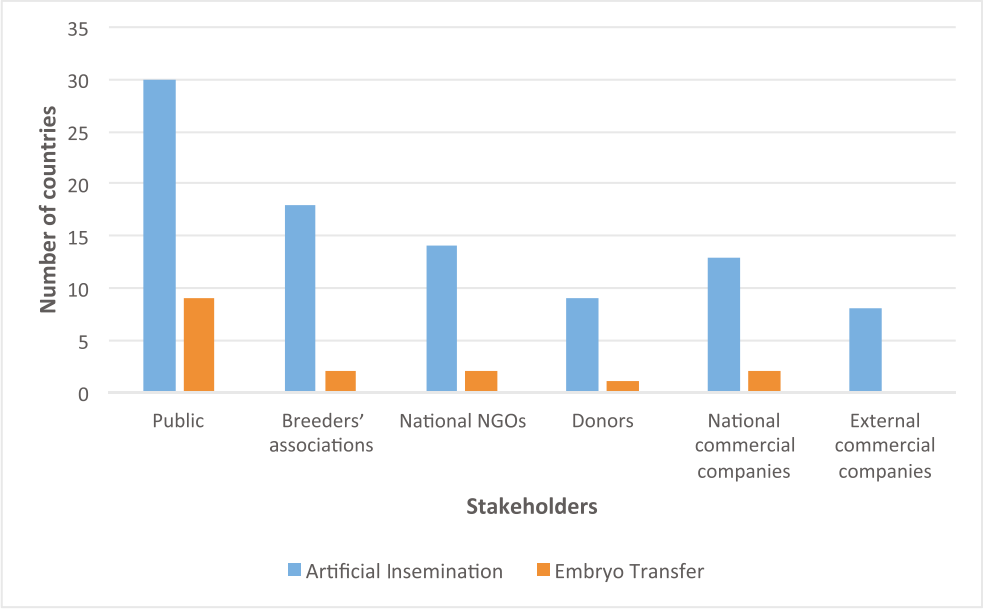
Utilisation of reproductive technologies

Artificial insemination (AI) and embryo transfer (ET) are indispensable tools for genetic improvement. They play an effective role in propagating improved breeds.

Artificial insemination

Analysis of the development of insemination shows that African governments are encouraging the use of AI to improve the national herds (Figure 71). The need for alternative methods to increase milk production has led to the establishment, in the majority of the countries, of local centres for semen collection where bulls are selected and trained.

Artificial insemination is widely used for cattle, mainly dairy cattle, and to a lesser but increasing extent for other species such as pigs. In almost all the countries, numerous projects have been introduced to establish AI services and to develop their activities as shown in Table 17.



Source: Country Reports, 2014

Figure 71: Number of countries and stakeholders using artificial insemination and embryo transfer

Table 17

Experiences in the use of artificial insemination across Africa

Country	How AI is applied	General comment
Botswana, South Africa and Mozambique	AI is widely used mainly in dairy cattle and to a lesser but increasing extent in other species such as sheep, goats and pigs. Some of the countries collect semen from local breeds, which is processed and stored for subsequent use. Distribution of semen of Tswana cattle takes place in Botswana.	
Cameroon	Some commercial farms or cooperatives are assisting the government in supplying cattle semen. The IRAD Bambui Regional Centre uses semen from Holstein-Friesian bulls to crossbreed with local cows. Semen collected is evaluated, processed and chilled for subsequent use in selected local cattle farms. AI and Embryo Transfer techniques are used at the Jakiri and Dumbo Stations.	Presently, IRAD is the only functional AI centre in the Central African Region: Republic of Chad, Republic of Central Africa, Gabon, Equatorial Guinea and the Congo Republic, that rear the same cattle breeds as Cameroon.
Ethiopia	The National Artificial Insemination Centre was established in 1981 with the mandate to serve at the national level. It is a government organisation that makes this service available to rural, peri-urban, and urban areas through its regional offices throughout the country.	Semen collection is based on exotic and indigenous breeds (Friesian, Jersey, Brahman, Boran, Barka, Fogera, Horro and Sheko) and their crosses.
Kenya	The Kenya Animal Genetic Resources Centre (KAGRC), hosting the Central Artificial Insemination Station in Kabete, has facilities to freeze and store at extremely low temperatures (cryo-preservation) semen, embryos and ova, but currently it only preserves cattle semen. Private AI service provision has also been ongoing since the early 1990s and it is on the increase.	The KAGRC has acquired a new expanded mandate which includes the production, preservation, distribution and conservation of animal genetic material, and rearing of breeding animals. It has built a distribution network of products (agents) easily accessible to the AI service providers and farmers.
Mozambique	The collection of semen from indigenous cattle is planned. Plans are made to exchange semen and to get technical assistance and liquid nitrogen from South Africa.	

Table 17

Experiences in the use of artificial insemination across Africa

Country	How AI is applied	General comment
Mauritania	Genetic improvement has been taken up by the government, particularly through the promotion of AI using semen from exotic bulls on local breeds.	The government and farmers themselves have addressed the problem of dairy cattle breeding stock supply by using (a) heifer breeding units (HBU) or livestock multiplication units (LMU) which are either privately or publicly owned and were set up to produce crossbred heifers for distribution to farmers, and (b) production of replacements on-farm using imported semen.
Rwanda	Rwanda possesses a National Bull Stud located at Masaka in Kigali. They collect about 150,000 semen straws per year from Friesian, Jersey and Inyambo (Ankole) bulls. This has been running since mid-1990s. Due to the poor performance of imported bulls, a programme using in-country selected young bulls was initiated in 2013. Inyambo semen is collected and in addition to cryo-storage, it is used in artificial insemination of public and private herds (active conservation).	The cattle breeding programme aims to provide training in AI technique and crossbreeding indigenous cows with exotic bulls to improve milk yield.
Tanzania	The National Artificial Insemination Centre is a government-run institution whose primary mandate is semen collection, processing and distribution to the local farmer market. The facility was established in 1985 under joint collaboration with the Swedish government.	The stakeholder involvement in the various elements of the breeding programmes indicates that the government plays a big role in provision of AI services only in cattle (specialised dairy). These are plans to modernise the centre to include embryo preservation.

Table 17

Experiences in the use of artificial insemination across Africa

Uganda	The National Animal Genetic Resources Centre and Data Bank (NAGRC&DB) is mandated to produce genetically superior breeding stock. It is located at the Animal Breeding Centre in Entebbe.	There is an ongoing breeding programme involving semen and embryo production, AI, ET, liquid nitrogen production and distribution, and preservation of semen and embryos.
Zambia	With the recent installation of semen collection, processing and packaging facilities at the national AI centre, semen is being collected for Angoni and Baila cattle.	
Zimbabwe	AI is used widely in the large-scale commercial sector to improve the national herd and economically empower farmers and villagers. It is practised on a 'do-it-yourself' basis and farmers send their workers at the AI centres to attend AI courses. Smallholder farmers have not been able to use AI due to high cost of equipment and semen.	

Source: Country Reports, 2014

AI has had advantages from a genetic improvement point of view through its effective dissemination of germplasm and the opportunities for strong selection of breeding stock. Equally important, AI has had advantages in controlling or eradicating diseases that could have been transmitted in natural mating systems. However, the use of AI has also failed in many situations in most of the countries because of the lack of infrastructure and the cost involved, such as for transportation and liquid nitrogen for storage of semen, or because the breeding programme has not been designed to be sustainable. The advantages and disadvantages of using AI should, therefore, be critically reviewed for each case before designing breeding programmes.

Multiple ovulation and embryo transfer (MOET)

In Africa, embryo transfer (ET) is still not as developed as in other continents. As shown in Figure 71, governments play a vital role in the provision of embryo transfer services. Experience from Africa shows that multiple ovulation and embryo transfer (MOET) technology has been practised in specialised centres since 1930. However, the impact has been



Photo Courtesy: Kenya Agricultural and Livestock Research Organisation – KALRO

Figure 72: AI breeding technology being applied on Sahiwal cattle in Transmara, Kenya

insignificant to farmers. Table 18 presents some initiatives on the use of artificial insemination and embryo transfer in Africa since 1930.

Table 18

Initiatives in the use of artificial insemination and embryo transfer in Africa since 1930

Country	Name of the Programme/ Project	Activities undertaken
Algeria	Local Breeds Conservation Programme National Centre for Artificial Insemination and Genetic Improvement	- Conservation of semen and embryo in gene banks - Semen production - Artificial insemination - Crossbreeding with indigenous female breeds
Botswana	Ramatlabama Bull Stud and Artificial Insemination Laboratory	- Cattle semen collected and used fresh, from local bull breeds (Tswana, Tuli, Bonsmara and Africander) and exotic bull breeds (Brahman, Simmental, Hereford, South Devon, Santa Gertrudis, Friesian, Charolais, Pinzgauer, Sussex, Gilbviech and Jersey)
Burkina Faso	National Centre for multiplication of high-performing animals (CMAP)	- Multiplication and diffusion of the Azawak Zebu - Production and freezing of bovine semen and embryos
Burundi	Rehabilitation of the National Insemination Centre Programme for the introduction of exotic breeds (either from improved bulls or from frozen semen)	- Semen production - Semen importation - Training courses for veterinarians - Introduction of exotic dairy breeds (Jersey, Guernsey, Friesian, Alpine Brown, Montbéliarde and Ayrshire) - Crossbreeding with Ankolé and Sahiwal breeds to improve milk production
Cameroon	Breeding Programme Using Artificial Insemination	- Crossbreeding with female indigenous breeds - Crossbreeding using imported frozen semen from the United States of America or Europe (Holstein, Jersey, Charolais, Montbéliarde, Aberdeen-Angus, Normande and Brahman) - Meat and/or milk production

Table 18

Initiatives in the use of artificial insemination and embryo transfer in Africa since 1930

Country	Name of the Programme/ Project	Activities undertaken
Comoros	PNDHD - Artificial insemination unit	- Crossbreeding with females of indigenous breeds - Crossbreeding using imported frozen semen
Congo	Swine Artificial Insemination Programme (DGE/FPGR/CRVZ/ CNSAF partnership)	- Swine artificial insemination
	Swine Artificial Insemination Programme in Pointe Noire, initiative of the Forum of the Young Enterprises of Comafrique (FJEC)	- Swine artificial insemination
	Swine Artificial Insemination Programme (public-private partnerships and NGO DGE / CRVZ / ENSAF / FPGR)	- Swine artificial insemination
Côte d'Ivoire	National Artificial Insemination Centre	- Development of AI in cattle and sheep - Collection, storage and distribution of the best breeding semen throughout the country
Ethiopia	Support to National Artificial Insemination Centre	
Ghana	Development of Sanga cattle	- Crossbreeding using Friesian semen - High milk production and adaptation to endemic diseases such as dermatophilosis
Libya	Artificial Insemination and Embryo Transfer Centre for Genetic Improvement Research	- Crossing with other breeds coming from the Mediterranean islands, Italy and Tunisia, for example, Friesian and Jersey
	Cattle Development Project	- Two AI units established, one in Tripoli and the other in Benghazi for genetic improvement and hygiene - Semen collected and used fresh - Using frozen Friesian semen through specialised international companies

Table 18

Initiatives in the use of artificial insemination and embryo transfer in Africa since 1930

Country	Name of the Programme/ Project	Activities undertaken
Libya	Programmes for the genetic improvement of layer chickens	- Selection of local breed flocks for high production - Artificial insemination was used in this programme - Three veterinarians were trained in Canada on these aspects - First experiments were carried out including: • Development, improvement, propagation of breeds and conservation of breeds in the form of stored embryos • 50 fertilised ova were produced of which 36 were transferred into surrogate mothers resulting in two pregnancies • 14 frozen embryos were imported from Canada resulting in three pregnancies but all were aborted at varying stages of pregnancy
	Embryo Transfer Technology	
	Artificial Insemination Centre	- Semen collection, processing and freezing at 600 thousand doses a year from 20 selected bulls - 10 improved bulls were selected according to Libyan specifications - One from AI accredited centres in Germany - Offers services to the public-sector stations, and all breeders and specialised associations. - Ceased the importation of frozen semen
Mali	Artificial Insemination Technique	- In zones of intensification of animal production, trials were conducted over several years in Sotuba - Experience different methods and progress from the insemination technique using speculum to the one using rectal fixation of the cervix based on natural or induced heat

Table 18

Initiatives in the use of artificial insemination and embryo transfer in Africa since 1930

Country	Name of the Programme/ Project	Activities undertaken
Mauritius	Artificial Insemination	- Introduction of the Jersey breed
Morocco	Artificial Insemination Centre of Ain Jemâa	- Use of semen production, storage and storage technology
	Artificial Insemination Centre of Fouarat	- Use of semen production, storage and storage technology - Conservation of the Oulmès-Zaer breed
	Breeding Station of Ain Jemâa in Casablanca	- Transformed into an artificial insemination centre in 1968 - Characterisation of the Oulmès-Zaer breed - Transformation of its genetic structure in order to increase the percentage of improved imported breeds and crossbred origin from 52 per cent in 2002 to 60 per cent in 2010
	Upgrading of the cattle herds	- Support for the multiplication and selection of imported pure dairy breeds - The sustained import of these breeds and the intensification of artificial insemination.
Mozambique	Artificial Insemination Centre, at the Animal Production Institute (IPA)	
Nigeria	Artificial Insemination (AI) in the genetic improvement of local breeds and promotion of dairy production	
	Animal genetic improvement centres, artificial insemination centres (AI) and extension programmes	
Sierra Leone	Dual purpose cattle development in Sierra Leone	- Crossbreeding with semen from exotic breeds - Increase meat and milk productivity

Table 18

Initiatives in the use of artificial insemination and embryo transfer in Africa since 1930

Senegal	Artificial Insemination Pilot Programme in Kaolack with PAPEL, with the assistance of EISMV	- Inseminate indigenous breeds, Gobra, with the semen of Holstein and Montbéliarde breeds to improve milk productivity and meat yields
	Establishment of genetic improvement centre (CNAG)	- Provision of heifers to dairy farms - Production and dissemination of semen for genetic improvement
Seychelles	Artificial Insemination Programme	- Semen of Friesian and Jersey used to upgrade the local Creole cows - Use Brown Swiss and Semental breed
Sudan	Artificial insemination technology was first introduced into Sudan in Khartoum North (Kuku)	- Improve the productivity of the national herd - Upgrade the low producing zebu cattle - Control of infectious breeding diseases - Make the processes of milk and meat production economically viable.
South Africa	ARC Animal Improvement institute	- Semen production
	Grootfontein	- Embryo Transfer

Source: Country Reports, 2014

In Kenya, ET technology was introduced more around the early 1980s, but the adoption has been very low. Currently, farmers can access this service through the East African Semen and Embryo Transfer Association (Kinyamu, 2014). In Mauritania and Rwanda, ET is done in collaboration with international institutions, mainly for experimental research in cattle. With financial support from the Government of Mauritania and technical support from FAO, a camel breeding centre was established to carry out ET. In Cameroon, the Namchi cattle breed was considered threatened and efforts were made to reconstitute the population using ET on Goudali zebu cows. The results were inconclusive (FAO/IAEA, 2003). In Namibia, MOET methodologies have only been used on a limited basis in the stud industry, mainly due to the absence of an ET centre and unavailability of liquid nitrogen. South Africa has been involved in embryo imports and exports. A restricted number of Gorno Altai embryos were imported to

establish a cashmere industry in the country. In Zimbabwe, the technology is currently available mainly in private breeding companies. In Botswana, ET has been tried by a few farmers including the Department of Agricultural Research. In Zambia, imported embryos come from countries such as USA, Great Britain, The Netherlands and South Africa.

Genetic improvement programmes

Crossbreeding and synthetic breed formation

Several attempts to improve FAnGR in Africa have been made, mainly by 'upgrading' with exotic breeds. Remarkable results, especially for meat production with different species, have been obtained in well-designed crossbreeding schemes. Improved FAnGR have been successfully produced or introduced in favourable areas. In Zimbabwe and several countries in East Africa, this has occurred with much success. Evidence indicates acceptable results in well targeted crossbreeding programmes (Mpofu, 2002; Kahi, 2002; Yapi-Gnaore, 1999). In Kenya, improved dairy cattle account for 23 per cent of the total cattle population and 75 per cent of dairy cattle in East and Southern Africa. Some countries, such as Uganda and Ethiopia, lag far behind; improved breeds account for only 3 per cent and 1 per cent, respectively (Heifer International, 2014).

The improvement programmes above were favoured by resourceful environments, and well developed infrastructure and markets. Policies aimed at increasing food production have encouraged local breeders to use exotic germplasm to replace local breeds (chickens), or for crossbreeding/upgrading (cattle and sheep) (FAO, 2007). Crossbreeding has often been promoted with the assumption that crossbreeds would produce greater outputs as a result of the contribution from the exotic breed to productivity and that of the local breed to environmental adaptation.

In maritime climates and in relatively intense peri-urban production systems, many attempts have failed due to the introduction of breeds not adapted to tropical conditions, or due to lack of long-term strategies for the breeding programmes to be sustainable. The effect of indiscriminate crossbreeding in the countries are well known and are sometimes visible as indicated by the gradual reduction of the population sizes of pure indigenous breeds. Most livestock in the countries are found in communal areas where controlled breeding is hard to practise. As such, indigenous

breeds of different species (cattle, sheep, goats, pigs and donkeys) are at risk because most farmers want to have improved breeds owing to their high production performances and economic returns. The introduction of exotic germplasm and use in crossbreeding (both controlled and uncontrolled) is causing significant introgression of the exotic genes and dilution of the indigenous germplasm. As a result, the indigenous breeds are being threatened.

The general failure of the exotic breeds to perform satisfactorily under the local environments has, over time, contributed to the development of composite breeds that combine the merits of exotic and locally adapted breeds. Crossbreeding work on cattle has been underway for more than 50 years, with the proportion increasing at higher rate in the last decade than in the previous periods. Kosgey et al. (2006); Kosgey and Okeyo, (2007), Mueller (2006) and Peacock et al. (2011) have reported on the success and failures of crossbreeding on small ruminants. Introduction of exotic chicken likewise has been implemented for a long period of time.

Few formal studies have been undertaken to assess the impact of crossbreeding. There were few studies that attempted to investigate the benefits of the introduction of exotic breeds. The only study that can be mentioned with regard to economic aspects of crossbreeding programmes is one on goat crossbreeding by Workneh (2000), which proved that crossbreeds are not more beneficial than indigenous goats under farm condition. A study by Onzima et al. (2015) to evaluate the economic viability and profitability of crossbreeding programmes for improving indigenous goat breeds under smallholder subsistence production systems, was conducted in Uganda. Gross margin analysis revealed that crossbreeding is overall beneficial, but under the smallholder subsistence system, the economic benefits are not significant. It is, therefore, concluded that to realise the full genetic potential of the crossbreeds, the genetic improvement of the indigenous breeds needs to be accompanied by improved management.

Evaluation of indigenous and exotic cattle, sheep and goat breeds for meat production conducted over the past two to three decades in Africa has shown the important attributes of indigenous and exotic breeds, and how these can be exploited to the best advantage in pure breeding and structured crossbreeding systems. Government crossbreeding efforts in the countries have had little success in the development of specific new breeds. Research studies that have been conducted in dairy cattle in

Africa are in general agreement with the findings from elsewhere that, for given production systems or management levels, there are crossbreed combinations (generally between 50 per cent and 75 per cent exotic inheritance) that can optimally combine the high milk yields of the exotic dairy cattle breeds and the superior adaptability, fertility and longevity of the indigenous breeds (Cunningham and Syrstad, 1987).

The main challenges in dairy crossbreeding have been how to develop and put in place suitable and sustainable institutional arrangements and financial resources as well as expertise for provision to farmers of crossbred dairy females of the desired genotypes. The sustainability of these programmes has often been hampered by, among other factors, the inability of breeding stations and farmers' own individual herds to produce adequate numbers of the desired crossbreed genotypes to meet demand as well as the absence of exit strategies to ensure continued provision of crossbreeds when government or donor funding runs out. Consequently, smallholder dairy producers have often been forced by the shortage of crossbred females to milk their low yielding indigenous cows. This situation may also apply to other schemes where crossbred breeding stocks are needed by smallholder farmers. The involvement and interest of the private sector in the provision of crossbred dairy females will need to be promoted in order to ensure long-term sustainability of such schemes.

Genetic improvement programmes for increasing chicken productivity also focused on the use of imported temperate breeds (Dana et al., 2011). Many exotic breeds of chicken (White and Brown Leghorns, Rhode Island Red, New Hampshire, Cornish, Australorp, Light Sussex, and others.) were introduced in the different countries. The other approach to improve productivity of the indigenous chicken production has been the use of crossbreeding to exploit heterosis. This approach involved crossing of unselected indigenous chickens to different levels of exotic breeds. In Ethiopia, evaluations of crossbred chicken at the Debre Zeit Agricultural Research Centre indicated that 62.5 per cent White Leghorn crosses showed superior egg production to the locals and pure White Leghorns (DZARC, 1991; 2007) under intensive system.

In a crossbreeding programme at Assela, Brannang and Persson (1990) also compared different York x local crosses, and their results indicated that egg production declined with increasing level of exotic inheritance (above 50%). Increasing the level of exotic blood also resulted in the loss

of broody behaviour, a trait of considerable economic value under village systems. Although the crossbreeding programmes produced successful results under experiment stations, almost all of them were discontinued decades ago for various reasons (Dana et al., 2011).

In the 1970s and 1980s, the Ministries of Agriculture in Kenya and Ethiopia initiated a cockerel distribution and exchange scheme. This involved importation and distribution of cockerels to be used as breeding males in villages. In Ethiopia, the scheme failed due to lack of appropriate design of crossbreeding; it is logical to crossbreed after pure line selection of indigenous chicken, which was not the case in this scheme. Farmers were unwilling to remove their local cocks and the exotic cocks failed to adapt to the village environments (Dana et al., 2011). In Kenya, the genetic improvement was started through a crossbreeding scheme by the National Poultry Development Programme (NPDP). Unlike Ethiopia, the programme utilised crossing between cockerels and pullets of exotic breeds with the local indigenous chicken. The programme witnessed improved performance in the crossbreeds, but declined with subsequent generations (Okeno et al., 2012). Failure of the programme to meet stakeholders' expectation led to its termination in 1993.

In Malawi, crossbreeding has been adopted to improve indigenous chickens, where Black Australorp was introduced since 1960 (Safalaoh, 2001). The government supported and implemented three hatcheries, one in each region (Mzimba, Lilongwe and Karonga) to facilitate hatching and distribution of six weeks old Black Australorp to households in villages. The theory of crossing was viable, to improve meat and egg from Black Australorp and adaptation to scavenging from indigenous chicken through combined effects in a crossbreed. However, no tangible results and impact have been noted.

The African Chicken Genetic Gains, supported by the Bill & Melinda Gates Foundation, is an Africa-wide collaboration led by the International Livestock Research Institute (ILRI). In November 2014, ILRI and partners initiated this new collaboration to provide better chickens to smallholder farmers in Africa. Part of the wider 'LiveGene' initiative tests and makes available high-producing, farmer-preferred genotypes that increase smallholder chicken productivity in Africa. The programme attempt to improve chicken genetics and the delivery of adapted chickens to support poverty reduction, productivity growth,

increased household animal protein intake, and the empowerment of women farmers in rural communities. Target countries are Ethiopia, Nigeria and Tanzania (ILRI, 2015).

In Ghana, using the genotypes such as Naked Neck and frizzle-feathered birds to improve the performance of local chickens is one of the surest ways of increasing profits and conserving the existing genetic diversity. A breed improvement strategy was carried out to incorporate heat-tolerant genes into exotic chickens to make them more productive. The base populations used were offspring of a cross involving local chicken male lines heterozygous for the Naked Neck (Na) and Frizzle (F) genes and exotic female lines homozygous recessive for the two genes. The F_1 crossbreed Naked Neck and Frizzle lines generated from the initial cross were backcrossed with the highly productive exotic parent lines, generation after generation. At the end of the fifth generation, three different phenotypic groups were segregated. These were combined crossbred Naked Neck and Frizzle, crossbred Naked Neck only and crossbred Frizzle only. The outcome of the breeding programme was improved chicken breeds, which were highly productive and adaptable to the hot and humid environments. The innovation succeeded in improving the egg production and meat yield of local chickens for smallholder farming systems in rural Ghana. Results obtained from farm trials showed about 100 per cent increase in egg production for the layers and early maturing, and increased meat yield for the cockerels (Hagan, 2015).



Photos Courtesy: Ministry of Livestock, Madagascar; Ministry of Agriculture, Livestock and Fisheries, Kenya

Figure 73: Breeds with morphological variants found in indigenous chickens

Selection programmes for livestock breeds

There are many arguments in favour of selection programmes for indigenous FAnGR breeds. Indigenous FAnGR are suitable in pure breeding systems, especially in the low input smallholder sector where the levels of management may be too low for the less adapted exotics and where crossbreeding is not recommended because controlled mating between exotic and local breeds cannot be achieved. These arguments have contributed to the development of selection and breeding programmes for the improvement of indigenous FAnGR breeds (Boxes 6, 7 and 8).

Box 6: The multiplication of Africa's indigenous breeds internationally: The story of the Tuli Breed

The Tuli breed was developed from cattle indigenous to south-western Zimbabwe and eastern Botswana. In 1942, a decision was made to purchase some of these cattle from the smallholder farmers and study them to determine if the type could be improved and whether or not they would breed true. In November 1945, 3000 acres were set aside in Guyu near Gwanda for the establishment of the Tuli Breeding Station. The founding herd had 20 cows and one bull. The idea was to breed bulls to assist in improving smallholder stock, but the commercial farmers also showed interest in the breed and started buying bulls from the station. A breed society was formed in 1961. Because of security problems associated with the liberation war, the Tuli herd was moved to Matopos Research Station in 1979. The selection programme is still in progress. The breed is now used in many commercial herds throughout Zimbabwe and there are seven stud breeders in the country. The improved Tuli has been distributed to several countries in Africa, especially in neighbouring Botswana and South Africa. It has also been used in forming a synthetic breed called the Okouma in Gabon. It has also been exported to Australia, Canada and the USA.

Source: Mpofu (2002).



Photo Courtesy: AU-IBAR

Figure 74: Tuli cattle at the Matopos Research Institute, Zimbabwe

There are a number of selection programmes in Africa where FAnGR were introduced into communities for 'improvement' purposes by government departments, NGOs, donor organisations, private companies and charities. These breeding programmes have varied goals depending on the species of FAnGR. Those that were found attractive in many developing countries, as suggested by Smith (1988), were mostly nucleus herd breeding schemes, where to date, the selection of breeding stock is concentrated in a few herds from which the selected animals are spread to other herds. They are designed to allow a good recording on a limited number of animals and data management at reasonable cost. They may be combined with the use of efficient reproduction technologies. Open nucleus breeding schemes, which also allow in-flow of high potential breeding animals from other herds, have been proposed as ideal for genetic improvement in situations with moderate levels of management (Smith, 1988; Barker, 1992). These selection programmes often concentrate on a narrow set of traits to the detriment of adaptive production traits that have evolved over time in the animals, and are of importance to the communities. For example, zebu cattle are heat and disease tolerant apart from having the ability to survive on poor levels of nutrition, food and water.

There have generally been deliberate efforts to identify clear selection objectives that involve relevant players, especially FAnGR producers who tend to be recipients of selection decisions. One good example is the N'Dama cattle genetic improvement programme initiated in 1994 and was operational in 1995 at the International Trypanotolerance Centre (ITC) in The Gambia (ITC, 1999; Bosso, 2006). The breeding goal was discussed and agreed upon with the National Agricultural Research Services (NARS) and the representatives of the target groups (farmers) (ITC, 1999). In 1990, a FAO consultancy mission was conducted at ITC. The report revealed the importance of traits like disease tolerance, milk production, meat production and ability for traction (Dempfle, 1990).

The question of which traits should be included in the breeding goals was revisited by Dempfle and Jaitner, J. (2000). A Participatory Rural Appraisal (PRA) study was carried out in 1996. The objective of this study was to investigate motives of cattle owners to breed, and to provide background information on the role of livestock in rural Gambian households of varying socio-economic status and ethnic origins (Bennison et al., 1997). The results confirmed that traits such as milk, meat, traction and manure were prominent. To validate the results of the PRA, a workshop was organised in

1996. From the discussions, it was concluded that "the N'Dama cattle will remain the breed of choice for the low-input system and that emphasis for the improvement should be on milk and meat, without the loss of disease resistance and other adaptive traits".

Box 7: The open nucleus breeding programme of the Djallonké sheep in Côte d'Ivoire

The programme (Programme National de Sélection Ovine – PNSO) was designed to take into account the maximum number of Djallonké sheep raised in the country. After several years of extension work, the PNSO programme was initiated in 1983 with farmers involved in the extension service since 1977. The enrolled farms consisted of private (smallholders and companies) flocks receiving technical assistance from extension services and two state farms. All the farms involved were instructed to breed only Djallonké ewes and to eliminate from their flock animals showing Sahelian sheep-type phenotype. The objectives of the programme were to improve growth and live weight of pure-breed Djallonké sheep and provide sheep farmers with improved breeding stock. The dissemination of the selected rams was so effective that the number of second category rams produced every year was not enough to supply the demand. The structure of the PNSO was composed of one central performance evaluation station for rams (the nucleus) and farmer flocks of only breeding ewes (the base population). Selection was on the male side only. The initial rams in the nucleus in 1983 were from the two state farms and the research station where selection for high growth rate was already in practice. Farmers in the base population used the selected rams from the nucleus for mating. In return, ram lambs in those farms were brought to the nucleus for evaluation and eventually selected to be sired. At the end of 1992, the base population of ewes was composed of 71 farms (including the two state farms), representing 12,000 breeding ewes enrolled in the programme. Of these ewes, 76 per cent were from private flocks and 24 per cent from the state-owned farms. In March 1999, 143 farms were involved in the programme, which represented 17,000 breeding ewes (88 per cent from private farms and 12 per cent from state farm).

Source: Yapi-Gnaoré (1999)



Photo Courtesy: Ministry of Agriculture, Senegal

Figure 75: Djallonké sheep, a drought and trypano-tolerant breed

Box 8: D'Man sheep breeding programme in Morocco

D'Man is an important sheep breed of Morocco. It acquires its importance from its exceptional reproductive performances and its high adaptation to the oasian environment. It is known as one of the most prolific sheep breeds in the world and one that does not exhibit seasonal anoestrus. The first D'Man breeding programme was initiated by INRA in the early 1970s. It concerned three herds composed of animals purchased from the region and gathered in three research stations. INRA aimed to conserve the D'Man breed, which seemed threatened by droughts and mismanagement, and to evaluate its performance under improved management. Selection programmes were initiated in the three stations with the objective of maintaining ewes' prolificacy rate at high levels and increasing lamb growth rate at least to the level of the remaining national breeds. Beginning in the mid-1980s, the National Sheep Development Plan (Plan Moutonier) designated pure-breed husbandry regions and allocated regions for crossbreeding programmes. D'Man straight-breeding plans were adopted in both the Draa and Ziz valleys. A three-stratum plan was adopted in each of the Draa and Ziz valleys in 1986. Each plan was composed of a nucleus, a group of elite animal multipliers, and the remaining D'Man raisers. This breeding plan was conducted between 1986 and 1994. Cooperatives and associations' breeders produced a large number of rams and ewes during that period (12,672). Selection was aimed to improve prolificacy and weight at 180 days and to eliminate horns. This phase of establishment of the straight-breeding programme resulted in increased interest among farmers as well as public agencies and national professional associations such as the ANOC (Association Nationale Ovine et Caprine) in D'Man sheep breeding.

Source: Darfaoui (2000)



Photo Courtesy: Ministry of Agriculture and Rural Development, Algeria

Figure 76: D'Man sheep, a transboundary breed found in Algeria and co

Based on the results of the PRA study, a bio-economic model was adapted utilising all known biological and economical relationships (Dempfle, 1986). This economic model was used to obtain an economic definition of the overall breeding goal. After reviewing the literature and

the local production system, it was agreed in 1998 that the improvement programme should aim to increase milk and meat production without losing trypanotolerance and other adaptive traits. Matjuda et al. (2014) documented the historical selection applied by Nguni breeders that contributed to the national genetic evaluation scheme, and offered prospective breeding objectives to guide future selection practices. Nguni cattle breed raised at the Agricultural Research Council (ARC) in South Africa have been characterised as having high fertility, low maintenance requirements, ease of calving, adaptability, resistance to parasites, resistance to tick-borne diseases, good temperament, longevity, browsing and good walking ability (Scholtz, 1988; South African Livestock Breeding, 2004). Consequently, the breed is viewed as having cost-effective capacity for beef production and the ability to thrive under harsh conditions.

A survey of pastoralist and agro-pastoralist households in south-east Kenya was conducted to determine their production objectives and management strategies in order to optimise and extend a breeding programme for indigenous small East African Shorthorn Zebu cattle. Okeno et al. (2011) generated essential information on breed selection practices and traits of economic importance of indigenous chicken farmers in Kenya. Duguma et al. (2010) recommended a combination of approaches to be used to precisely capture the breeding objective traits of livestock producers. They have noted that elucidation of objective traits using the tools with active involvement of producers could result in appropriate livestock genetic improvement that is well grounded in practical reality and truly reflects owners' preferences.

Scholtz et al. (2013) gave an overview of livestock breeding and attempted to identify sustainable breeding strategies in anticipation of climate change in South Africa. In south-east Kenya, Mwacharo and Drucker (2005) gave reasons for keeping cattle. The breed/trait preferences identified reflected the multiple objectives of the livestock keepers, with both adaptive traits and productive/reproductive traits rated as important. Kosgey (2004) identified breeding objectives for tropical small ruminants and developed sheep breeding schemes with specific attention to disease resistance. In South Africa, Kluyts et al. (2003) reviewed the development of breeding objectives in beef cattle breeding and the derivation of economic values. Clearly defined, realistic and achievable selection objectives developed in consultation with the beneficiary farmers should be the vehicle of every sustainable genetic improvement programme.

The absence of conventional and reliable recording systems in nearly all the African countries, and especially in the smallholder sub-sector in most countries, is a major constraint to implementing genetic evaluation. There are very few countries in Africa conducting routine genetic evaluation programmes. In South Africa, there is a rich history of genetic evaluation of livestock dating back to the early 1900s, with evaluation in the dairy industry keeping pace with global advances in statistical methodology. Increasingly accurate estimated breeding values (EBVs), produced in the past two or three decades, have aided selection decisions. This has been coupled with an increase in the number of traits officially recorded and for which EBVs are calculated. Currently, EBVs are routinely published for more than 20 traits for the major dairy breeds.

The genetic trends realised for traits of economic importance in the South African Holstein population were assessed for the period 1983 to 2008 (Ramatsoma, 2014). In 1974 in Kenya, the Livestock Recording Centre (LRC) was created with the mandate of improving milk and beef production through genetic improvement. The centre also conducts evaluations of livestock genetic resources using pedigree and performance data and BLUP analyses using REML procedures to obtain EBV. Today, the space for genetic evaluation has become very competitive. There are collaborative programmes which involve major players to include genomic selection in the current beef, dairy and sheep sectors. High levels of heritability and significant responses to selection for growth rate were recorded in indigenous cattle (Tawonezvi et al., 1986a, b; Tawonezvi, 1989; Khombe et al., 1994; Bosso, 2006). Therefore, permanent and cumulative genetic improvement can be achieved through sustained selection within indigenous breeds than through crossbreeding which yields non-cumulative benefits and may result in continued loss of genetic integrity of the adapted indigenous breeds.

Participation of smallholder farmers has not always been considered in the design of earlier conventional improvement programmes. Successful implementation of these programmes has, therefore, been limited. Financial and space constraints at breeding stations have limited the effective populations of the improved herds or flocks, and the general absence of the necessary strategies and schemes for the multiplication and dissemination of the improved indigenous breeding stock have limited their utilisation. It is noted that individual farmers do have breeding strategies that are in some cases at variance with stated government policies. Breeding in

this sector is largely uncontrolled and this is a major impediment to the implementation of any meaningful selection and breeding programme. The introduction of foreign genetic material is not controlled as well resulting in haphazard mating systems.

Experience shows that it is extremely important that farmers get involved early in the improvement process to ensure that their needs are taken into account and that they provide the support needed for the programme to work (Ahuya et al., 2004; Ahuya et al., 2005; van der Westhuizen and Scholtz, 2005; Kosgey et al., 2006; Peacock, 2008; Peacock et al., 2011). In these cases, it is important, from the perspectives of farmers and governments, to ensure that the most suitable animals are developed in relation to the real needs, given environmental, socio-economic and other resources.

The realisation of indigenous chicken potential has prompted current genetic improvement programmes. A viable option is to develop a protocol that will ensure improved meat and egg performance (Okeno et al., 2013a), sustained adaptation on slightly modified scavenging environments and ensuring conservation of indigenous chicken ecotypes. In 2006, a collaborative programme called the smallholder Indigenous Chicken Improvement Programme (InCIP) was initiated in Kenya and Malawi. To get founding population, indigenous chicken eggs and live chicken were collected from various agro-ecological regions or ecotypes, namely Kakamega, Bondo, Narok, West Pokot, Bomet, Taita Taveta, Lamu, Egerton and Mwingi in Kenya. In Malawi, eggs and live birds were sourced from Mzimba and Lilongwe Districts, Northern and Central Regions of Malawi respectively. These ecotypes are currently on station at the Egerton University poultry research and breeding facility and the University of Lilongwe in Kenya and Malawi respectively, for multiplication, performance recording and selection. This is the first attempt to improve indigenous chicken in both countries.

Studies on characterisation of Kenyan indigenous chicken had been done in Kenya (Okeno et al., 2013b; Ngeno et al., 2014) and establishment of their potential is ongoing. It is upon the performance records that selection and mating are based. In line with the project objectives, several studies have been conducted and findings disseminated. Ngeno (2011) reported variations in body weights among the ecotypes, and estimated heritabilities and genetic correlations for growth at various stages. Magothe et al. (2012) found out that genotypes (the Naked Neck, frizzle-feathered and crested-head) do influence body weights and growth patterns. The authors noted

that the crested-head genotype had a slower growth rate and was lighter compared to the normal-feather genotype when subjected to the same level of management.

In determining forward/directional selection, a study by Okeno et al. (2011) determined the selection criteria by farmers and traits of economic importance along the indigenous chicken value chain. They reported selection based on growth rate, large body size, high egg production, hatchability and good mothering ability. In this study, the authors reported the normal feathered, crested-head, Naked Neck and giant genotypes as the most predominant genotypes. To define breeding objectives among farmers, marketers and consumers, the study identified egg number, growth rate, body size, fertility, disease resistance, meat quality, egg size, egg shell colour, broodiness and mothering ability to be traits of economic importance that should be included in future breeding programmes (Okeno et al., 2011).

Okeno (2013b) evaluated the breeding objectives for purebreed and crossbreed selection schemes for adoption in indigenous chicken breeding programmes and reported a possibility of improving indigenous chicken dual purpose breeds or specialised lines for eggs and meat production. Broiler line and dual purpose breeding schemes are first and second most profitable, respectively (Okeno, 2013a). To achieve these results, it requires the establishment of a breeding protocol, which should entail choice of breeding goal, choice of selection criteria, design of the breeding scheme, recording of the birds, genetic evaluation of the chicken, selection and breeding, progress monitoring, genetic response and dissemination of genetic improvement. This, therefore, calls for development of pure phenotypes through elaborate data recording, mating of same phenotypes and selecting off-shoots out.

Development of crosses can be achieved through mating of different phenotypes within and between pure line types and the existing exotic strains of broiler and layer strains. Characterising the crossbreed growth, egg and adaptation traits for heterosis estimation should follow. Alternatively, indigenous chicken composite can be developed through crossing and selection practices. Upon genetic improvement, the improved indigenous chicken will be distributed to farmers through eggs, day old chicks, and chicks after brooding age.

Development of commercial breeds of the guinea fowl in Ghana was initiated. One basic challenge confronting potential investors in commercial

guinea fowl production in Ghana is source of good quality day-old guinea fowl keets. Commercial broilers or layers of improved breeds of guinea fowls are not readily available in Ghana. The low productivity (slow growth rate, poor fertility and hatchability, high mortality rates, pronounced aggressiveness, and so on) of the local guinea fowl discourages the setting up of commercial enterprises using local breeds. Local farmers could have earned more income from guinea fowls if they had improved breeds to upgrade their stock. Ghana will not exploit the full potential of guinea fowls, unless commercial strains/breeds for egg and meat production are developed. The goal of the guinea fowl project in the Department of Animal Science Education, University of Education, Winneba, is to improve the local breed through genetic selection for egg (layers) and meat (broilers) production. The programme for developing guinea fowl broilers has been initiated and the breeding objectives are to select for improved growth rates/body weights, docility and disease resistance.



Photo Courtesy: AU-IBAR

Figure 77: White guinea fowls reared at the University of Ghana breeding farm

In many countries of the arid zone the dromedary has regained its role as a supplier of milk, meat and traction. During the past 25 years, the amount of research on camels has increased considerably, reflecting a growing interest among research workers and governments in this species. In camel, the selection pressure by human was quite soft compared to other domestic ruminants such as cattle, sheep and goat. There has been no "invading" camel breed at the world level and the gene exchanges between

camels remain marginal. The selection achieved by the breeders in the camel history had only oriented its phenotypes for special use as packing, racing and more recently to dairy, meat or wool production.

The knowledge regarding the camel breed's or type's performances is still low. Keeping of regular records of dairy or growth performances in order to create a nucleus for genetic improvement is quite marginal and generally involves few animals. Clearly, except some activity on camel health and productivity, there was no reported national selection programme in most of the "camel countries". As a consequence, the camel productivity has not increased sufficiently yet (Faye, 2013).

Despite the important roles played by camels in the pastoral communities of northern Kenya, they have been largely neglected by scientists, policy makers and the government (Field, 1994). Farm Africa (2002) has observed that camels have been neglected and underused for a long time. During the colonial and early post-colonial period, camels were under extensive traditional nomadic, pastoral system, which did not receive interventions from the Government of Kenya or other agents (Box 9).

Box 9: Advocacy for camel research and development in Kenya

The United Nations Educational, Scientific and Cultural Organisation (UNESCO), in the process of finding solutions to desertification in the 1970s, established the Integrated Project on Arid Lands (IPAL) that identified the untapped potential of camels. IPAL conducted camel research in Marsabit District, while the Turkana Rangeland Monitoring and Evaluation Unit (TREMU) conducted comparable research in Turkana District in the 1980s. The IPAL programme published numerous technical and scientific reports. At the end of the project, it translated into a Government of Kenya establishment, the Marsabit Kenya Agricultural Research Institute (KARI) in 1988, to continue with camel research. The research findings of IPAL project culminated in the camel project of the Food Agricultural Research Management in Africa (FARM-Africa) that operated in Laikipia, Samburu and Marsabit Districts and the Government of Kenya Turkana Camel Project (TCP) in Turkana District. To build a holistic approach to the camel research and development, FARM-Africa spearheaded the formation of the Kenya Camel Association (KCA) in 1995 to advocate on camel issues for the wellbeing of camel keepers. Subsequent camel research findings and development outcomes influenced the Government of Kenya together with other stakeholders to focus on the camel as an important economic resource. The continued interventions in camel research and development led to the spread of camels to new communities in non-traditional areas and embracement of the camel in the Kenya National Livestock Policy. For the first time, camels were included in the Kenya National Housing and Population Census of 2009, which indicated camel population had increased to about three million in 2009 and were distributed countrywide.

Source: Ngeiywa and Njanja (2013)

Research on dromedaries is carried out by the Mauritanian Institute for Scientific Research in matters of anthropology, sociology and oral history, and by the National Centre for Animal Husbandry and Veterinary Research (CNERV) in matters of serology, virology, bacteriology and parasitology. With financial support from the Islamic Republic of Mauritania and technical support from FAO, a camel breeding centre is being constructed to carry embryo transfers on camels. Tadesse et al. (2014) conducted a study with the objective of describing and comparing camel husbandry practices, herd structure, owners' trait preferences, breeding practices and production constraints in the Afar and Somali pastoral communities of Ethiopia. In this study, solutions and possible suggestions in relation to livestock sciences were given for bad husbandry and breeding practices of camel. In addition, baseline information was generated to inform production and breed improvement strategies and options for the different camel populations.

Selection programmes for emerging or species of limited distribution

Grasscutters serve as a potential source of food and protein in many sub-Saharan African countries, but their availability is restricted to certain seasons of the year. African countries have limited grasscutter selection and breeding programmes that record phenotypes on pedigreed animals, and the lack of evaluation or national testing programmes to assess the genetic value of germplasms. Research carried out in Nigeria has made it possible for selection and improvement of stock for captivity to take place. This has improved knowledge and techniques for grasscutter production. More recently, a major research programme on glasscutters was initiated in Benin under the Project Benino-Allemand d'Aulacodiculture (PBAA) as discussed in Box 10.

Box 10: A case of the larger grasscutter – *Thryonomys swinderianus*

National programmes on promotion of grasscutter breeding and national grasscutter husbandry centres have been successfully established in Benin, Côte d'Ivoire and Gabon, which provide domesticated grasscutter breeding stock to the farmers. To ensure sustainability, several grasscutter breeders' associations in these three countries have also been formed. The associations organised training of the new farmers on grasscutter husbandry, and helped in pedigree and performance recording and marketing of both breeding and slaughter stock. The grasscutter breeding programme has the following outlined objectives.

1. *Ex situ* conservation of grasscutter through progressive domestication,
2. Identification of traits of economic importance and development of effective selection and mating schemes,
3. Effective extension strategy of grasscutter husbandry by initiating and strengthening breeder associations, and
4. Marketing of improved grasscutter breeding stock strains and slaughter stock.

Besides the above, economic, socio-cultural and environmental objectives of grasscutter breeding programme include the:

1. Development of local alternative protein sources through cost-effective grasscutter husbandry in peri-urban and rural area as a complementary income source for the families,
2. Documentation of the indigenous knowledge on cultural role of grasscutter for incorporation and use in conservation programmes, and
3. Reduction of bush fire and the negative impacts of poachers and hunters.

Based on the first three years of operating the selection scheme, a new scheme was developed and applied from 1991. This scheme operated in a pyramid structure of three levels, namely the Nucleus, the Multipliers and the Producers. In the Nucleus, intense selection was carried out. Although not closed, all male and most of the female replacements were obtained from within the Nucleus. The Nucleus supplies some female replacements and all the male parents to the Multipliers. In the absence of genetic parameters, the index of selection had been calculated from weighted averages. Individuals that were selected for breeding were those whose performances were superior to the average of the population of interest. However, with the availability of the genetic parameters, index method is being adopted, hence allowing for improved selection. Only the best breeders are practising this method.

Source: Mensah and Okeyo (2005)

The aim of PBAA was to select improved grasscutter stocks genetically adapted to life in captivity and to promote the rearing of the animal in rural and sub-urban environments (Baptist and Mensah, 1986; Mensah, 1991). The research focused on the ethology of the animal, feed, pathology and reproduction, as well as on the technical feasibility of farming grasscutters at the level of small-scale farmers. The feeding and nutritional requirement, production system and housing, dentition, reproductive performance, anatomy and morphology, environmental issues and the benefits of grasscutters have all been studied. Reproductive behaviour was observed with particular emphasis on the process of giving birth, breastfeeding and weaning. Growth performance and reproduction, namely the fertility rate, fertility and prolificacy have also been studied. Research has also been carried out to improve their adaptability to a restricted life in captivity and to develop breeding programmes in rural and peri-urban areas of Africa.

Since the study began in Benin in 1985 on the captive breeding and improvement programme of the grasscutter, two sub-populations were

established based on phenotypic performance. This first attempt in establishing a selection scheme presented some challenges, resulting in the design of a new breeding scheme in 1991. Genetic parameters and estimates of relative economic values (REVs) of traits such as survival, body weight, growth rate, reproduction, docility and food intake are reported by the grasscutter section of the Department of Animal Science Education at the University of Education in Winneba, Ghana.

Community-based breeding programmes

Historically, not all programmes have considered the vital role of livestock keepers in their design. Therefore, programmes better adapted to the specific conditions of communities and involving small-scale farmers in the breeding strategies, called community-based breeding programmes (CBBP), have been run in a variety of locations across the African continent. CBBP are considered as pathways to the genetic improvement of livestock in Africa. The approach typically involves the participation of local communities/farmers in defining breeding goals, designing breeding strategies and implementing genetic improvement programmes (Gizaw et al., 2010; Haile et al., 2010; Gizaw et al., 2011) as Boxes 11, 12 and 13 show.

Box 11: Development of community-based breeding programmes (CBBP) for local sheep breeds in Ethiopia

The Ethiopian community-based sheep breeding programmes started with approximately 60 households each in eight communities in four locations (Afar, Bonga, Horro and Menz) with distinct sheep breeds and production systems, involving more than 10,000 sheep. The goal of the project was to improve productivity and income of these small-scale sheep producers by providing access to improved animals and facilitating them to target specific market opportunities. The purpose of the programme was to develop breeding schemes that suit the communities' conditions and farmers' needs. A local governmental agricultural research organisation has been associated with each of the project sites. Local enumerators were recruited for each community to help the research team in animal identification and recording. Indigenous knowledge of the community was considered at each phase of the project. The core in this project has been to organise the community members to work together in performance recording, ram selection, management and use. The programme was successfully established in sedentary communities, but it did not succeed in the pastoralist communities (Afar). From the results obtained, the breeding programme has led to tangible outcomes in that fast-growing ram lambs that used to be sold off for slaughter are now being retained by the communities for breeding.

The acute shortage of breeding rams observed previously in flocks of participating communities has also been addressed as farmers are now fully aware of the importance of breeding males. Preliminary data analysis indicated increased marketing of lambs as a result of more lamb births and faster growth and reduced mortality due to the selection programme and other complementary interventions, although definitive conclusions cannot be made yet. Operationally, indicators of success include: promising progress with the selection scheme in which more than seven rounds of selection have already been performed in each site; data collection and recording system are in place; huge demand for breeding rams from neighbouring communities as well as government and NGOs; the system of ram sharing (use) and revolving fund is working fairly well; and, sheep breeders' cooperatives that operate the breeding programme have been established.

Source: Mueller et al. (2015)

Breeding programmes described as community-based typically relate to low input systems with farmers having a common interest to improve and share their genetic resources. CBBPs are more frequent with keepers of small ruminants, in particular smallholders of local breeds, than with cattle, pigs or chickens with which farmers may have easier access to alternative programmes. Constraints that limit the adoption of conventional breeding technologies in low input systems cover a range of organisational and technical aspects. They include socio-economic challenges such as illiteracy, infrastructural limitations and problems regarding movements of livestock. Furthermore, the public sector must realise the importance of supporting the implementation of well operated breeding programmes for small ruminants in rural areas.

In some cases CBBPs have proved to be successful (Roth, 2015). They generally aimed at improving milk and meat production of local breeds. In Ethiopia, since 2009, four project sites use solely indigenous breeds in order to preserve their adaptive traits. Cooperatives have been established in each area with the purpose of organising the rotation of rams between groups of sheep keepers. The Ethiopian projects have not shown that the postpartum weights of ewes and the number of lambs born have increased, while mortality rates have decreased. This indication of progress is, however, most likely due to an overall improvement in management together with better access to animal health services. Furthermore, increased interest in breeding rams derived from the project among sheep keepers and organisations outside the project as well as in the public sector have increased their market values. More than 500 households in remote communities have used the approach successfully for five years. The

genetic traits of the animals have improved, so has their overall health and productivity, while incomes from lamb sales have improved substantially for the community.

In Kenya, indigenous goats have been crossed with British Toggenburg goats since 1997 in order to yield faster genetic improvements. A decentralised animal health care system, including livestock keepers, educated to become community animal health workers (CAHWs), has been set up. Furthermore, breeding activities have been controlled and financed by the Meru Goat Breeders Association (MGBA) since 2004, including registration of goats in the Kenya Stud Book (KSB). Results have been positive; the number of participating farmers and genetically improved animals together with meat and milk yields have increased. This is due to the use of the Toggenburg, a functioning selection scheme where selection is based on the productivity of the animals, improved goat management, health care and rotation system. Registering animals in the KSB has led to higher market prices and has consequentially raised the incomes and socio-economic status of the owners. The CAHWs have played a vital role in improving the health and productivity of goats. The decentralised animal health care system has facilitated contact between the public and private sector (Roth, 2015).

The Kenya dual purpose goat (KDPG) breeding programme was started in 1980 to contribute to increased production of meat and milk, and improve incomes in smallholder farming systems. The project was part of a Small-Ruminant Collaborative Research Programme (SR-CRSP) operated under the auspices of the Ministry of Livestock Development (MLD) and funded by the United States Agency for International Development (USAID). The KDPG was developed utilising scientific principles for crossbreeding, selection and stabilisation of the breed. Ten years after the inception of the project, there was a change in the organisation of the MLD by the government and in 1991, activities under the scientific research division were taken over by KARI.

Farmers and pastoralists have been involved in choosing which traits to improve, setting up selection criteria and creating breeding strategies. Local extension staff have been hired for registration support and genetic evaluation. Farmers and pastoralists have received training in animal management, pedigree and performance recording as well as in animal health care. The most important success factors for both Kenya and Ethiopia were the breeders' associations created and the cooperatives,

making the use of breeding materials sustainable. They have also created jobs, spread knowledge and made breeding animals and animal health care services widely accessible to farmers (Roth, 2015).

Box 12: CBBP to exploit the characteristic values of the East African goat and the Galla goat – Kathekani Farmers Programme in Kenya

The East African goat is one of the most successful domestic stocks and is more tolerant to trypanosomiasis, internal parasites and pasteurellosis than the Galla goat. The Galla goat is kept for its higher body weight and milk yield, compared to the East African goat. To take advantage of the different characteristic of both goats, a community-based breeding programme was established.

The goal of the programme was to use both breeds to improve the livelihoods of the Kathekani farmers and enhance food security. The programme was designed to build on the strong local community capacity to manage livestock production and to exploit the available gene pool to achieve higher productivity. Cultural factors were also considered. The breeding programme is communally controlled through formation of groups, which establish breeding and improvement goals. The results are positive: The Galla/East African crosses are attaining much higher market weights in a shorter period as compared to the indegenous East African goat. Also, crossbreds are preferred for their large carcass size by butchers and traders. The project has demonstrated the benefits of community-based management practices. Stronger linkages among farmers and among other community members have resulted in farmers being in a better position to network and access information they require, meeting their livestock production needs. Farmers are in control of the programme, which maintains their participation and promotes others to be involved. The breeding programme is successful as it has been developed as an integrated livestock production package, not as an isolated project, and organised community activities have led to faster realisation of the development objectives.



Photo Courtesy: Ministry of Agriculture, Livestock and Fisheries, Kenya

Figure 78: East African goat, a transboundary breed renowned for its disease resistance

In Malawi, a study was carried out by Nandolo et al. (2016) to identify farmers' goat breeding objectives as a preparatory step towards setting up the breeding programme. Participatory workshops were held with farmers, where those with more than seven does were asked to select, with reasons, the best, average and worst does from their flocks. Productive, reproductive and morphometric data for the ranked does were recorded. There was some agreement between the farmers' ranking and the trait measurements taken suggesting that proper measurement of those traits will assist in meeting the farmers' objectives.

Box 13: Promotion of breeding and diversity of poultry species in rural Malawi

In rural Malawi, poultry constitutes over 80 per cent of the total poultry population and are raised and utilised by about 80 per cent of subsistence farmers. Different poultry species are raised, mostly indigenous to the locality except for chickens where traces of the Black Australorp breed have been identified. Despite the importance of rural poultry, little attention has been given to improving their management, productivity and diversity. Several constraints such as Newcastle disease, predation, poor housing, feeding and mating systems have been identified. A community-based project on improving and sustaining food self-sufficiency through promoting integration, multiplication and intensified utilisation of diversity of rural poultry has just started in villages of the Mkwinda and Mitundu Extension Planning Areas (EPA), Lilongwe Agricultural Development Division. These villages surround Bunda College of Agriculture. The project aims to operate through open nucleus breeding centres established in rural communities and managed by a committee of farmers. This project is designed to promote breeding of a diversity of poultry species in the rural areas and improving management practices. The project concentrates on indigenous species of chickens, pigeons and ducks. The goal is to improve productivity of meat and egg supply, and sustain diversification within flocks utilising the existing free-range production system. All management and performance evaluation decisions are taken and implemented by the community and supporting research has full farmer participation. Farmers from within the community will multiply and distribute breed stock to other farmers. Distribution will be through the traditional stock sharing system.

Source: Gondive et al. (2003)

The main breeding objective was to increase meat production, but the two selected sites (Mzimba and Nsanje) had different pathways towards this objective. Farmers in Mzimba were more interested in higher growth rates and higher mature weights, while those in Nsanje were more interested in improving survival traits, which are more directly related to off-take rates of community-based goat breeding programme in Mzimba and Nsanje Districts of Malawi. In this regard, CBBPs are more appropriate than the conventional breeding systems as Table 19 summarises. They should be considered as the basis for future improvement programmes that are intended to benefit smallholder farmers.

Table 19

General characteristics of conventional and community-based breeding programmes

Characteristics	Conventional breeding programme	Community-based breeding programme
Geographical limit	Regional – inter-regional	Communities
Market orientation	Commercial	Subsistence – commercial
Agent of programme	Breeding company – breeder organisation	Farmer – breeder
Breeding objective	Defined by company – breeder organisation	Defined by breeder – farmer
Breeding structure	Large-scale, pyramidal	Small-scale, one or two tiers
Genetic resources	International	Local
Infrastructure	Available	Limited
Management	Intensive – high input	Extensive – low input
Risk taker	Company – farmer organisation	Farmer
Decision on share of benefits	Variable	Farmer

Source: Mueller et al. (2015)

The USDA Livestock Improvement Project funded eight CBBPs, four in Malawi and four in Uganda, to engage smallholder farmers directly. These communities are learning to develop their own goat breeding objectives and to track their desired traits for farmer-led breeding programmes to meet their needs. It is also actively supporting other African countries in the network, who desire to set up CBBPs in their own countries, through information and resource development, sharing and technical support. Community-based breeding programmes are flexible and can be tailor-made to suit case specific community situations (FAO, 2015; Mueller et al., 2015). They also depend on involvement of local institutions as well as organisational, technical and financial support. To date, CBBPs have been confined to small stock. There is need to develop innovative ways of extending CBBPs to other livestock species.

Strengths, gaps and challenges in improvement programmes

Sufficient genetic variation in livestock populations is necessary both for adaptation to future changes in climate and consumer demand, and

for continual genetic improvement of economically important traits. Unfortunately, the current trend is for reduced genetic variation, both within and across breeds. The latter occurs primarily through the loss of local breeds. Inferior production is a key driver for loss of breeds, as they are replaced by high-output international transboundary breeds. Selection to improve productivity of local breeds is therefore critical for their long-term survival. Table 20 provides an assessment of the strengths, gaps, opportunities and challenges related to the implementation of genetic improvement programmes in Africa.

Table 20

Strengths, gaps, opportunities and challenges of genetic improvement programmes

Component	Strengths	Gaps	Opportunities and challenges
FAnGR	- Existence of a rich reservoir of FAnGR	- A significant proportion of these genetic resources is undocumented	- To explore, conserve and use the genetic variability
Variability	- Wide genetic variability adapted to a variety of climatic environmental conditions	- Lack of suitable and sustainable breeding strategies	- Establishment of coherent breeding programmes and schemes that meet farmers' objectives, taking into account production systems and environments
Programmes	- Existence of genetic improvement programmes in some countries in the continent	- Lack of coherence in existing programmes and absence of farmers' involvement - Absence of improvement programmes in most of the locally adapted breeds - Lack of breeding policies	- Raising awareness on the importance of breeding programmes for local breeds - Facilitating farmers' involvement in breeding programmes - Existence of niche markets for autochthonous livestock added value products

Table 20

Strengths, gaps, opportunities and challenges of genetic improvement programmes

Component	Strengths	Gaps	Opportunities and challenges
Breeding goals		- Lack of well-defined breeding goals for most of the native breeds	- Identify and develop, jointly with farmers, clear breeding goals and objectives that take into account farmers' needs and demand
Identification and recording	Existence but limited identification and recording systems	- Only few countries are members of ICAR or developed livestock identification and traceability systems	- Exploring simplified existing recording systems - Raising awareness on the importance of animal identification and product traceability
Genetic evaluation	Existence of genetic evaluation expertise (though limited to few countries)	- Lack of genetic evaluation of most of the native breeds	- Opportunity to share expertise and infrastructure between countries - Opportunity for building capacity
Dissemination of genetic superiority	Existence of AI in most countries	- Small herd sizes where AI is not used, thus limiting the dissemination of genetic superiority resulting in increased inbreeding	- Implement community-based breeding schemes - Use AI as a backup to community-based breeding schemes
Crossbreeding	Practised by all the countries	- Lack of policy on structured crossbreeding in most countries leading to genetic loss of indigenous breeds	- Set up structured crossbreeding systems that maintain the genetic integrity of native breeds
Capacity building	Existence of specialised institutions such as universities, research institutions and extension services, among others	- Limited number of trained animal breeders - Limited curricula focus on animal breeding - Lack of farmer organisations of local breeds	- Develop curricula focusing specially on animal breeding and breeding schemes - Promote establishment of national and regional breed societies/ associations - Promote networking/ partnership between countries

Source: Country Reports, 2014

Status of conservation programmes

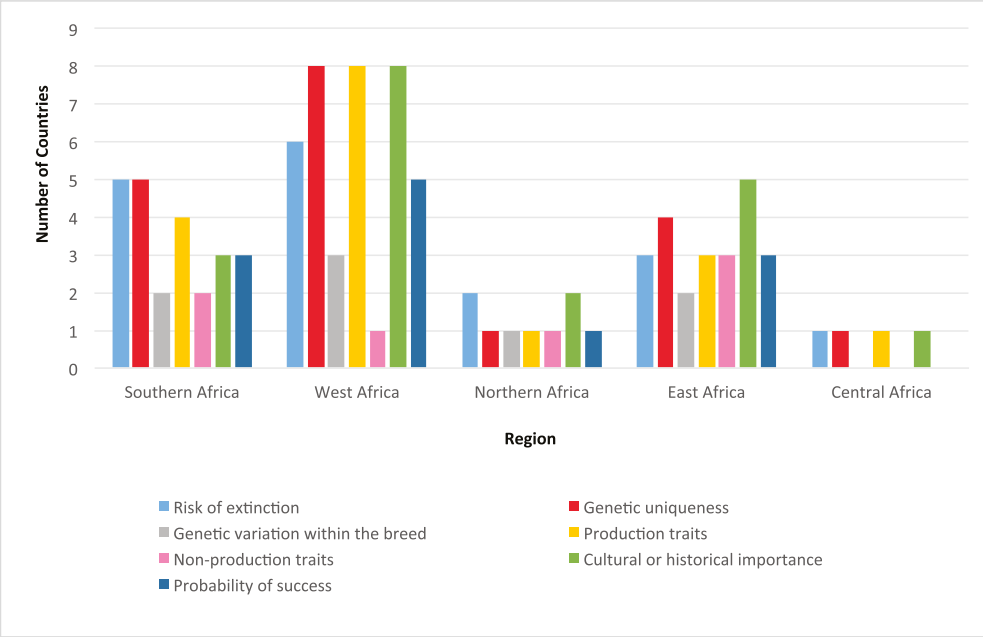
The major agencies responsible for FAnGR conservation programmes are governments, breeders' associations, private farms and research institutes or universities. In addition, some local communities through observance of their cultural practices are indirectly involved in FAnGR conservation (FAO, 2007). Major funding for FAnGR conservation programmes is provided by government and international donor agencies. However, funding of FAnGR conservation programmes by governments has generally been both inconsistent and inadequate.

Conservation strategies and programmes

Currently, there are two main methods of conserving FAnGR in Africa, namely *in vivo* conservation of animals (which includes *in situ* and *ex situ*) and *in vitro* conservation of germplasm material. Several actions have been initiated in various African countries to conserve some endangered breeds, using either *in vivo* or *in vitro* methods. *In vivo* conservation is undertaken mainly by pastoralists and small-scale farmers who keep the breeds. Most of the countries make use of formal approaches to prioritise breeds for conservation programmes and consider mainly the genetic uniqueness of the breed, its cultural or historical importance, the production traits and the risk of extinction (Figure 79).

In vivo conservation programmes in Africa

Smallholder farmers in Africa have, for millennia, played key roles in conserving and using native breeds to support their livelihoods. They have maintained the rich biodiversity and the associated local knowledge in addition to the crucial role in sustaining livelihoods and other environmental benefits. Future conservation interventions should, therefore, aim to support these efforts in order to maintain the existing genetic wealth (Box 14 and 15).



Source: Country Reports, 2014

Figure 79: Number of African countries within regions using the different formal approaches to conservation

Box 14: The unique Kuri cattle of Lake Chad Basin

The Kuri is a rare cattle breed found predominantly in the North Eastern states of Nigeria (Adamawa, Bauchi, Borno and Sardauna), along Yobe river valley and Southern Chad. These animals are also known locally as Lake Chad, Kouri, Baharié, Buduma, Budduma, Budumu, Boudouma, Dongolé or Kuburi. Their closest living relative is the trypanotolerant N'dama, a humpless longhorn predominately found in parts of Western and Central Africa. The unique Kuri are nature's gift to aqueous transhumance, given their bulbous horns which aid in swimming as they serve as natural 'floaters'. They are the core of sustenance of the pastoralist community in this area.

Unfortunately, the Kuri population size continues to dwindle. In 1947-48, the population was reported at 45,000 and in 1972 at 200,000 (Renard, 1972). Currently, its population is estimated at 10,000. This unique cattle breed's populations continual decline is due to various threats including unceasing civil unrest, rampant crossbreeding with the Arab Shuwa and M'Bororo zebu, disease ravages, droughts and most importantly, the receding Lake Chad. This population is obviously threatened, as their habitat (Lake Chad) continues to shrink as a result of shifting climatic patterns and man-made effects led by over-use of the fresh waters for irrigation projects and overgrazing resulting in land degradation, amongst others. For the survival of this unique and rare cattle breed, there is need to put in place rehabilitation measures for their natural habitat (Lake Chad) and set the conservation ball in motion by initiating management strategies to facilitate the population's recovery before the magnificent Kuri is referred to in memoirs, years after their extinction. (Mpofu and Rege,2002).

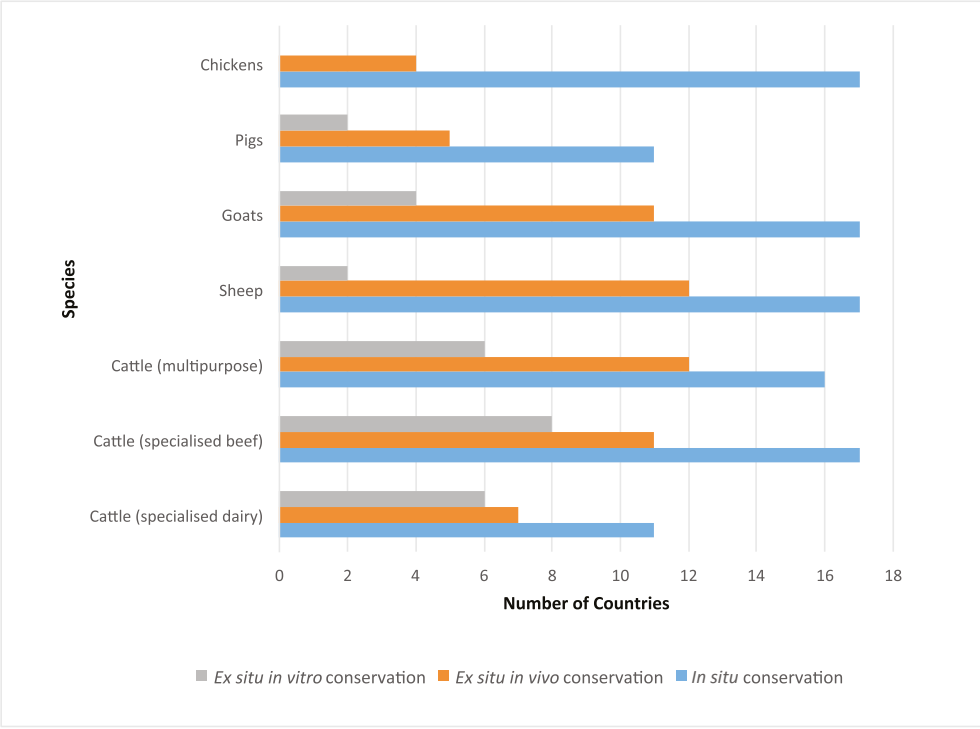
Source: Mpofu and Rege (2002)

Box 15: The case of the Sicilo-Sarde breed in Tunisia

Sicilo-Sarde, the only native milking sheep in Tunisia and in North Africa in general, has experienced considerable population reduction, from 200,000 ewes in 1995 to 25,000 in 2000. The breed was saved and the population decline reversed by farmers' initiatives in partnership with researchers and policy makers. Achievements of the Sicilo-Sarde Breed Association (SBA) were mainly due to its clear ideas and convictions to improve their breed as their main source of living. INAT, INRAT and ICARDA joined efforts with the SBA because they found opportunity for technology transfer and innovation. The existence of market demand for both milk for cheese and lambs was an incentive for sustainability. There is a need to enhance the efforts of this breed association in product quality, safety, traceability and labelling. Farmers rearing other breeds in the country were inspired by the Sicilo-Sarde story and, policy makers, researchers and livestock development agencies are now looking at the Sicilo-Sarde case closely to identify key ingredients for suitable and sustainable livestock development models. Other countries with breeds under similar threat can learn from this case.

Source: Djemali et al. (2009)

Most of the *in situ* conservation activities for FAnGR have focused on cattle, sheep, goats, pigs, poultry and camels from both locally adapted and exotic breeds, as well as emerging or non-conventional species. Analysis of country reports reveals major differences in respect of conservation activities in Africa as shown in Figure 80. Most of the programmes



Source: FAO, 2014

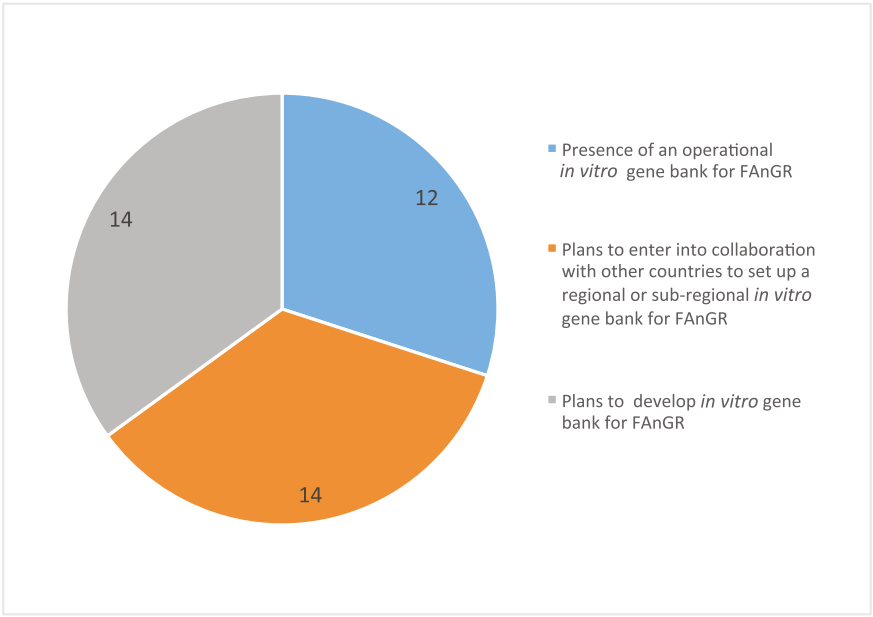
Figure 80: Overview of the countries indicating extent to which breeds are covered by conservation programmes

described include an important role for nucleus herds of local animals kept at governmental or institutional farms. These farms sell breeding material and are used to train local farmers. In nearly all these countries, the conservation activities are restricted to a few breeds in each species. Most conservation programmes are initiated either by the governments or research institutions.

In vitro conservation programmes in Africa

Currently, *ex situ* conservation is quite low due to lack of appropriate technology and expertise. Only 12 countries reported that they undertake *in vitro* activities (Figure 81), whereas 28 countries are planning to establish similar centres. The lack of prioritisation of *ex situ* conservation programmes by the relevant authorities has led to low financial commitment to these programmes.

The majority of the countries with gene banks indicated semen as the most important genetic material stored. This has been facilitated by the installation of semen collection, processing and packaging facilities at the national AI centres. Some countries have national gene banks while others have several specialised agricultural research institutes responsible for maintaining genetic resources, as Table 21 shows.



Source: FAO, 2014

Figure 81: Number of countries with established *ex situ* conservation programmes on FAnGR

Table 21

Gene banks for FAnGR and their objectives

Country	Name of the gene bank	Objectives
Botswana	Laboratory (Farm Animal Genetic Resource gene bank), Department of Agricultural Research (DAR)	• For storage of germplasm in liquid nitrogen, DNA and reproduction work • To cryo-preserve germplasm of cattle, sheep, goats, pigs and camels
South Africa	Germplasm Conservation and Reproductive Biotechnologies (GCRB), Irene	• Reproductive Physiology and Technologies: (General physiology, endocrinology, In vitro embryo production, Multiple ovulation embryo transfer, embryo splitting, sexing technology, ooegenesis and spermatogenesis, nuclear transfer, capacity building) • Cryobiology of sperm, oocyte, somatic cell and embryos: (Cryopreservation: slow freezing, vitrification, dried freezing and capacity building)
	Agricultural Research Council (ARC) Loskop Conservation Centre	• Promote the conservation and development of indigenous livestock breeds by utilising traditional knowledge in conservation with modern biotechnological techniques
	National Zoological Gardens of South Africa (NZG) Biobank	• Providing biomaterials that are viable, diverse and representative of Africa's wildlife populations. Various types of tissue, including embryos, fibroblasts (cells), blood, sperm, tissue, hair and egg shells are banked
Tunisia	Banque Nationale de Genes	• Conservation and evaluation of plant, animal and micro-organism genetic resources and coordination among the various operators in the field and promotion of conservation and sustainable use of genetic resources
Egypt	National Gene Bank - Cairo	• The conservation and maintenance of plant, animal as well as the micro-organisms genetic resources in the agricultural sector • To explore and collect genetic resources with priority given to the endangered Egyptian genetic resources, to conserve, characterise, evaluate and to provide genetic resources for use in public and private education programmes and by farmers

Table 21

Gene banks for FAnGR and their objectives

Country	Name of the gene bank	Objectives
Rwanda	National Gene-Bank – Huye	• Collects, documents, conserves and manages living samples of genetic resources, including plants, animal breeds, forest genetic resources, microbes and wild relatives of crops • Actively participates in livestock breed characterisation and documentation
Burkina Faso	CIRDES	• Collection of genetic material • Analysis and conservation of semen and embryos • Molecular genetics and cytogenetics

Source: Country Reports, 2014

Efforts have been made by the African Union to implement regional and continental gene banks. The proposed locations of the animal gene banks in the different regions are:

- The Centre International de Recherche-Développement sur l'Élevage en zone Sub-humide (CIRDES) (Bobo-Dioulasso, Burkina Faso) in West Africa
- The Gene Bank for Animal Genetic Resources at the Department of Agricultural Research (DAR), Gaborone, Botswana, in Southern Africa
- The National Animal Genetic Resource Centre and Data Bank (NAGRC&DB) in Entebbe, Uganda, in East Africa
- The University of Dschang, Cameroon, in Central Africa
- The Banque Nationale de Genes in Tunis, Tunisia, in North Africa
- A separate animal gene bank that will serve as a continental back-up to provide security against accidental loss will be under the mandate of the African Union Commission and will be established at the African Union – Pan African Veterinary Vaccine Centre (AU-PANVAC). AU-PANVAC will hold samples of each region, thus providing for an African ownership and security against accidental loss.

Aquaculture and fisheries conservation and selection programmes

There are two general approaches to improving the genetic quality of fish raised in aquaculture, namely 1) importing an exotic species or improved variety developed elsewhere (centralised approach), and 2) locally developing a new species or variety (decentralised approach) (Brummett, 2014). Although the history of aquaculture is relatively recent in Africa, it is not new to the majority of the countries. In fact, most known aquaculture systems were introduced over the last 35 years. The first successful pond production of tilapia in Southern Zaire dates from 1946. During the next 15 years, classical fish farming technology was introduced from Europe into various African countries and development spread rapidly. By the late 1950s, about 300,000 fish ponds were in use. The species cultured included a variety of over 30 indigenous and exotic species. The tilapia species continue to be the focus for aquaculture development, in particular *Oreochromis niloticus*. *Clarias gariepinus* and *Cyprinus carpio* are also favoured species. There is a lack of improved strains of the common cultured fish in Africa.

Selection programmes have been haphazard and the limited results have not reached farmers. Poor brood stock management has led to inbreeding on fish farms and even research stations. Natural hybridisation, mostly between different species of tilapia has occured. In Africa, many introductions and crosses have been made over the years, either purposefully or by accidental mixing. Nile tilapia introductions were generally in small numbers of individuals or were representatives of a limited number (Pullin, 1988; Agustin, 1999).

Most of the research in genetics so far conducted in Côte d'Ivoire focused on population genetics. The main objectives were to characterise wild and cultured stocks of fish in terms of genetic variability between and within populations, identity differentiation in natural populations, make bio-geographical inferences, and identify populations with special potential and those of interest to fish farmers. These research activities are important because they can lead to the development of strains for aquaculture or the protection of fish populations which are at risk of extinction.

Genetic tools developed in advanced countries were adapted, or new ones established, for the research conducted in Côte d'Ivoire. Species studied include natural populations and their cultured strains from Côte d'Ivoire and other regions in Africa (Yapi-Gnaoré, 2001). The work at the Bouaké research station in Côte d'Ivoire demonstrated how the Nile

tilapia genetic diversity has been managed. Captured in Burkina Faso in the 1950s and transferred to Bouaké, what was originally a pure population of *O. niloticus* was hybridised with other strains and species, and subsequently widely distributed in Africa and elsewhere (Thys van den Audenaerde, 1988). Transfers from Bouaké to Paraguay (1968), Sierra Leone (1970), Venezuela (1971), Brazil (1971), Benin (1979), Guinea (1978 and 1983), Mali (1982) and back to Burkina Faso (1982) have been reported (Pullin, 1988). The Baobab Fish Farm in Kenya, until recently (no longer operating) grew a hybrid strain of *O. niloticus*, *Oreochromis spilurus* and *O. mossambicus*. Kafue Fish Farm, in Zambia, maintains stocks of *O. niloticus*, *Oreochromis andersonii*, *Oreochromis aureus*, and gets wild *Oreochromis mortermeri* and *Oreochromis macrochir* from the Kafue River. All of these species easily cross with each other and perform less well than the original *O. andersonii* stock (Brummett, 2014).

There is an ongoing collaborative research initiative "The Volta Basin Tilapia Breeding Project" between FAO/WorldFish and six riverine states (Burkina Faso, Ghana, Mali, Côte d'Ivoire, Togo and Benin) which aims to develop a better performing strain of Nile tilapia using traditional selective breeding, much in the fashion as the Genetically Improved Farmed Tilapia (GIFT). The work builds on the efforts championed between 2000 and 2004 by the Water Research Institute Aquaculture Research and Development Centre (ARDEC) of the Ghana Council for Scientific and Industrial Research (CSIR). Similarly, work is ongoing on the selective breeding of *O. niloticus* and in particular *C. gariepinus* in Cameroon (Nguenga et al., 2007), in Kenya (Charo-Karisa, Osure and Gitonga, 2007) and in Nigeria (Williams et al., 2007).

Despite the long history of fish farming in Cameroon (since 1948), the development of the sector has been largely driven by international donor support. Little attention has been paid by the government and there has been no master plan for aquaculture development with clear and achievable targets (Nguenga et al., 2007). There are 12 fish stations and 20 fish breeding centres under the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA), but most of them are now in a state of disrepair or abandonment. Within the Agricultural Research and Development Institute (IRAD), the Foumban Fish Culture and Fisheries Research Station, with regional and international vocation, has the responsibility to carry out research activities on aquaculture and inland fisheries throughout the country. Each station constitutes the nucleus of activities in a given area

and a number of breeding centres are attached to it. The fish stations were designed with the primary objective of producing fingerlings to support the development and expansion of aquaculture (Nguenga et al., 2007).

In Kenya, the Sagana Fish Farm of the Fisheries Department, Sangoro and Kegati Aquaculture Research and Development Centre of the Kenya Marine and Fisheries Research Institute (KMFRI), Moi University Fish Farm and Kibos Fish Farm of the Lake Basin Development Authority (LBDA) are some of the centres that can host breeding programmes. Since 2006, two of these centres, namely the Sangoro and Kegati Aquaculture Stations, have been running catfish and tilapia breeding programmes with funding from the Government of Kenya. These breeding programmes target fast growth and survival of *C. gariepinus* and Nile tilapia. Besides breeding centres, the government has over 20 hatcheries or multiplication centres scattered across the country. These include LBDA's five fry production centres in the Lake Basin at Yala, Alupe, Chwele, Borabu and Rongo. The Fisheries Department has several fry production centres, although only a few of these are operational. The Fisheries Department's Operational Multiplication Centres include the Wakhungu Fish Farm and demonstration ponds at Murang'a, Kisii, Kisumu, Lutonyi, Yala and Nyamira. The average capacity for fingerling production at these hatcheries is approximately 140,000 fingerlings per year (Ngugi and Manyala, 2000). This is equal to two million fingerlings annually from the government centres. Rehabilitation of these hatcheries could lead to much higher production of fingerlings (Charo-Karisa, Osure and Gitonga, 2007). Progress is being made in reducing incentives for importing alien lines and species.

For *O. niloticus*, there are existing breeding programmes at Akosombo in Ghana and Abbassa in Egypt, that have reportedly recorded 10-15 per cent improvement in growth over several generations in spite of many problems (Brummett, 2014). In Egypt, the World Fish Centre has started a programme on pedigree selection of *C. gariepinus* in 2005 to improve the performance and quality of cultured catfish. For *O. mossambicus*, a breeding programme has been established at Stellenbosch University in South Africa. *O. shiranus*, an indigenous species in Malawi, is being improved at the Malawi National Aquaculture Centre specifically to provide Malawian fish farmers with alternatives to *O. niloticus*, which is banned (Brummett, 2014).

There is also an ongoing breeding programme for *O. aureus* in Egypt. Aquaculture in Rwanda mainly concerns *Tilapia nilotica*. The programme

T. nilotica, from Lake Albert, was brought to restock some lakes in Rwanda. Ugandan *T. nilotica* has been imported. Little is known about the genetics of indigenous tilapia nor has the Ugandan *T. nilotica* been compared with, for example, Hybrid Tilapia or GIFT4 lines from South Asia. There is need to develop a more systematic programme for 'provenance' testing of the various tilapia lines and breeds, and identify and select the best varieties for Rwanda.

The lack of skilled personnel and efficient extension services is hampering the transfer of new and improved technologies. Of major concern in the region are movements and introductions of species, release programmes and activities that are either part of an enhancement programme or associated with cultural and religious traditions. The contribution of these introduced species to total production has continued to decline over the past decade, in addition to negatively affecting the ecosystem and biodiversity in several parts of the regions. Although illegal introductions are suspected, GIFT has not been legally re-introduced to Africa for commercial farming. An on-station comparison of the GIFT and Akosombo strains of *O. niloticus* that could lead to the first major introduction was underway in Ghana. Theoretically, the use of improved strains could represent a threat to indigenous African tilapia populations in terms of declining abundance or reduction of genes with potential importance for future selective breeding programmes. There is insufficient data on tilapia ecology and genetic diversity for informed decision-making on the potential impacts of introduced strains on wild African tilapia stocks.

At least two fish farmers in Zambia are working to improve the performance of *O. andersonii*. However, it is imperative to do more, as pure populations of several species are under serious threat from genetic contamination. Among the most important species that remain, *O. andersonii*, *O. macrochir*, *S. melanotheron* and *S. galilaeus* probably have the highest potential to become economically viable aquaculture species (Brummett, 2014).

Conservation of other livestock species

African governments are currently encouraging income generating projects for the rural farmers. The role of small livestock like rabbits in poverty alleviation programmes has been acknowledged for decades and successful national rabbit projects have clearly been demonstrated in Africa (Oseni and Lukefahr, 2014). For years, several success stories

involving the implementation of rabbit breeding projects with large numbers of smallholder backyard rabbit units have been recorded across Africa. Notable examples and lessons learned have been comprehensively reported by Oseni, S.O. (2012) and include, among others, the National Rabbit Project of Ghana, the Heifer Project International (HPI), Rabbit Project in Cameroon (HPI-CAM) and the CECURI Rabbit Project in Benin. A special case is made for the sustainable development of smallholder, low input rabbit production systems in Africa on account of their popularity, low investment requirements and low economic risks, as well as their contributions to family nutrition, income generation and gender empowerment.

Trying to understand the issues surrounding bee conservation in Africa is complex. It requires consideration of both the history of bee research in the regions as well as the prevailing socio-economic and cultural circumstances (Eardley et al., 2009). In Africa, there are only a few countries, such as South Africa, Kenya and Ghana, that have substantial capacity and enthusiasm for pollinator conservation. Bee research in Africa has included extensive research on the honeybee, *Apis mellifera L.*, especially in South Africa (Hepburn and Guye, 1993; Johannsmeier, 2001), as shown in Box 16, limited work on stingless bees, haphazard descriptions of new species, revisional taxonomic studies for two-thirds of the known genera, a host of distributional records, and a relatively small number of studies on ecology and social biology.

Prospects for bee research in Africa are improving, and there is a growing awareness of the need to conserve pollinator diversity. This is largely driven by an interest in agricultural pollination management. However, the potential importance of all bees, as part of an ecosystem approach to conservation, is recognised in a number of projects (Eardley et al., 2009). Genetic selection in bees is usually geared towards three criteria: a) production of the colony; b) aggressiveness; and, c) tendency to swarm (Hepburn and Radloff, 1997). Whereas a lot of research on honeybee races has been conducted on behaviour, taxonomy and distribution, very little has been done in Africa. In Rwanda, the first interventions in the beekeeping sector were initiated by government in the 1980s, after which ARDI (Association for Promotion of Integrated Development in Rwanda) entered into an MoU with the government in 1991 for 11 years, to take charge of the beekeeping sector. During this period, the introduction of modern beekeeping was intensified. In 2002, beekeeping was selected as a

provider of employment with active promotion by government. A number of honey collection centres (HCC) were built, which were eventually converted into beekeeping cooperatives by the RCA (Rwanda Cooperative Agency).

Box 16 : Genetic and behavioural aspects of the African honeybee, *Apis mellifera*

Many African farmers are unaware of the potential benefits associated with beekeeping in terms of pollination and hive products. As a result, their actions lead to deforestation and exploitation of the plant sources of pollen and nectar for other uses such as construction and fuel. Harvested and handled with care, African honey is of high quality, with unique attributes such as taste and colour, and has high environmental credentials. It is produced by indigenous honeybees thriving in natural environments, free from introduced diseases and predators that are a problem in the developed world. This means that African honey has little risk of contamination by drug residues, a factor that could greatly enhance its quality and value on the world market if apiculture is managed properly. Apiculture can be improved by training farmers in modern beekeeping methods that enhance afforestation and planting of honey plants, protection of bee colonies, conservation of certain tree species, prevention of diseases and the risk of bush fires, improving the quality of hive products, identification and development of races. Better apicultural practice increases honey production, reduces bee loss and improves pollination efficacy. The attributes of the African bee discussed above will help the apicultural practice in East Africa and other areas of the world. However, the genetic improvement of honeybees for commercial beekeeping is not without fundamental problems. For instance, African researchers are yet to characterise these attributes at their native range and no breeding lines have been developed for selection in many of the research bases. However, marker assisted selection (MAS) and breeding based on these attributes will increase the overall genetic diversity of honeybees leading to healthier, hardier bees that can better fight off parasites, pathogens and pests. This will improve the honeybee's phenotypes for optimal hive production, pollination and other characteristics of agricultural value. As a result, beekeepers will have a better income as the market for their honey will improve and encourage more farmers to practise beekeeping as an income-generating project. Indirectly, this has the benefit of conserving indigenous forest biodiversity and enhancing pollination of their commercial crops.

Source: Kibogo (2016)

In the field of genetics, it is clear that in the past, most honey collectors would leave the most aggressive bees alone, meaning that these bees had the best chance to survive, multiply and swarm, and occupy empty hives. The more docile bee colonies were and still are preferred for honey collection, and were and are thus more disturbed and/or destroyed than their aggressive counterparts. This management practice might over the years have led to a negative selection for more aggressive bees colonising the traditional hives in the forest zones. This is, however, difficult to prove. Without active hive management and production recording, it is unlikely

that any selection by humans in the bee genetics has taken place in the past. It is very likely that in Rwanda, there are three distinct different "breeds" or ecotypes of the African honeybee, namely the Nyungwe lowland forest type, the Virunga highland forest type and the Akagera African savannah type. These bees have adapted to their environment through natural selection and are probably dominant in terms of their genetics and suitability for the area where they were selected. With the advent of Varroa in Rwanda and Uganda, selection is for those colonies showing resistance, good production, low tendency to swarm and limited aggressiveness.

The genetic selection in Rwanda is best done as phenotypic selection of colonies with the highest production, lowest tendency to swarm and low aggressiveness. To achieve this performance, testing and recording is required. This selection work can be best taken up in the demonstration and training apiaries to be developed for each of the three principal beekeeping areas with bees from that area. In South Africa, beekeepers working with Langstroth hives have increasingly had problems with theft of complete hives and have resorted to selecting more aggressive bees to make life harder for thieves. In consultation with the beekeepers, a selection strategy was developed, which suits farmers and their specific conditions. In this way, the availability of docile well producing colonies in Langstroth hives is increased.

In Algeria, cooperatives are working hard in beekeeping. Research activities are conducted in "Institute of Small Animals" (El-Kohl, 1996). In Egypt, extensive crossbreeding and the production of commercial bee lines for increased beekeeping have been practised. Today, it is arguable whether there are many 'pure' lamarckii colonies left in the country (Dewitz et al., 1994). In Tunisia, instrumental insemination of Carniolan queens is conducted at a "German Station". A planned research programme in bee selection in Kenya was carried out; 80 per cent of Kenyan land, including some arid areas, is suitable for beekeeping.

Until 2003, interventions made in livestock development had overlooked the equine resources in Ethiopia. However, the government is now paying due attention to these resources. The Debre Zeit, Holetta and Adami Tulu research centres have evaluated performances of donkeys found in the central highlands. Major emphasis was placed on assessing productive and reproductive performances of the breeds, and their crosses under improved feeding and management conditions. In Botswana, there are opportunities that donkey meat can be exported to Europe and, therefore, the donkeys may be used

more for meat production as opposed to the present where they are mainly used as draught animals. The government has no specific breeding initiatives for horses and donkeys. This trend will lead to a significant reduction in the numbers of donkeys and threaten their existence given their slow reproductive rate. Therefore, in Nigeria, efforts are being made to start a conservation programme for donkeys at National Animal Production Research Institute (NAPRI), Zaria. The objectives of the programme include maintenance of breeds at risk and within breed diversity, social, cultural and economic values as well as ecological values, research and education. Conservation priorities are established on the basis of level of extinction threat, preservation of gene pool, product and cultural values as well as the level of adaptability to a particular environment.

In Egypt, there are established farms specialising in Arabian horse breeding; some of them are internationally famous for their pedigreed Arabian horses. The old horse station in Alzahraa breeds pedigreed Arabian horses (Figure 82) and holds regular international auctions. In Lesotho, breeding of horses, particularly the Basotho pony, is well controlled under the mare camp system, which is community-based. FAO has further strengthened village level organisations (Basotho pony mare camps) responsible for multiplication of this horse. Funds from Ireland have, in the past, been used to save the Basotho pony horse from extinction.

Horse breeders in South Africa are abundant. The Kaapse Boerperd originated from one of the first locally developed breeds in South Africa, the Cape Horse. This breed was a result of crossbreeding the (Arabian horse) with Berber horse introduced into the Cape colony in the 17-18th centuries.

Selection for an adapted, even-tempered and hardworking horse led to the emergence of a uniform composite. Further crossbreeding led to the disappearance of the original Cape horse. In 1948, Arab and American saddle horses were used in a controlled programme to improve the breed. The breeding of the Nooitgedachter commenced in 1951 when the Department of Agriculture started developing a nucleus of Basotho-type ponies. These ponies were descendants of the Cape horse that had adapted to the mountainous highlands of Lesotho in the early 19th century. It is used mainly as a riding pony, but is also used for patrolling inhospitable areas and game counting in game reserves.



Photo Courtesy: Ministry of rural development – Mauritania

Figure 82: The Arabian horse found in Mauritania

Conservation of emerging or species of limited distribution

Although crocodiles have been ranched in Africa for many years, captive breeding has not been significant in commercial production until quite recently. Several African countries now have an interest or involvement in commercial crocodile production. In Kenya, near Mombasa, a farm for the Nile crocodile (*Crocodylus niloticus*) has been set up to produce hides from captive-bred stock. The farm is a demonstration project of a large cement factory that is attempting to return its limestone-mined areas to productive agriculture.

Some sophisticated experiments are under way on crocodile nutrition, with food for the animals produced in an intensive aquaculture project using tilapia. Zimbabwe has made great strides in captive breeding. In 1979, 87 captive females at two farms produced 1,906 eggs, and a third farm has set aside 30 captive females for breeding. Four of the country's five crocodile farms are on the shores of Lake Kariba and the other is at Victoria Falls. The government allows each farm an annual allotment of wild eggs (averaging 2,000 to 2,500) for stocking its rearing programmes. Each farm is also striving to become self-sufficient in egg production by developing successful breeding programmes. The government is considering reducing each farm's allotment by the number of eggs produced annually in the farm



Photo Courtesy: Chiredzi Crocodile Farm

Figure 83: Crocodile farming on Chiredzi Crocodile Farm, Zimbabwe

so that each will eventually become independent of the wild populations. Zimbabwe farmers operate under a system that obliges them to return a small percentage of live animals to the wild if the government requires it. At present, this requirement is being waived because the wild population is increasing on its own. Zimbabwe has built its crocodile conservation programme on a broad base.

In South Africa, captive Nile crocodiles were first bred for restocking purposes in 1974 and they have been bred in increasing numbers since then. The country has four crocodile farms, and another five are planned or under construction. Apart from the Natal Parks Board Crocodile Research Station at St. Lucia Estuary, which breeds Nile crocodiles for restocking and conservation purposes, all farms are for tourism and hide production. Following the example of Zimbabwe, the South African farmers (present and potential) formed a crocodile farming association in 1982. In Botswana, several farms patterned after those in Zimbabwe are planned for establishment in the Okavango area. In Chad, in the late 1960s, French businessmen established a farm for Nile crocodiles near Lake Chad. It collapsed after only a few years. In Côte d'Ivoire, the government has obtained assistance from Zimbabwe to establish a conservation programme for its three native crocodiles, namely the Nile crocodile (*Crocodylus*

niloticus), the African slender-snouted crocodile (*Crocodylus cataphractus*), and the Congo dwarf crocodile (*Osteolaemus tetraspis*). Recommendations were made for conserving the wild populations as well as for establishing farms.

Guinea pigs, widely reared for meat in Latin America, are also bred in a number of African countries, a practice that has received virtually no attention from government institutions and agricultural sector policy makers. The findings of three years of joint research indicate that there are many socio-economic advantages of traditional guinea pig farming in Cameroon and that the productivity of these small herbivores may be improved through the development of a more appropriate feeding system as well as through the adoption of simple livestock management techniques based on controlled weaning and mating, and the elimination of inbreeding.



Photo Courtesy: Mrs Neema Urasa, Tanzania

Figure 84: Guinea pigs (cavies) rearing in Tanzania as an emerging livestock species

In the 1980s, the first cavy research and development activities were put in place within a project on rabbit production for smallholders (Lukefahr and Preston, 1999; Lukefahr et al., 2000). Heifer International Cameroon (HIC) has continued to promote cavy culture in the country (Lukefahr

et al., 2000). In the 1990s, another development project focused on mini-livestock species, including cavies for Cameroon. Within the research collaboration with the Italian University of Milan, a number of studies took place that, for the first time, established and mapped the distribution of cavy culture in Cameroon and even across Africa (Ngou Ngoupayou et al., 1994, 1995; Nuwanyakpa et al., 1997). In addition, Manjeli et al. (1998) conducted the first year-round study that characterised all production and reproduction parameters for traditional cavy culture in Cameroon. During the course of these projects, with the Institut de Recherches Zootechniques et Vétérinaires, Yaoundé (presently IRAD) and the University of Dschang, a substantial number of studies took place. These studies were aimed at improving productive and reproductive performance of cavies (including body measurements). Outcomes of the various experiments have been published (Niba et al., 2012).

The Cavy Project is focused on enhancing alternative and rapid access to food and income in Cameroon and the eastern Democratic Republic of Congo (DRC) by improving cavy production. Lead institutions comprise the BecA-ILRI Hub, the International Centre for Tropical Agriculture (CIAT, Nairobi), the University of Dschang School of Agriculture (Cameroon), and Université Evangélique en Afrique (UEA) in Bukavu, South Kivu Province, DRC. One of the specific objectives of the Cavy Project is to implement genetic diversity (using SSR molecular makers) and integration of genetic diversity data with various metadata to design sustainable cavy production systems. The main idea is to understand the genetic diversity within and between domestic cavy populations from West and East Africa, and the performance of these populations, as a basis for establishing a rational breeding programme. Within the project, cavy populations from two regions in Cameroon and three 'territoires' in Sud-Kivu, eastern DRC, have been sampled to assess genetic diversity of the animal in Africa. In addition, further molecular analyses were being conducted on cavies from Côte d'Ivoire. An overall assessment of the genetic diversity has been conducted, pooling all molecular data from Cameroon, eastern DRC and Côte d'Ivoire, and comparing them with a few samples from Colombia (BecA-ILRI Hub, 2014).

Ostrich farming has gained momentum across Africa as documented in parts of Western, Eastern and Southern Africa. The South African ostrich industry is one of the largest exporters of red meat in the country. The first commercial ostrich farm was established in South Africa in about

1860 solely for harvesting the feathers. Today, ostriches are farmed in many areas in Southern Africa for their skin, which is used in making luxurious, high-fashion leather goods and also for their high quality low fat and low cholesterol red meat. The ostrich flock at the Oudtshoorn Research Farm was developed as a research resource from birds donated by a local commercial breeder in 1964. As such, the research farm has since taken up the responsibility to maintain this unique and valuable resource, and to provide information and breeding material to the ostrich industry. This project aims to ensure the management, long-term conservation and selection of the ostrich flock at the Oudtshoorn Research Farm to aid ostrich research and to benefit the ostrich industry as a whole (Cloete and Engelbrecht, 2014).



Photo Courtesy: AU-IBAR

Figure 85: Ostriches on Safari Ostrich Farm, Oudtshoorn, South Africa

Ostrich farms began to spread gradually to other countries, particularly Egypt. Burlini, F. (1994) and Cloete, Van Schalkwyk and Brand (1998) give the account of ostrich breeding in South Africa, Zimbabwe and Namibia. In Zimbabwe, extensive, semi-intensive and intensive breeding systems are used. It is reported that extensive breeding, with natural or artificial incubation, can give better hatchability and chick survival compared to intensive systems; dietary factors may be involved (Foggin and Van Niekerk, 1996).



Photo Courtesy: Ministry of Livestock – Madagascar

Figure 86: Rabbit rearing in Madagascar

A programme to domesticate the giant rat was initiated at the Department of Forest Resources Management, University of Ibadan, Nigeria, in the early 1970s (Ajayi, 1971; 1975; Ajayi et al., 1978) with the aim of maximising meat production from the species.

Rearing rabbits is increasingly becoming popular in Africa, particularly among the youth and smallholder farmers as they require low capital investment and limited space. They also multiply fast. It has been practised in Uganda since the 1870s when Christian missionaries first introduced the long-eared animals. From the 1970s to 1980s, there were efforts to promote rabbit production through importation and multiplication of exotic breeds, mainly the New Zealand White, by the government. However, there was little success. This was mainly because the enterprises attracted to rabbit farming were very few. In the 1990s, however, there was phenomenal growth in rabbit farming as various organisations and institutions promoted rabbit for food and income generation. In recent years, there has been increased awareness of the advantages of rabbit meat production in Africa as a means to alleviate animal protein shortages and

generate income, particularly in areas with high human population and limited agricultural land. Africa already boasts of a few rabbit farmers.

Attempts at wild animal domestication have not been restricted to vertebrate species; invertebrate species including snails and caterpillars have also been the subject of domestication. In Africa, the feasibility of farming the giant snail was demonstrated by a number of researchers in West Africa in the early 1970s (Ajayi, 1971; Plummer, 1975; Ajayi et al., 1978; Hodasi, 1979). Giant African snails are an integral part of the African culinary tradition. In West Africa, a major snail consumption region, wild stocks have been endangered by over gathering for some years now. Production systems must be developed in Africa to save this resource from extinction.



Photo Courtesy: AU-IBAR

Figure 87: A roadside vendor in Ghana selling giant snails

The major objective of the small-scale snail farming sector is to replace wild snail gathering gradually with rational production techniques. Snails have been raised in small pens in many areas within the sub-region and

currently in Ghana, there is a major campaign to promote snail farming both as a backyard activity to supplement household income and protein supply and as a large-scale commercial activity. Genomic approaches should help in identifying critical populations for conservation.

Strengths, gaps and challenges of conservation programmes

To help in decision-making in conservation and development strategies of FAnGR breeds, key factors influencing the success or failure of issues and measures related to the conservation and development of these FAnGR were identified, as they allow the integration of many driving factors influencing the breed dynamics. Strengths, gaps, opportunities and challenges of conservation programmes are presented in Table 22.

Table 22

Strengths, gaps, opportunities and challenges of conservation programmes

Conservation method	Strengths	Gaps	Opportunities and challenges
In vivo	Applied by the majority of livestock owners	- Inbreeding - Unjustified/ uncontrolled crossbreeding - Lack of awareness on the risk status of locally adapted breeds	- Promote setting up of suitable breeding strategies - Linking station programmes to smallholders' herds/flocks (Community-based/open nucleus schemes) - Promote awareness for the risk status of locally adapted breeds
In vitro	Existence of a nucleus of gene banks	- Lack of standards for storage, conservation and exchange - Lack of policies and regulations to govern operation of shared gene banks	- Build collaboration, partnership and capacity - Genetic resources are very sensitive and they need complete trust among countries in the use of shared gene banks - Develop regional policies on gene banks - Establishment of a continental backup gene bank

Source: Country Reports, 2014; AU-IBAR questionnaires, 2014



Ghanaian Ashanti pigs – the farrow is an outcome of the support offered by AU-IBAR for the conservation of breeds at risk

Photo Courtesy: AU-IBAR

CHAPTER SIX

Policy and Institutional Frameworks for Animal Genetic Resources



A camel caravan in Azawak Basin of Niger
Photo Courtesy: Ministry of Livestock, Niger

Few African countries have stand-alone livestock policies. Most of the countries have their livestock policies imbedded in the general agricultural policies. Few countries have policies and legislation directly formulated and designed for the management of FAnGR. Despite the existence of numerous institutions within the countries' ministries (Agriculture, Livestock, Fisheries, Environment or Natural Resources) dealing with aspects of FAnGR, there is a lack of focus in addressing issues related to the management of FAnGR as well as a noticeable lack of coordination among the different national institutions. These policies often exist in different institutions; their harmonisation becomes a challenge, hence reducing their effectiveness. Even within the institutions, the existing institutional and policy frameworks tend to cater more for issues of trade and animal health.

Policy and legislative frameworks for FAnGR

Some countries in Africa have taken measures to put in place specific policies on FAnGR, for example, Mali, Uganda, South Africa and Ghana have policies and legislation specifically targeting FAnGR. Others have 'draft' policies that have been in the process of development for a long time without finalisation; Tanzania and Kenya are examples of such. These policies have components on livestock productivity improvement through selection, breeding and conservation of indigenous FAnGR. They also give directions on crossbreeding issues.

In some of the countries, the existing policies and regulations in the domain of FAnGR mainly relate to prohibition or control of imports and exports of FAnGR. This narrow focus on trade and health-related issues, such as fear of spreading animal and zoonotic diseases, does not provide conducive environments for the development of the wider FAnGR sector. Recent analyses reveal that almost all the countries in Africa do not have formal policies and legislation targeting crossbreeding. These same countries have been exposed to indiscriminate crossbreeding and to a wide introduction of exotic breeds since colonisation. Similarly, the analyses reveal that there are no clear policies and legislation targeting transboundary FAnGR, yet many of those FAnGR transcend borders of various countries.

National and regional policies and frameworks

Governments generally achieve their national policy goals through introduction of various policy actions. With regard to improvement

of the livestock sectors, most of the countries have established research and development institutions that deal with various aspects of FAnGR. These mainly include selection, conservation (*in situ* and *ex situ*) and biotechnology (AI and ET). Some countries use diverse policy actions to achieve policy goals depending on the preferred species/breeds and perceived threats to their animal populations. Seychelles has policies that target pig production. Mozambique and Ethiopia have policies that target poultry and bee production. These trends highlight the importance of these particular species for these countries.

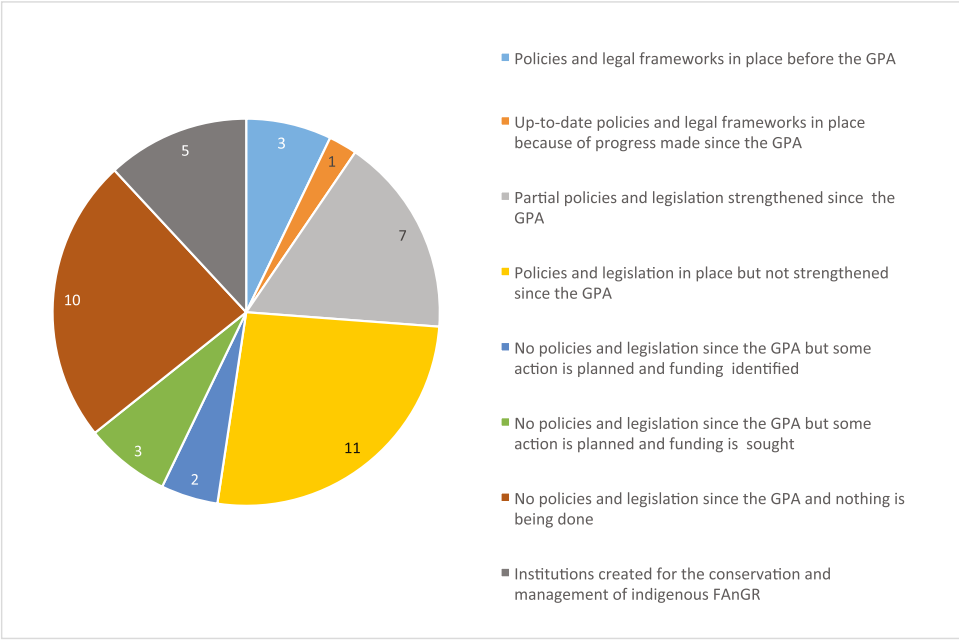
One of the main reasons for the lack of policies and legislations directly formulated and designed for the management of FAnGR is that policy makers are usually not fully aware of the contribution of FAnGR to national economies, and the commensurate need to provide policy and budgetary support. Providing these two would offer some recognition of the contribution of FAnGR to national economies and development.

Biotechnology is prominent in the policies and legislation of various African countries. One example of biotechnology in common use in many countries is the importation of frozen semen of exotic breeds and species from abroad to improve the indigenous FAnGR. Whereas these procedures have profound impact on the future populations of local breeds, legislation on the importation of semen and their use for crossbreeding are often absent.

Rwanda is one of the few countries that have policies that give directions on crossbreeding issues. Rwanda has a strategy on animal genetic improvement. The forward-looking strategy recognises the lack of adequate numbers of local purebred animals to be able to maintain concerted but controlled crossbreeding activities. This scenario implies that unless the programme of crossbreeding is terminated at a pre-determined period, the size of local pure animal populations will be negatively affected or become threatened. Thus, policy revision may be needed. A lesson from this strategy is that, while a biotechnology tool may lead to the desired goal in the short term, a decision for its application should take into account the base animal populations and the duration of the programmes. However, the worst scenario is expected in countries where biotechnology tools are deployed in the absence of formal policies, strategies and legislations.

Even when directions are given on crossbreeding issues, existing crossbreeding policies do not give the way forward when F1 crosses, which tend to have the highest level of heterosis, are produced. Most of the time,

these policies do not take into account the fact that when crossing, there is a need to expand and maintain the local population. There is also a need, when crossing, to determine the level of blood mix in order to create and stabilise an adaptable synthetic breed. Only a few countries had national policies and legal frameworks by 2007 when the Global Plan of Action (GPA) was adopted as shown in Figure 88. The adoption of the GPA was intended to assist countries with technical support in the identification and management of their FAnGR. It is within this framework that countries provided information on the state of their FAnGR and were to develop FAnGR-related policies as well as legislations.



Source: FAO (2014)

Figure 88: African countries that have developed comprehensive national policies and legal frameworks relative to the adoption of the GPA

Several countries have identified the existence of gaps in the development and implementation of the FAnGR policies and legal instruments. Sierra Leone identified the lack of political and financial will to adequately support the FAnGR sector as the major policy constraint. The case of Sierra Leone reflects a bigger problem of the disconnect in the contribution of livestock sectors to national GDPs and the budget support to the sectors. The issue of public budget support to the livestock sector in Africa vis á vis the contribution to the agricultural and total national GDPs is important.

The general pattern is that the budget support to the sector is inadequate. It is believed that this situation serves as a disincentive to the development of the livestock sector, including the FAnGR sub-sector. Without concrete policies and adequate funding for the development or proper utilisation of African breeds of livestock, the purity of these resources with unique attributes cannot be guaranteed for future generations.



Liberian native sheep, Djallonké

Photos Courtesy: Ministry of Agriculture, Republic of Liberia



Gobra bull in Senegal

Photos Courtesy: Ministry of Agriculture, Senegal

Figure 89: Some of the African livestock breeds with unique attributes

A broader analysis reveals that although public expenditure on agriculture has gradually increased over time since 2007, the amount spent on the livestock sector is just about 4 per cent out of the total allocated to the Ministry of Agriculture, Forestry and Food Security. In most African countries, even those with the necessary legal frameworks, institutions are inadequately funded and/or lack the necessary competent staff to fulfil their set objectives.

A case study on the allocations to the livestock sector was conducted by FAO in 2010 for 14 SADC countries (Agyemang and Han, 2014). The results from five countries (Madagascar, Mauritius, Swaziland, Zambia and Zimbabwe) showed that the share of the public support for agriculture in relation to the overall budget was 6.7 per cent in comparison to the agricultural contribution to the GDP, which was found to be 14.6 per cent in the five countries and 26 per cent in the region as a whole. It can be argued that the public spending on agriculture in the region and in the five countries falls short of what would be expected on the basis of GDP contribution. None of the five countries reached the goal of 10 per cent, the figure agreed upon in the Maputo Declaration (African Union, 2013).

Some observations on livestock and FAnGR policy and development

In Burundi, the livestock sector was not fairly considered in terms of programmes despite the sector's potential in the country's economic development. The Burundi farming sector has no national policy and action plan representing a constraint to development of FAnGR programmes. In Botswana, the government has developed policies that promote livestock production through subsidised loans for feed and other animal husbandry inputs. The policies also support the construction of boreholes and provision of free veterinary services. Policies are implemented but not to the satisfaction of livestock producers because in most cases, there is shortage of extension officers who could facilitate the implementation of activities from these policies. Poor transport for extension officers is also a hindrance when they need to consult with farmers. Farmers feel that they are more of recipients of the policies and laws since they are rarely consulted for their contribution to the formulation process. In addition, the public is not aware of the existing laws and so awareness creation is more than necessary.

In Burkina Faso, there is a national strategy and a law on genetic improvement, but the enforcement of the law is weak. Constraints lie in the inadequacy of the design and development of law enforcement instruments and the lack of a national consultative framework. The policy has led to the establishment of the National Permanent Secretariat for the Management of Animal Genetic Resources. In Ethiopia, there are many policies, strategies and guidelines related to conservation development and sustainable use of livestock. Most of them do not specifically address

FAnGR, but there are laws and regulations that have relevance to the management of FAnGR. There are also import/export regulations to provide legal guidance on the FAnGR trade. It is encouraging that there are draft policies that pertain to FAnGR awaiting approval, such as the Breeding Policy. However, the government's conservation and sustainable utilisation policy implementation efforts in general, and the management of FAnGR in particular, are affected by a number of factors including weak or lack of institutions for the management of FAnGR and a weak legal framework for the implementation of FAnGR management issues.

In 2004, Ghana developed a livestock policy that has components on the management conservation and sustainable use of FAnGR. The implementation is poor due to the poor financial and infrastructural capacities of the Ministry of Food and Agriculture. The gaps in the implementation of the policy related to the conservation of local FAnGR also concern the poor consultation and involvement of policy makers and FAnGR stakeholders. Lesotho has policies on selective breeding to maintain purity and this has been accomplished through isolation of breeds by geographic location. Some laws governing livestock farming are present, but they are old and need to be reviewed to address current realities (Laws of Lerotholi 1905 and the Importation of Livestock Proclamation 1947).

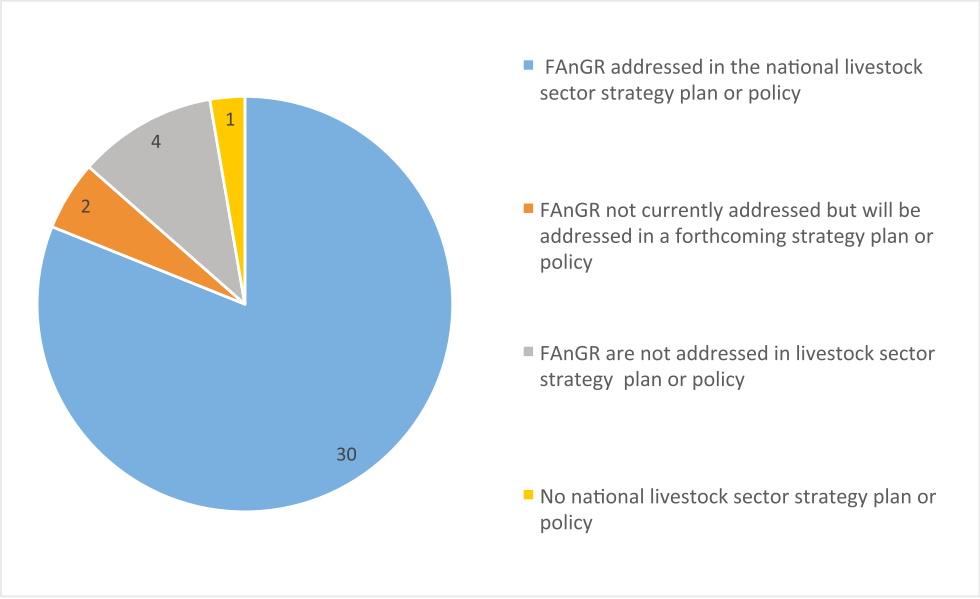
In Malawi, the livestock policy developed by the Department of Animal Health and Livestock Development (DAHLD) in 2006 mentions some elements of FAnGR but lacks details and clear measures on implementing the FAnGR issues. There is also limited human resource capacity to translate the policy objectives on FAnGR into concrete actions. In Tanzania, the 2006 National Livestock Policy offers some direction on where the sector is heading. The policy's implementation is ongoing with strategies and a programme already in place. The Breeding Act has not yet been enacted. Similarly in Kenya, the breeding bill has taken over 10 years to actualise. Some of these delays are occasioned by wrangling among the various professions on who should be the custodian of this legal instrument.

For Uganda, the National Animal Breeding Programme (NABP) has been in place since 1997. The policy has led to the establishment of the National Animal Genetic Resources Centre and Data Bank (NAGRC&DB) through which much of the breeding activities stipulated therein are being implemented. The formulation of the policy was followed by the enacting of the Animal Breeding Act 2001 by Parliament. This Act became effective in July 2001 and is now being implemented. However, this is undermined by weak enforcement instruments and lack of appropriate institutions to

carry out organised performance recording and evaluation with feedback mechanisms for decision-making, which are crucial for any improvement programmes. The development and enactment of laws and policies affecting the agricultural sector in the country is a slow, tedious and expensive process. There is also insufficient financial support for implementation of these policies.

In Zambia, a livestock development policy is now available and has some components on FAnGR. However, more needs to be done including the introduction of appropriate animal recording systems, monitoring of trends, characterisation as well as the development of an appropriate organisational infrastructure for the management of FAnGR.

The status of inclusion of the management of FAnGR in the national livestock policies and/or strategies among African countries is shown in Figure 90, while Figure 91 gives an overview of the countries that have developed policy frameworks for the sustainable use of FAnGR.



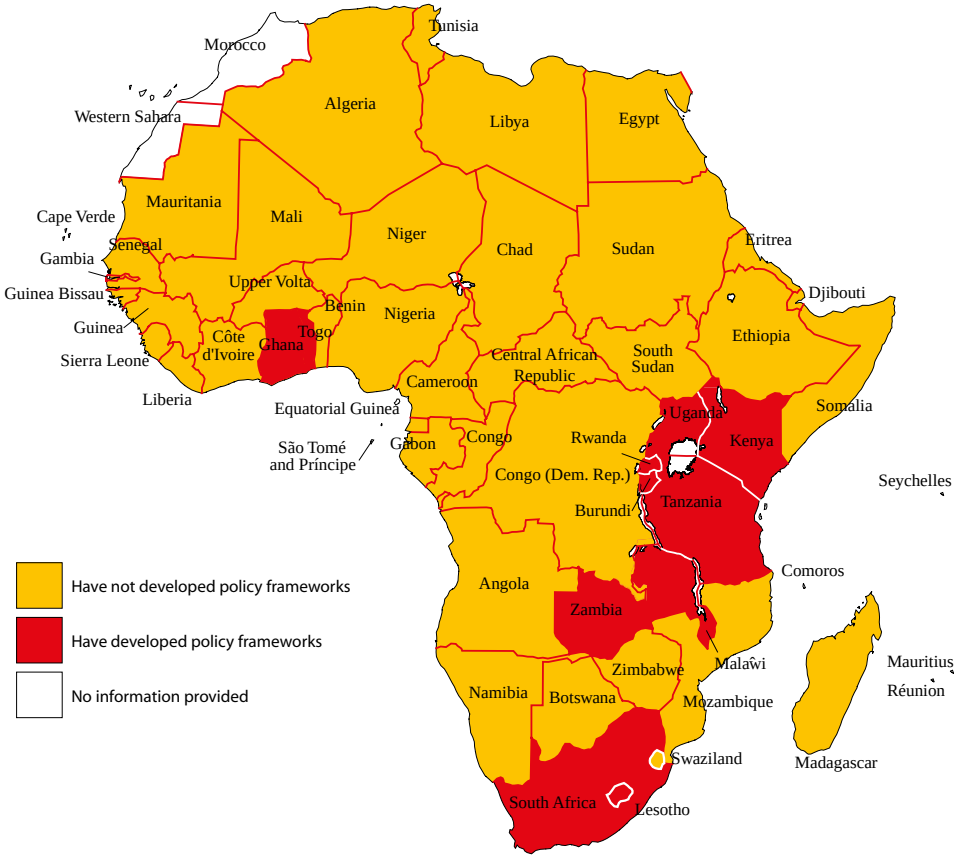
Source: Country Reports, 2014

Figure 90: African countries that have FAnGR addressed in the national livestock sector strategy plan or policy

Gaps in the development and implementation of national FAnGR Policies and legal instruments

The gaps identified in the development and implementation of national FAnGR policies and legal instruments included poor consultation

between policy makers and animal breeders as well as farmers when it came to the implementation of policy related to the conservation of FAnGR. Consequently, the interests of these stakeholders are sometimes overlooked during the development of the FAnGR policies. The lack of policy framework on the management of FAnGR prior to the development of the policies and the legal instruments was noted as a general problem in some West African countries including Nigeria and Burkina Faso.



Source: Country Reports, 2014

Figure 91: African countries that have developed policy frameworks for the sustainable use of FAnGR

In Senegal, the conservation of local breeds was not taken into account when developing policies prior to the country's participation in the regional project on endemic ruminant livestock (PROGEBE). In East Africa, Uganda in particular, the development and enactment of laws and policies affecting the agricultural sector was noted to be low and the process was tedious and expensive. Efforts on the dissemination of and sensitisation on the laws and policies as well as their enforcement were also inadequate.

In Eritrea, limited or no human capacity in FAnGR was considered a serious gap. Sudan cited the lack of animal breeding policy intended to empower the development of FAnGR strategies. In Kenya, where policies exist, they are scattered in different government agencies some of whom are not directly involved in the management of FAnGR. In the Southern Africa region, in Malawi, limited or no human capacity in FAnGR is a critical gap in the whole process of policy and legal instrument formulation process. The lack of funding committed towards FAnGR is a notable gap. In Mozambique, there are no FAnGR policies formulated.

Regional policies and legislation

In 2010-2011, SADC developed a Regional Agricultural Policy that reflects existing policies of its 14 member countries. The policy covers agricultural activities including crops, livestock, forestry and fisheries. The policy document emphasises the importance of FAnGR to food and nutrition security. The SADC regional policy endeavours to highlight some of the key issues related to the management of FAnGR such as conservation, utilisation and use of biotechnology.

Following the adoption of the ECOWAS Agricultural Policy (ECOWAP) and its harmonisation with the NEPAD's agricultural programme in 2005, the ECOWAS Commission was mandated to develop an Action Plan for the Development and Transformation of Livestock Farming for the region as part of the framework for the implementation of the ECOWAP. This livestock-oriented plan covers the period 2011 to 2020. The objective of the plan is to effect the economic transformation and valourisation of the meat and dairy sectors so as to achieve sustainable food security and poverty reduction, and to provide reasonable income to those in the sector without endangering the natural resources. Four strategic components are meant to address this objective, namely 1) creation of a favourable environment for the development of the cattle meat and dairy sector, 2) provision of security for transboundary movements and prevention of conflicts, 3) improvement of the livestock production sector as well as livestock genetic resources, and 4) promotion of the livestock meat and dairy sectors.

The IGAD is supporting the Livestock Policy Hubs established in the different countries to enhance development and review of the livestock policies. The programme focuses on enhancing capacity for review of livestock policies, their implementation strategies together with associated action plans and budgets, and the enabling legislation required to bring

about the change. The IGAD is currently involved in the development of a Regional Legal and Regulatory Framework for the management of FAnGR. The overall objective is to enhance the contribution of livestock to food security and economic growth in the region. The specific objective is to develop and validate FAnGR regional legal and regulatory framework that would regulate and enhance breed utilisation, conservation improvement and exchange of genetic materials at regional and national levels.

The conservation and utilisation of FAnGR is a critical issue in the East African Community (EAC). A regional committee on FAnGR was approved by the EAC Sectoral Council on Agriculture and Food Security with detailed terms of reference including aspects on protection of property rights. This was emphasised to protect local FAnGR from being lost to others, and to patent innovations associated with FAnGR. The EAC is currently involved in the development of a comprehensive Regional Strategy for the Conservation and Rational Utilisation of Animal Genetic Resources in the East African Community. The specific objectives are to 1) harmonise and coordinate mechanisms for national and regional FAnGR efforts, 2) address policy and legal development issues, 3) address key factors causing threats to FAnGR and the dynamics of the threats and how to mitigate them, 4) strengthen the national animal genetic conservation programmes through capacity building, upgrading and management requirements, 5) address infrastructure development, upgrading facilities and identifying/selecting/setting up centres of excellence for the region, 6) implement joint research projects and cross-border ventures, 7) indicate collaboration mechanisms with regional/international organisations, 8) set up information and knowledge management (establishment of a platform for information sharing), and 9) establish an implementation framework for the strategy.

Institutional framework and capacity development

Institutional frameworks include not only the physical institutions and their operations, but also markets, farmers' organisations, and their norms for operation and bylaws regulating their activities. Similarly, capacity development is not only limited to public officials and institutions, but also covers the development and strengthening of relevant farmers'/breeders' organisations, NGOs and CBOs. The Global Plan of Action (GPA) emphasises the importance of strong national and regional institutional

frameworks such as Focal Points (FP) and networks to ensure coordinated and collective action in the management of FAnGR.

National level

At national level, governments have established ministries and have provided them with duties and responsibilities to implement government policies related to food security, cooperatives, conception, implementation, coordination and assessment of policies in domains such as agriculture, livestock, forestry, fisheries and rural development. Countries have also put in place institutions with specialisation on FAnGR and breeding and significant infrastructure to pursue their objectives. Box 17 and Table 23 give the duties and responsibilities for implementing government policies related to FAnGR with regard to some selected countries.

Box 17: An overview of desert aquaculture in Southern Africa

In the SADC region, aquaculture development has recently become a priority topic. Namibia, through its Ministry of Fisheries and Marine Resources (MFMR), is spearheading the development of national aquaculture at the community level in order to empower rural communities to be self-sufficient in food production, and to derive income through fish production integrated with the existing and potential agricultural practices wherever natural conditions permit. Similarly, the Government of South Africa, through its national Department of Agriculture, Forestry and Fisheries (DAFF) and other support sectors, is taking steps to accelerate the development of aquaculture production at a commercial level. Mauritius, Mozambique, United Republic of Tanzania and Zambia have begun drafting specific aquaculture-oriented legal frameworks and are developing strategic plans to support the sector. Until now, very little has been achieved with regard to developing aquaculture in the desert and arid lands of Southern Africa. A lack of available technical information has caused the concept to be relatively unknown. This fact is probably due to the general belief that aquaculture can only be practised where abundant surface water is guaranteed. This belief has led to the idea that erecting a fish farm in arid lands is costly, risky and, therefore, unsustainable in the long term. Ongoing innovations, through research and development, are gradually modifying this attitude. Potential areas for arid land aquaculture are being identified through the examination of water availability and quality, environmental suitability and provision of technical know-how. Competition for land use in deserts and arid lands is limited since these lands are considered unsuitable for crop production except where irrigation facilities are available or livestock ranching is practised. The ever rising prices of fish, caused by increasing demand and diminishing supplies, are encouraging private commercial farmers to consider developing aquaculture wherever feasible, including in arid locations where adequate surface or subsurface water is available and easily extractable. Naturally, commercial farmers always seek to establish and operate ventures that realise a sustainable return on investment; their operations are, therefore, strongly market-oriented.

Source: Crespi and Lovatelli (2011)

Table 23

List of selected countries that have assigned duties and responsibilities to implement government policies related to FAnGR

Algeria

- The Executive Decree No. 05-434 amending and supplementing Decree No. 88-04 establishing a National Centre for Artificial Insemination and Genetic Improvement
- Decree No. 88-04 establishing a National Centre for Artificial Insemination and Genetic Improvement

Benin

- Decree No. 2005-192 on the attributions, organisation and functioning of the Ministry of Agriculture, Livestock and Fisheries
- Order No. 1145 MAEP/D-CAB/SGM/DA/CSRH/SA concerning the attributions, organisation and functioning of the Livestock Directorate

Burkina Faso

- Decree No. 97-428/PRES/PM/MRA on the organisation of the Ministry of Animal Resources
- Decree No. 92-212/PRES/PM/ AGRIRA deals with the composition and organisation of the Ministry of Agriculture and Animal Resources

Burundi

- Decree No. 100/154 on the organisation of the Ministry of Agriculture and Livestock

Cameroon

- Decree No. 2012/382 of 14 September 2012 on the organisation of the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA)
- Decree No. 74-182 establishes the Society for the Development and Exploitation of Animal Production (SODEPA) and approves its statutes, modified and completed by Decree No. 81-395 of 9 September 1981

Congo

- Decree No. 2007-306 on the attributions of the Ministry of Agriculture and Livestock
- Decree No. 98-169 on the attributions and organisation of the Directorate-General for Agriculture and Livestock
- Order No. 9398 of 25, November 2010 lays down the attributions and organisation of the services and offices of the Directorate-General for Animal Husbandry
- Order No. 9105 of 17 November, 2010 establishes, attributes and organises the Ministry of Agriculture and Livestock, a support centre for the cattle sector

Côte d'Ivoire

- Order No. 184/MINAGRA/MESRIT of 21 August 1996 establishes the National Commission for Genetic Resources (CNAG)
- Order No. 024/MINAGRA of 25 February 1997 establishes the Bureau of Genetic Resources (BRG).

Table 23

List of selected countries that have assigned duties and responsibilities to implement government policies related to FAnGR

Djibouti
- Law No. 200/AN/07/5th L on the organisation of the Administration of the Ministry of Agriculture, Livestock and the Sea, in charge of Hydraulic Resources

Gabon
- Decree No. 01397/PR/MAEPDR of 6 December 2011 redefines the organisation of the General Inspectorate of Services of the Ministry of Agriculture, Livestock, Fisheries and Rural Development

Guinea
- Decree No. D/98/148/PRG/ SGG establishes, organises and allocates the deconcentrated structures of the Ministry of Fisheries and Livestock
- Decree No. D/97/074/ PRG /SGG fixes the organisation of the Ministry of Fisheries and Livestock

Mali
- Law No. 05-008 of 11 February 2005 establishing the National Directorate of Production and Animal Industries

Mozambique
- Decree No. 5/78 creating the National Institution of Poultry Breeding (AVICOLA)

Niger
- Decree No. 2005-091/PRN/MRA on the organisation of the Ministry of Animal Resources
- Decree No. 2005-42/PRN/MRA determining the attributions of the Ministry of Animal Resources

Democratic Republic of Congo
- Ordinance No. 08/74 of 24 December 2008 fixes the attributions of the Ministries, determines the powers of the Ministries of the Democratic Republic of the Congo

Rwanda
- Prime Ministerial Decree No. 96/03 carries the mission, functions, organisational structure and job summary of the Ministry of Agriculture and Animal Resources

São Tomé and Príncipe
- Decree No. 52/2013 approving the Ministry of Agriculture Fisheries and Rural Development

Senegal
- Decree No. 2013-1281 of 23 September 2013 defines the attributions of the Ministry of Livestock and Animal Productions
- Decree No. 2009-1408 bearing missions, organisation and functioning of the National Committee of Biosafety (CNB)
- Decree No. 2009-1409 on the missions, organisation and functioning of the National Biosafety Authority (ANB)
- Decree No. 2009-1407 on the organisation of the Ministry of Livestock

Table 23

List of selected countries that have assigned duties and responsibilities to implement government policies related to FAnGR

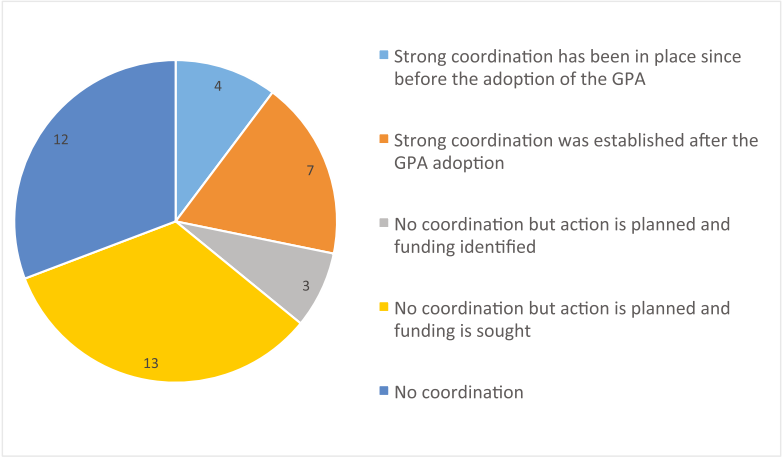
Chad
• Decree of December 1991 reorganises the Ministry of Livestock • Decree No. 4/EL, as amended by Decree No. 94/66/PR/EL of 9 May 1966, organising the Livestock and Animal Industries Service of Chad and determining its functions

Source: FAOLEX Database, AU-IBAR questionnaires, 2014

Most of the countries have established the institutions in line with the global agreements. With regard to the establishment of institutional mechanisms that enable the development of FAnGR, 60 per cent have confirmed that such mechanisms exist in their respective countries. In terms of coordination mechanisms on FAnGR and on conservation objectives, 55 per cent of the countries acknowledged the existence of such mechanisms. Fifty-five per cent of the countries agreed that such coordination mechanisms existed and that they have been put in place for the management of FAnGR. Most of them (52 out of the 54) have established National Focal Points (NFPs) under the framework of the Global Plan of Action. Those are generally anchored in the ministries in charge of livestock. NFPs are institutions nominated by the respective governments to oversee management and development of FAnGR. They initiate, lead, facilitate and coordinate country activities related to the development and implementation of NSAPs for FAnGR and to interface with a variety of stakeholders in FAnGR within the country. They communicate and maintain close links with other relevant departments and governmental bodies as well as cooperate, educate and raise public awareness on FAnGR.

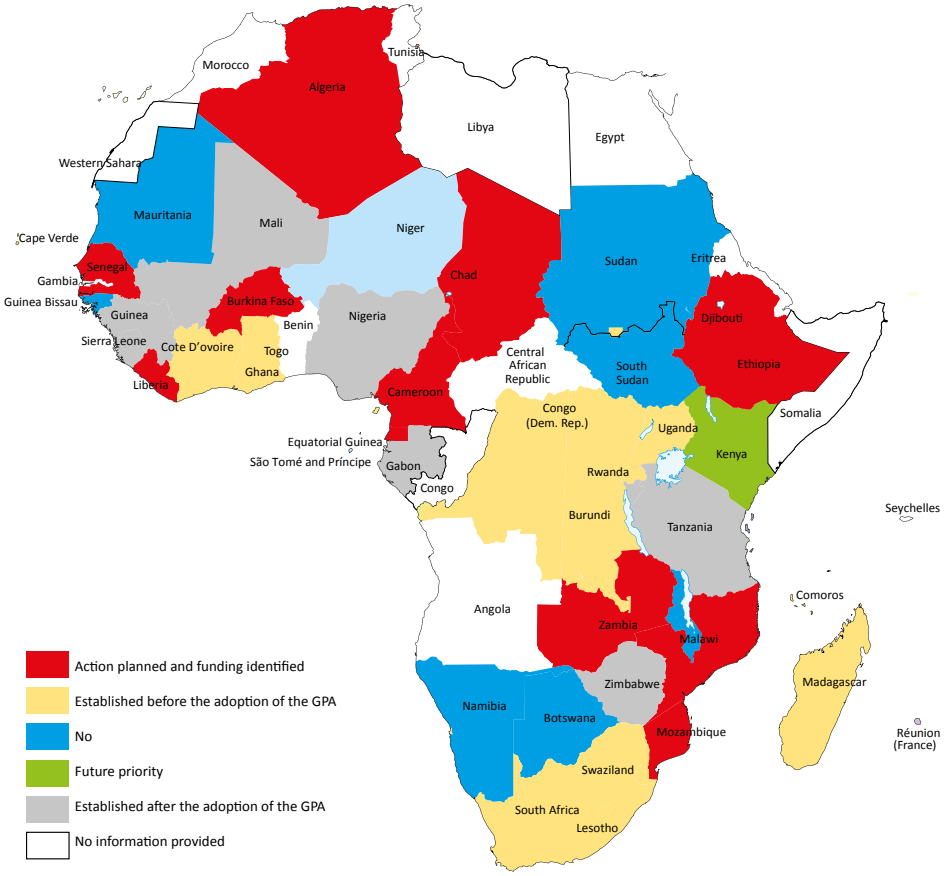
In 45 per cent of the countries, breeders or farmers' associations were considered to be organised enough to take part in the discussions on and/or development of FAnGR. The NFPs have nominated national coordinators for the management of FAnGR. As indicated in Figure 92, most of the countries mentioned that there was no strong coordination and interaction between the NFPs and other stakeholders involved in FAnGR such as the breeding industry, livestock keepers, government agencies, research institutes and civil society organisations.

In Figure 93, some of the countries mentioned that they had established a National Advisory Committee for Animal Genetic Resources, but which



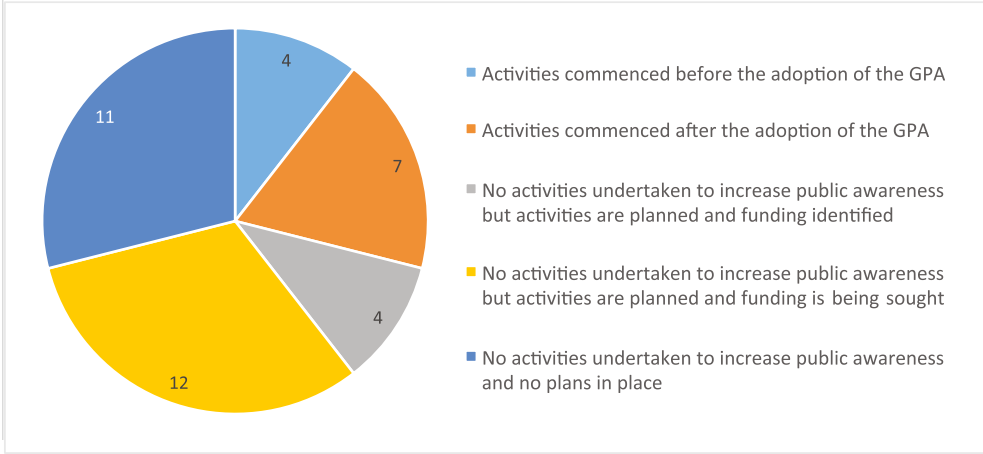
Source: Country Reports, 2014

Figure 92: Strength of the coordination that has been put in place for the management of FAnGR



Source:Country Reports, 2014

Figure 93: Countries that have put in place National Advisory Committees for FAnGR



Source: Country Reports, 2014

Figure 94: Proportion of African countries that have undertaken activities to increase public awareness on the roles and value of FAnGR

lacked the necessary legal framework for functionality. Figure 94 shows that some of the countries' NFPs do not undertake activities aimed at increasing public awareness on the roles and value of FAnGR.

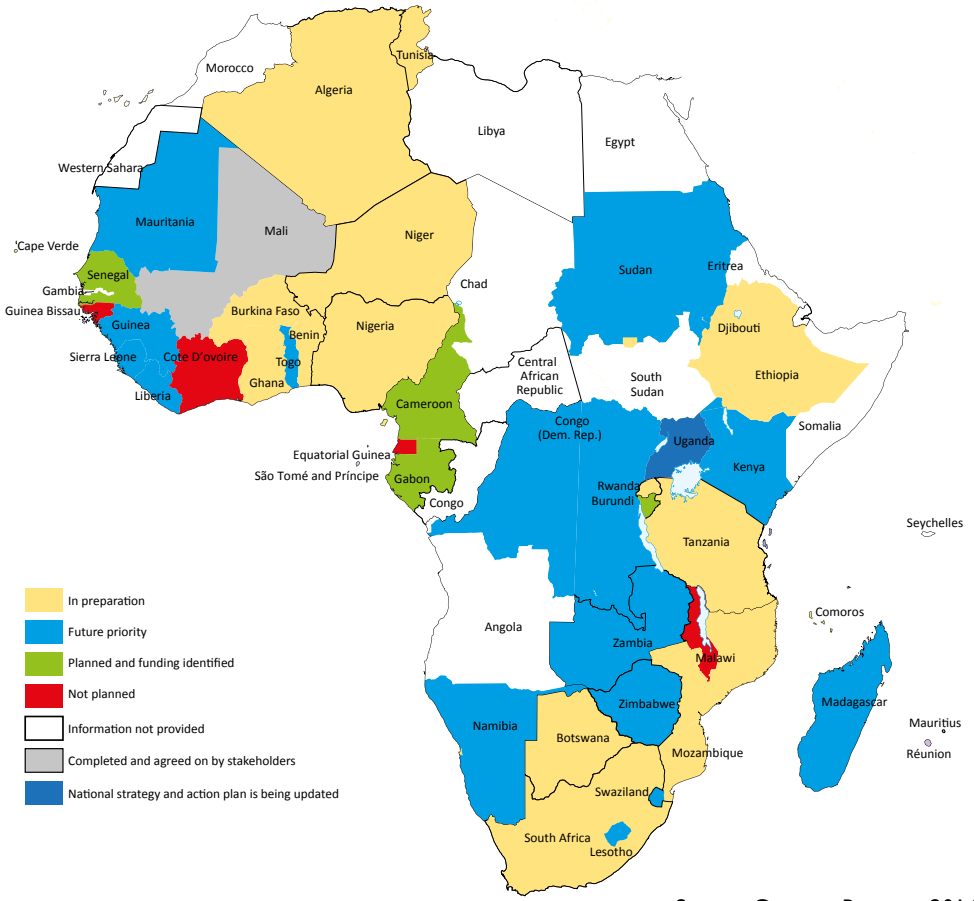
Implementing the GPA agenda for FAnGR at national level includes formulating and developing National Strategies and Action Plans (NSAPs). The main objective of NSAP for FAnGR is to ensure a strategic and comprehensive approach to achieving the sustainable utilisation, development and conservation of these resources to increase and improve food production and food security, reduce poverty and contribute to economic development. The preparation and implementation of NSAPs for FAnGR could contribute to identifying appropriate intervention options that will most effectively mobilise and use financial resources for capacity building in the management and development of FAnGR. Guidelines on the development of NSAPs on FAnGR are available, courtesy of FAO, to assist countries in the development of these strategies and action plans. However, many countries in Africa are yet to develop their NSAPs.

Training has been conducted to empower technical staff in all African countries to formulate and develop NSAPs in their respective countries. Figure 95 show that many countries in Africa have not yet established and implemented their NSAPs for FAnGR within their livestock policies. This is due to several challenges, among them the one related to funding.

Regional level

There are a few regional institutions that are dedicated to the development

of FAnGR in Africa. These include the Centre International de Recherche Développement sur l'Elevage en zone Subhumide (CIRDES) of Burkina Faso and the West Africa Livestock Innovation Centre (WALIC, formerly International Trypanotolerance Centre, ITC) in the ECOWAS region, the University of Venda in South Africa, a Centre of Excellence for the SADC region on FAnGR and the Nelson Mandela African Institution of Science and Technology (NM-AIST) in Arusha, Tanzania. There is also the BecA Hub located at the International Livestock Research Institute (ILRI) in



Source: Country Reports, 2014

Figure 95: Countries that have established and implemented their NSAPs for Animal Genetic Resources within their livestock policy

Nairobi, Kenya.

During the continental inception workshop of the project, 'Strengthening the Capacity of African Countries to Conservation and Sustainable Utilisation of African Animal Genetic Resources' in Abidjan (April 2013), it was recommended that Sub-Regional Focal Points (S-RFPs) should be anchored in sub-regional research and development organisations or RECs. This

would be essential to ensuring sustainability and to avoid the experience of Southern Africa where the S-RFP for the region, established under the Farm Animal Genetic Resources project, was anchored in South Africa and, unfortunately, disbanded following a decision by that country's authorities.

Africa has made efforts in the process of establishing or strengthening S-RFPs for the management of FAnGR with elected steering committees in all the five regions. Four of these S-RFPs are anchored in sub-regional research and development organisations, while one is in an agreed national institution. As Figure 96 shows, these are the five S-RFPs:

1) Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) for East Africa,
2) Centre for Coordination of Agricultural Research and Development in Southern Africa (CCARDESA) for Southern Africa,
3) West and Central African Council for Agricultural Research and De-



Source:Country Reports, 2014

Figure 96: Countries covered by the different sub-regional research and development organisations for the management of FAnGR

velopment (CORAF/WECARD) for West Africa,

4) Economic Commission for Meat and Fishery Resources (CEBEVIRHA) for Central Africa, and

5) The Algerian National Institute of Agronomic Research (INRAA) for North Africa.

At a partners' roundtable meeting in Kampala (in March 2014), it was agreed that an African Animal Genetic Resources Secretariat should be established to foster coordination, collaboration and coherence in the management of FAnGR in Africa. At the meeting of the Secretariats of the S-RFPs in Nairobi (July 2014), participants agreed that AU-IBAR would be the secretariat of the future Regional Focal Point (RFP) for FAnGR for Africa. Table 24 illustrates the strengths, opportunities, weaknesses and threats (SWOT) of the different S-RFPs established.

Table 24

SWOT of the Sub-Regional Focal Points newly established in Africa

Strengths	Weaknesses	Opportunities	Threats
Need expressed from countries: NC/NFP	Inexistence or not yet nominated (National Coordinators) NC in some countries	Building on RECs setting	Different FAO regional settings
S-RFPs anchored on Regional Research Institutions	Donors/ Project funding dependency	Building on existing institutions with mandate to manage FAnGR	Confusion of guidelines as "prescriptions"
AU-IBAR has a continental mandate	Weak NC (National Coordinators) will lead to weak S-RFPs which will in turn lead to weak ARFP	Building on past experiences of S-RFPs	Lack of budget for running the S-RFPs
Consolidation from the bottom			

Source: Country Reports, 2014

Breeders' Associations

Farmers, specifically livestock keepers and pastoralists, are very important stakeholders in FAnGR. They are the frontline users and custodians of FAnGR and play critical roles in the development, management and utilisation of these important resources. Livestock keepers in some countries are organised into livestock associations, which can be formal or informal in their organisational structures, and can be at local, regional or national levels. It must be noted that in some countries, these associations of livestock keepers constitute farmers' associations or specifically breeders' associations or societies when they are custodians of particular livestock breeds.



Photo Courtesy— AU-IBAR

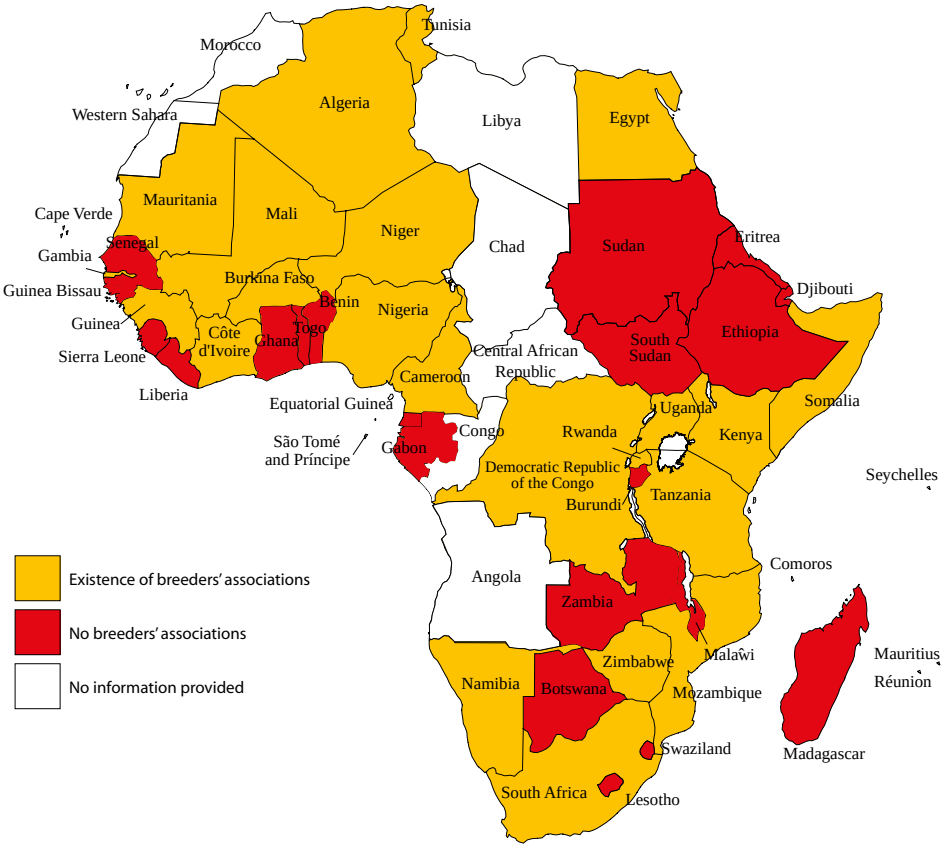
Figure 97: Training of farmers from the Red Maasai Sheep Breeders Society' of Kenya

Livestock farmers/breeders/keepers and their associations are the main custodians of FAnGR and they are, therefore, essential to the long-term success of conserving FAnGR by playing a number of roles, including the effective monitoring of threats to the breeds and species. They also have a role to play in promoting breeding strategies among their members and in implementing the strategies. Their roles also include distribution of improved genetic material, animal recording and securing finance. An apt

example is a women's organisation, Sandu Missira Livestock Association operating in one of the provinces in The Gambia, which was originally engaged in vegetable production but has switched to become multipliers of superior genetically improved small ruminants (sheep and goats) from ITC breeding programme.

On the continent, livestock associations have moved forward the agenda of conservation and sustainable utilisation of FAnGR. The African Livestock International Conference and Exhibition (ALICE) is one of the forums promoted by livestock associations such as the East and Southern Africa Dairy Association (ESADA), the Kenya Livestock Producers Association (KLPA) and the East Africa Farmers Federation (EAFF). In West Africa, community-based groups have served as partners in research and development to move rural agriculture forward. These include the West African Shorthorn Breeders Association (WASHBA) in the Saboba-Chereponi District of the Northern Region of Ghana, the National Azawak Breeders Association of Burkina Faso (UNEAB), Réseau de Communication sur le Pastoralisme (RECOPA), the Pig Farmers Association of Nigeria (PigFAN), and the Coopérative TIWAT de Filingué in Niger (Breeders of the Azawak cattle).

In the North African region, farmers' associations play a key role. The most known organisations in promoting the management of FAnGR include the National Association for Sheep and Goat Breeders (ANOC), the Sheep and Goat Associations of the Maghreb Union (UMAOC) and the Cattle Breeders' Associations of the Maghreb Union (UMAEB). These are national and regional organisations involved in coordination activities with local associations. In the Southern African region, well-established breeders' associations and societies are involved in the management of FAnGR. These include the Tuli Cattle Breeders' Society, the Boran Cattle Breeders' Society, the Aberdeen-Angus Cattle Breeders' Society, the Beefmaster Cattle Breeders' Society, the Brangus Cattle Breeders' Society, the Boer Goat Breeders' Association, the Nguni Cattle Breeders' Society and the Damara Sheep Breeders' Society. Figure 98 shows the countries that have established national livestock breeders' associations.



Source: Country Reports, 2014

Figure 98: Countries that have established national livestock breeders' associations

National livestock breeders' associations co-exist with smallholder associations dealing with local breeds and these will need support in order to flourish. The associations can exist as lobby organisations or producer cooperatives, but with the main objective of promoting the interests of their members. These associations can also exist as community associations at the local/village level depending on the governance structures in the particular country. Where there is a strong commercial sector, as in most developed countries, such associations are usually well organised and influential.

In some of the African countries, farmers' and livestock keepers' associations are generally not well organised and are unknown. Their capacity and the size of membership vary, and they are supposedly run on democratic principles. Members have to meet the requirements of active membership and participation and to agree to sets of agreed rules. They are able to participate in shared decision-making. Members are also eligible to register livestock and benefit from recording schemes and promotional efforts. Livestock keepers

and their associations are, by extension, key to the success of any breeding policy and it is therefore essential that, from the outset, they be involved in the formulation and development of the policies. Their interests, goals and perspectives should be represented throughout the planning process. In order to adequately play their role in the breeding and conservation domains, these associations need to be strengthened and their capacities relating to management of genetic resources improved. Figure 99 shows the countries that have established national livestock breeders' associations for meat and milk production.



Source: Country Reports, 2014

Figure 99: Countries that have established national livestock breeders' associations for meat and milk production

Breeders can be smallholder or large scale, but generally have a commercial orientation as they propagate their breeds. Pastoralist and nomadic breeders, who are custodians of some highly adapted indigenous breeds, constitute a very important segment that is often neglected.

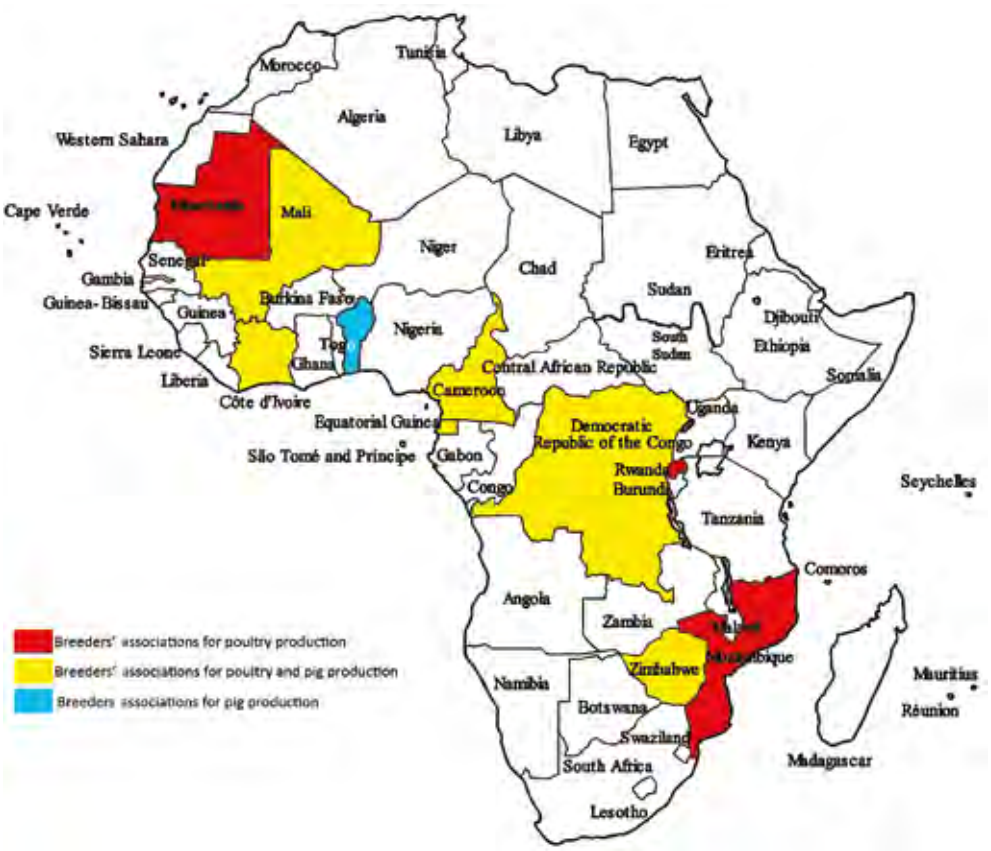
Breeders' associations appear to be more established in the Southern African region than other parts of the continent. South Africa has more

than 30 beef cattle breeders' associations alone, covering almost all the species. Although Zimbabwe has lost several breeders' associations due to the fallout of the Land Reform Programme, it still boasts of a number of them. Some of Botswana's and Namibia's breeders' associations are affiliated with their counterparts in South Africa. In Kenya, the Kenya Livestock Breeders Organisation (KLBO) is an independent farmers' body formed to coordinate and promote livestock breeding and improvement. It was initially called the East Africa Stud Book, and was started in 1921. It was responsible for keeping a pedigree register of livestock in East Africa, and is the only national body dealing with livestock registration and milk recording in Kenya. The organisation maintains a national database of pedigree registration and performance data of different breeds of livestock that have been voluntarily entered in the registration and schemes. Figure 100 shows countries that have established national livestock breeders' associations for sheep and goats, while Figure 101 shows countries that have established national livestock breeders' associations for poultry and pigs.



Source: Country Reports, 2014

Figure 100: Countries that have established national livestock breeders' associations for sheep and goats



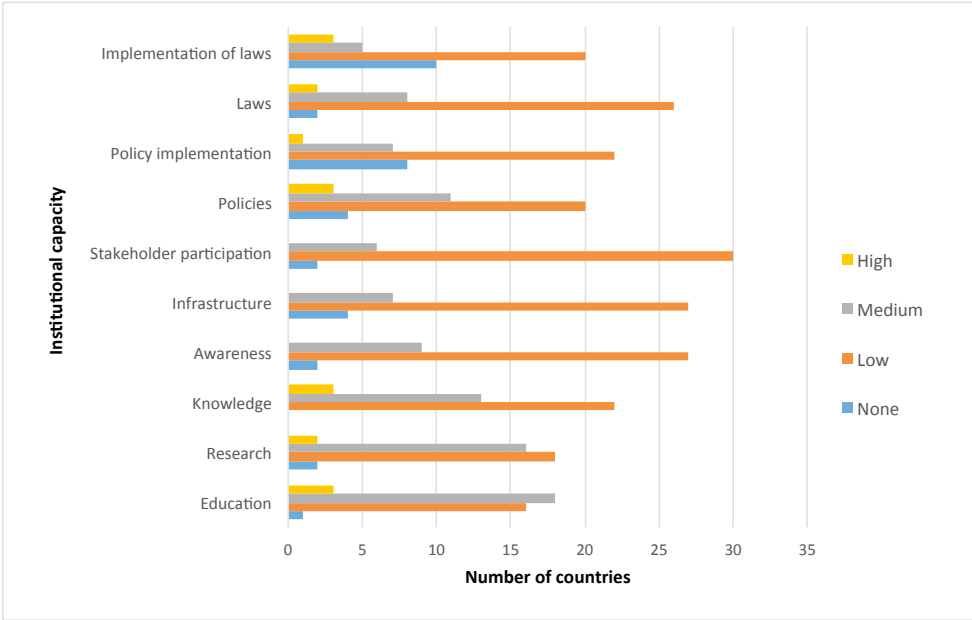
Source: Country Reports, 2014

Figure 101: Countries that have established national livestock breeders' associations for poultry and pigs

Human and institutional capacity development

Capacity in terms of expertise in the area of FAnGR has lagged behind for many reasons as indicated in Figure 102. This includes lack of specialisation in the field of FAnGR among African university faculties. The perceived complexity of courses in animal breeding and genetics, including biometrics, has also contributed to low interest among potential students. Some studies have highlighted that the number of trained animal breeders and geneticists is declining as practitioners retire and few new cadres are trained or recruited into the systems. For animal sciences, many of the universities with faculties or departments of agriculture tend to offer courses as part of a general BSc (Hons) Agriculture degree. Courses in animal breeding and genetics tend to be embedded within the general animal science courses. Some of the universities train students in animal breeding and genetics only at PhD level.

As the figure below (Figure 102) shows, the capacities and provisions in education, research, knowledge, awareness, infrastructure, stakeholder participation, policies, policy implementation, laws and implementation of laws are low to medium in most of the countries.

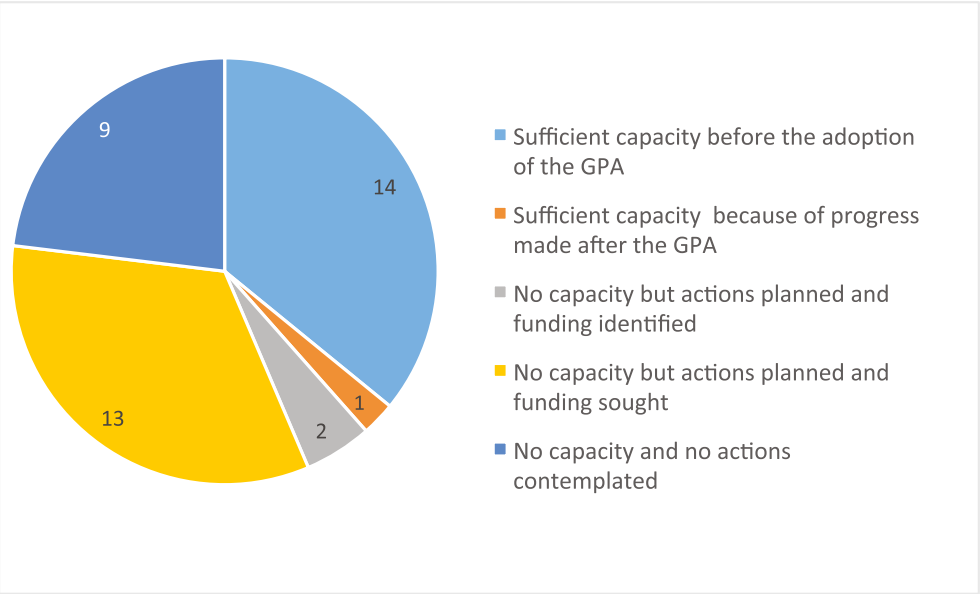


Source: Country Reports, 2014

Figure 102: Institutional capacity to support holistic planning of the livestock sector

Another level of capacity building that could benefit the livestock sector in general, and the FAnGR sub-sector specifically, is the strengthening of the institutions (teaching research, extension trade and marketing, policy and legal aspects) that deal with FAnGR and allied sectors. The idea of developing some selected African institutions at national and regional level to become effective centres of excellence could be supported by RECs. The case of CIRDES as a Centre of Excellence of UEMOA in Francophone West Africa and possible future ECOWAS involvement in WALIC can be cited. Other FAnGR-related Centres of Excellence are the University of Venda in South Africa for the SADC region. For East Africa, there are the Nelson Mandela African Institution of Science and Technology in Arusha, Tanzania, and the BecA Hub located at the ILRI in Nairobi, Kenya. Although these centres should, through their research and teaching

programmes, thrive to maintain their 'excellence' status, political and financial support from RECs in the respective regions is crucial. The case of WALIC, where there are no proper institutional arrangements or political and financial support from ECOWAS and its member states, illustrates the point about the need for regional collaboration and cooperation for the management of FAnGR. In most of the countries, there is insufficient institutional capacity to support holistic planning of the livestock sector, as Figure 103 illustrates.



Source: Country Reports, 2014

Figure 103: Number of countries that have put in place institutional capacity to support holistic planning of the livestock sector

It is envisaged that a group of centres of excellence working in a networking mode can realise a 'critical mass' of expertise needed to tackle various aspects of FAnGR issues on the continent. With adequate resources, the African experts could engage themselves in long-term research/enquiry in the domain of FAnGR and related sectors. Some African universities and National Agricultural Research Systems (NARS) are seeking collaboration with institutions in Europe and in the USA to support capacity development. The joint ILRI-Swedish University of Agricultural Sciences (SLU) project on "Capacity Building for Sustainable Use of Animal Genetic Resources in Developing Countries" is an integrated component of the ILRI research agenda on improving management of FAnGR, and the SLU agenda for

human capacity development. It provides opportunities for collaboration with and strengthening of NARS institutions and scientists in the area of animal breeding and genetics, and in communication and teaching skills (Malmfors et al., 2002; Mwai et al., 2005; Ojango et al., 2009).

Farmers' and breeders' associations and/or organisations play numerous roles and represent important actors in the various commodity value chains. Poor performance of these associations referred to in many of the countries can, in part, be blamed on weak capacities in developing the necessary structures, policies and bylaws for managing the organisations, in developing sustainable programmes, and in communicating with the outside world. Thus, capacity building in various aspects is needed on a continuous basis.

Whereas some of these capacity building activities can be undertaken using expertise within the associations, certain skills and competencies would have to be provided by experts from formal public and private institutions (research and training institutes, universities and other tertiary colleges, among others). Some of these capacity building programmes are currently being delivered by national, regional and international institutions through planned outreach programmes but on ad hoc basis. Scientists, (biological and social) extension and value chain experts from research institutes, universities and professional bodies (veterinarians, nutritionists, and so on) in various countries do support these associations. However, the low level performance, and only chequered achievements of some of the associations, demand more cohesive and content training programmes for the associations.

Stakeholders and their roles in the management of genetic resources

Stakeholders play important roles in the implementation of the various activities in the management of FAnGR. Their involvement and coordination is an integral part of FAnGR management and in the planning process. In most of the countries, steps have been taken to engage or empower the various stakeholders in the management of FAnGR.

In Benin, the government and some NGOs are actively involved in the organisation of professional farmers' associations. Some of these associations (ANOPER, ANEP, and so on) are adequately represented and play mandatory roles. In Botswana, the Livestock Improvement Act 2009,

provides for the establishment of breed societies for various livestock species. In 2013, the Office of the Registrar, which is responsible for overseeing the implementation of the Act, was established. Currently, there are different livestock producers' associations in the country (such as the Botswana Beef Cattle Producers Union, the Botswana Pig Producers Association, the Small-stock Industry Federation of Botswana, the Botswana Dairy Association, the Botswana Ostrich Farmers Association and the Botswana Poultry Association). Although these associations have been established, they are at different levels of development and as such, their effectiveness is not yet at the desired level with regard to improvement and management of FAnGR in the country. In Burkina Faso, the Azawak Breeders National Union and the Breeders' Association for the Zebu Peul were established. In Cameroon, livestock keepers' organisations exist at species level and have been in existence for decades. In Ethiopia, there are limited numbers of livestock keepers' producers/associations, which are established for the purpose of lobbying and/or marketing. There are two professional societies, one for animal production and the other for veterinary professionals. In addition, the Biodiversity Institute and the Pastoral Affairs Standing Committee have a seat each in the parliament. These stakeholders work towards raising awareness on FAnGR. Kenya has developed and supported livestock breeders' organisations, like breed societies and associations, and advocacy groups. The country has also developed a bio-cultural community protocol, namely the Samburu Bio-cultural Community Protocol, on involving local communities in ownership and utilisation of FAnGR. In Namibia, the Meat Board has a mentoring programme going on in the North Communal Areas and with some resettlement farmers. They are handled by either dedicated mentors or by experienced farmers.

Traditionally, farmers' associations such as the National Association of Farmers in Sierra Leone have worked very closely with technocrats, mainly in the Ministry of Agriculture, Cooperatives Department, NGOs and agricultural research institutions among others, in offering agricultural extension and other services. In The Gambia, the dissemination of improved genetic resources from an Open Nucleus Breeding Scheme (ONBS) into the general ruminant livestock populations represents a success story of the collaboration among the Gambia Indigenous Livestock Multiplier Association (GILMA), the Gambian Government Department of Livestock Services (DLS) and WALIC. The commercial and emerging South African farmers participate in the activities of their respective farmer

organisations, which have legal status in the country. This includes farmers' associations such as the Red Meat Producers Organisation, the National Emergent Red Meat Producers Organisation, the National Wool Growers Association (NWGA), the South African Pork Producers Organisation (SAPPO), the Southern Africa Poultry Producers Organisation, the Developing Poultry Farmers Organisation (DPFO), the Mohair South Africa, and the Ostrich Business Chamber. In Zimbabwe, stud breeders are coming together to resuscitate societies of specific breeds (cattle, goats and sheep). Government research institutions are supporting the initiative by becoming members of these societies, thus creating confidence among members. Even for indigenous breeds, the formation of breeders' associations is important to champion these breeds and set standards and keep records for improvement.

The private sector participation in the development of FAnGR institutions and networks is happening in some countries, but there is room for improvement. A value chain approach to the development of the FAnGR subsector requires that all value chain actors, including those in the private sector, play an active part in the governance as well as identifying opportunities for upgrading the FAnGR value chain by contributing to improving efficiency through new processes, introducing higher-value products and in changing the mix of products or activities in the sub-sector to add value. Product processing and trade in livestock products are key areas for the private sector, which has opportunities in the design and financial support for research products, especially to the Centres of Excellence. Public-private-partnership arrangements are also possible and viable in some situations and must be pursued in the development of programmes and projects. Private sector stakeholders in the FAnGR sub-sector also have a role in policy development process by bringing on board experiences on the inputs' supply and marketing of products as well as financing.

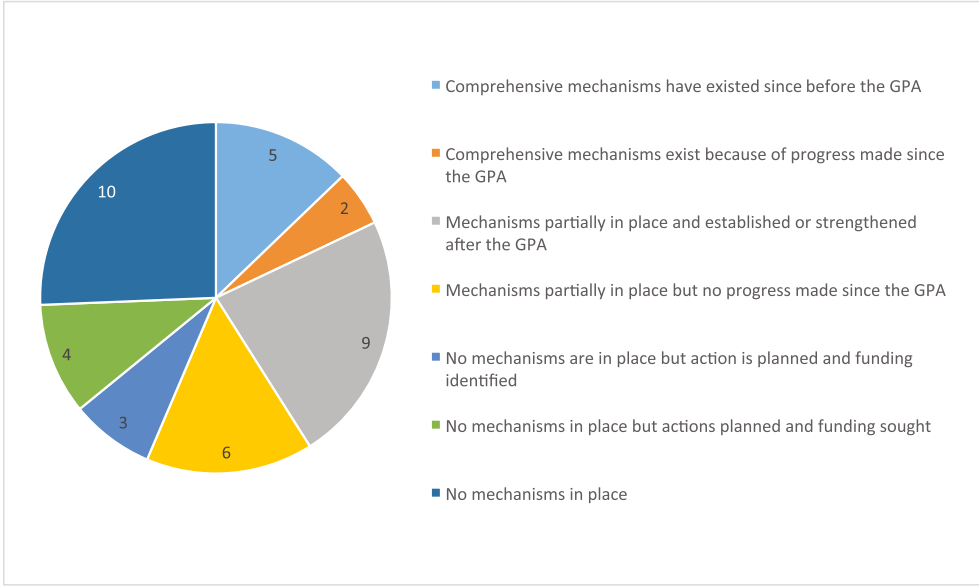
Mechanisms to facilitate interactions

Several governments have put in place mechanisms to facilitate interactions among agencies dealing with FAnGR, and within the livestock sector in general. The following examples from various regions of Africa illustrate some of these mechanisms for interactions. In Botswana, the government provides a network of extension officers to assist livestock keepers in different regions with the setting up of breeding goals, management of livestock as

well as disease management. However, because of the fact that majority of livestock are found in communal areas, breeding goals are sometimes difficult to implement due to the difficulty of controlling mating in these areas. The government also plays a vital role in the provision of AI services in the country. In Burkina Faso, the government plays the role of supervision, advice and support, control and provision of AI services. The breeders' associations play the role of organisation, raising awareness and mobilisation of farmers as well as development of constitutions and bylaws. They also conduct herd management, data recording and evaluation. NGOs play roles in the design, coordination and conduct of programmes. The Government of Cameroon, through the Ministry of Livestock, Fisheries and Animal Industries, owns and runs ranches and livestock stations where cattle, sheep, goats, horses and pigs are kept and bred. All the ranches and stations serve as mentoring and modernisation facilities where training and capacity building are carried out. Research in universities and the various stations of the National Institute for Agricultural Research are also up-to-date and in some instances better than the livestock stations of the Ministry. In Kenya, the Agricultural Development Corporation (ADC) was established and owns large-scale farms used to multiply improved livestock for sale to farmers.

In Côte d'Ivoire, the government plays a role through the management of ranches and stations, being in charge of the genetic improvement conservation, multiplication and distribution of N'Dama as well as the genetic improvement of sheep and goats. Breeders' associations or cooperatives implement crossbreeding programmes where specialised dairy breeds are crossed with multipurpose indigenous cattle. The Government of Mali implements breeding policy through the adoption and dissemination of regulations, and support for certain public services such as agricultural research and management. The breeders' associations, on their part, are involved in the application of technologies generated by research and ensure the application of the guidance disseminated by extension officers (public or private). In Uganda, the government and research institutions are the major players spearheading breeding activities. This is mainly because breeding activities can be expensive. However, as the programmes continue, there has been greater participation of other players including individual farmers. It is hoped that this trend will continue as the benefits of organised breeding are realised.

As indicated in Figure 104, few countries have put in place mechanisms to facilitate interactions among stakeholders, scientific disciplines and sectors as part of sustainable development planning.



Source: FAO (2014)

Figure 104: Number of countries that have put in place comprehensive mechanisms for the management of FAnGR relative to the adoption of the GPA

In Africa, there are few NGOs operating in the livestock sector. Prominent amongst them is Heifer International, which supports farmers with breeding stocks, AI services, recording and identification equipment as well as extension services in dairy, beef, goat, sheep, pig and poultry farming.

Information systems and networks

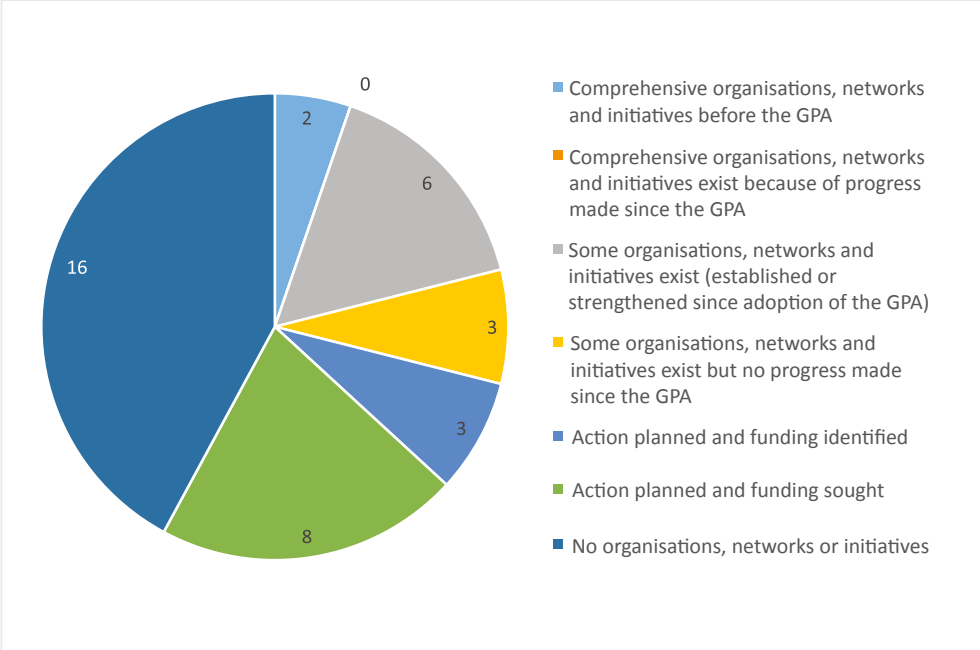
The Animal Resources Information System (ARIS) hosted by AU-IBAR is the main information system in Africa. AU-IBAR developed ARIS as it was within the scope of its mandate and with the overall objective of enhancing the information and knowledge management capacity of countries and RECs, to swiftly respond to disease emergencies and to properly plan interventions in animal production, marketing and trade, as well as to attract investment into the sub-sector. ARIS is managed by AU-IBAR after countries expressed the need for an all-encompassing African database/information system. The first version of ARIS was developed

in 2002 with the overall objective of collating, analysing and making available, in a timely manner, reliable and up-to-date data, information and knowledge on animal resources so as to support planning and decision-making. ARIS currently covers five core areas, namely animal production, health, trade and marketing, capacity, fisheries and aquaculture.

For FAnGR, the African Animal Genetic Resources Information System (AAGRIS) is hosted as a module within the core area of animal production in ARIS. It is envisioned as a 'one-stop-shop' for FAnGR that allows a wide range of end-users, particularly policy makers, to access knowledge, information and data to inform decision-making processes, especially on policies and legislation. AAGRIS is intended to help raise awareness and promote best practices in management of FAnGR in Africa. The goal of AAGRIS is to bridge the information and data gaps among key stakeholders, policy makers, countries and global audiences.

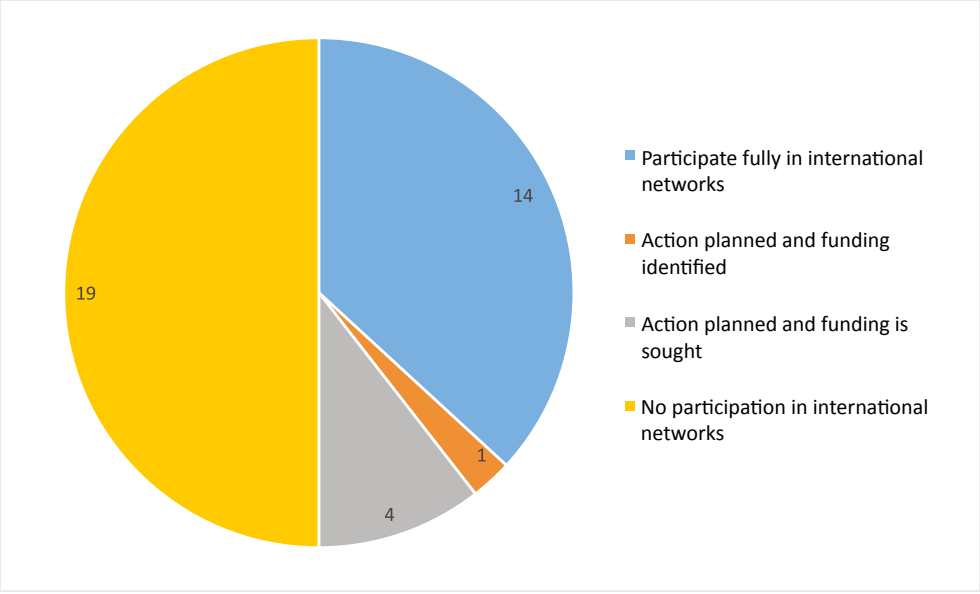
Similarly, some countries and regions have established information networks (Figure 105). In the SADC region, the Livestock Information Management Systems (LIMS) is hosted by the SADC Secretariat. The Ethiopian Livestock Market Information System is linked to the LINKS (Livestock Information Network Knowledge System), and delivers early warnings on livestock market information, which is delivered, in English and Amharic, in real time to pastoralists, livestock producers and traders in Ethiopia. The data is delivered on request using Community Information Centres (CIC) via SMS, emails, radio, television and the Internet (ETLMIS, 2013).

Despite the availability of these information systems, countries generally do not routinely provide data to, for example, the LIMS of SADC, although they are mandated to do so. Most of the countries do not have substantial incountry organisations, networks and initiatives for sustainable use, breeding and conservation of FAnGR established. Where they exist, they require strengthening. While Figure 105 gives the number of countries that have comprehensive organisations, networks and initiatives for the management of FAnGR, Figure 106 shows that most of the countries participate in international FAnGR-related networks, although their contributions to these networks have been below expectations.



Source: FAO (2014)

Figure 105: Number of countries that have comprehensive organisations, networks and initiatives for the management of FAnGR relative to the adoption of the GPA



Source: Country Reports, 2014

Figure 106: Number of countries that participate in international networks

Access and benefit sharing

All the 55 countries in Africa are signatories to the Convention on Biological Diversity (CBD) and have also ratified it, making it a legally binding international framework for the management of their biodiversity. Thirty-one (31) countries have signed the Nagoya Protocol and 27 have so far ratified it. The Protocol, being the latest of the international protocols with much bearing on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation, is of special importance to Africa due to the vast diversity of the genetic resources that has raised global interest and potential exploitation in the future.

Convention on Biological Diversity (CBD)

The Convention on Biological Diversity was opened for signature on 5 June 1992 at the United Nations Conference on Environment and Development (the Rio 'Earth Summit') and entered into force on 29 December 1993. The Convention is the only international instrument comprehensively addressing biological diversity. At the Sixth Meeting of the Conference of Parties to the Convention on Biological Diversity, in April 2002, the parties adopted a strategic plan, which included the target of "achieving by 2010, a significant reduction in the current rate of biodiversity loss at the global, regional and national levels as a contribution to poverty alleviation and for the benefit of all life on Earth".

Most governments, including those from Africa, missed their 2010 target and stated that assessing each country's progress towards achieving the biodiversity target had posed a challenging task in the absence of nationally agreed baselines, targets and indicators (Kamar, 2015). Approximately 20 per cent of the African countries reported that their biodiversity had not been sufficiently integrated into broader sectors such as agriculture, fisheries and tourism. They observed that beyond the sectors that directly deal with biodiversity and environmental issues, many other sectors in their countries had intended, but failed, to integrate biodiversity issues into their strategies and programmes. Furthermore, some governments stated that the failure to achieve the biodiversity target was attributable to shortcomings in records, communication and outreach. Currently, 49 African countries have national biodiversity strategies and action plans. Thirty five (35) countries have also completed their fourth national reports, which provide information on measures taken for the implementation of the Convention on Biological Diversity and the effectiveness of these measures (CBD, 2010).

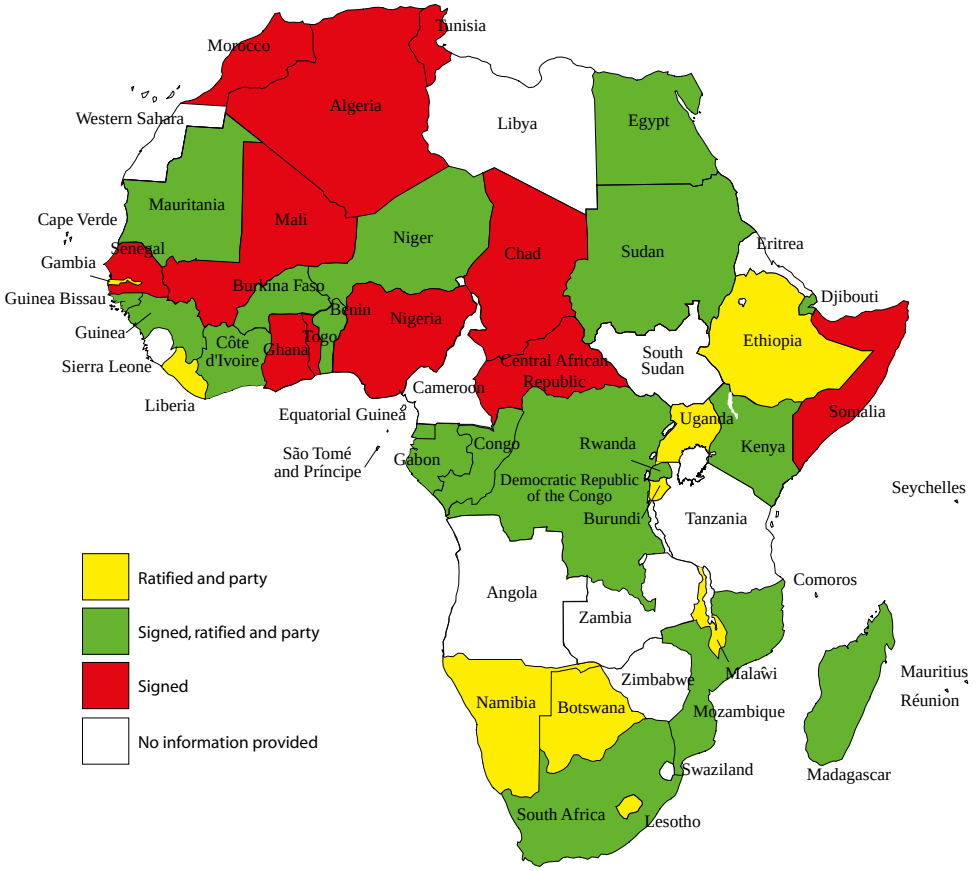
The Nagoya Protocol

The World Summit on Sustainable Development (Johannesburg, September 2002) called for the negotiation of an international regime within the framework of the CBD to promote and safeguard the fair and equitable sharing of benefits arising from the utilisation of genetic resources. The CBD's Conference of the Parties (COP) responded at its seventh meeting, in 2004, by mandating its Ad Hoc Open-ended Working Group on Access and Benefit-sharing to elaborate and negotiate an international regime on access to genetic resources and benefit-sharing in order to effectively implement Articles 15 (Access to Genetic Resources) and 8(j) (Traditional Knowledge) of the Convention and its three objectives.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation to the Convention on Biological Diversity was adopted at the tenth meeting of the COP on 29 October, 2010, in Nagoya, Japan. The three objectives are a) the conservation of biological diversity, b) the sustainable use of its components, and c) the fair and equitable sharing of the benefits arising from the utilisation of genetic resources. The protocol significantly advances the convention's third objective by providing a strong basis for greater legal certainty and transparency for both providers and users of genetic resources. Specific obligations to support compliance with domestic legislation or regulatory requirements of the party providing genetic resources and contractual obligations reflected in mutually agreed terms are a significant innovation of the protocol. By promoting the use of genetic resources and associated traditional knowledge, and by strengthening the opportunities for fair and equitable sharing of benefits from their use, the protocol *will create incentives to conserve biological diversity, sustainably use its components and further enhance the contribution of biological diversity to sustainable development and human well-being* (adapted from CBD, 2011).

African governments reported that there had been little progress because of reluctance from user countries to share benefits. In addition, many African governments lack regulations on bio-prospecting, resulting in the unregulated exploitation of their biological and genetic resources. On a positive note, the governments have now recognised that without a legal framework, it will be difficult to provide controlled and legally secure access to potential users of locally available biological and genetic resources. Accordingly, African countries are taking an active part in the current negotiations on the international regime on access and benefit-

sharing (Kamar, 2015). Figure 107 provides information on the status of ratification, acceptance, approval or accession by the African countries, where 27 countries have ratified the Nagoya Protocol. It has not been easy to verify in detail how countries are meeting their obligations under the conventions and what benefits have accrued to them.



Source: Adapted from CBD (2014)

Figure 107: Status of African countries in regard to the Nagoya Protocol



A Bororo bull on sale in a livestock market

Photo Courtesy: Ministry of Livestock, Niger

CHAPTER SEVEN

Priority Actions



Pietrain pigs, an exotic breed reared in Madagascar
Photo Courtesy: Ministry of Livestock, Madagascar

Alleviating poverty and contributing significantly towards food and nutritional security should be the highest national priority in almost all African countries. In order to achieve this important goal, production, productivity and sustainability of food and agriculture must be enhanced through the generation, development and transfer of appropriate technologies. The animal breeding sector offers innovative possibilities for FAnGR improvement and conservation in Africa. Genetic mapping of major traits as an aid to conventional animal breeding programmes is now being increasingly used mostly in developed and in a few African countries. As a result, some non-native breeds have found their way into Africa, such as the Barbary duck (Figure 108).



Photo Courtesy: AU-IBAR

Figure 108: Barbary duck of Madagascar

The African strategy for genetic improvement and conservation of FAnGR should take advantage of this technology and include both the provision of support through research, development, and the creation and fostering of appropriate climate. This largely depends on government and public awareness, political will, policies and programmes for building national capabilities and strengthening/developing regional and international cooperation. Creative partnerships between the public and private sector interests are critical in establishing a competitive strategy. Development of trained personnel is a high priority in Africa.

Based on the above, the needs presented in the countries was captured through their country reports and questionnaires and their analyses. The following should be considered as the key priority areas for the development of FAnGR in Africa, as shown in Table 25.

Table 25

Priority areas, actions and deliverables for the development of FAnGR in Africa

Priority	Short-term (1-2 years)	Medium term (3-5 years)	Long-term (>5 years)	By who	Remarks/Source of funding
Rehabilitating degraded rangelands **Natural Resource Management** **Subsidies on feed imports**	Rangeland research Minimum tillage when re-seeding rangelands Improve water availability – water harvesting, conservation, tapping underground	Policies on NRM Dam, water pans	Legislation on NRM targeting rangeland resources Afforestation to ensure water capture Legislation on catchment areas	Ministries in charge of livestock, environment, Attorney-General, Parliaments Stakeholders (ranchers, pastoralists, cooperatives, group ranch managers, among others)	National budgets Development partners through programmes/ projects Introduce CESS for the livestock industry to support the rehabilitation initiatives
Create Livestock/ FAnGR monitoring committees at country and regional levels	Stakeholder consultations and sensitisation activities with support from the line ministries	Legal status of the committees established in the African continent Develop national and regional strategies for management of FAnGR	Functional committees	Ministries in charge of livestock, Attorney-General, Parliament	National budgets; Development partner-supported initiatives; RECs can also budget to support the regional bodies
Advocacy and raising awareness of FAnGR	Inclusion of breeding strategies component in the national livestock development plans Development of curricula focusing on animal breeding and genetics Create awareness of LiDeSa among country stakeholders Publicising FAnGR through agricultural shows, media, billboards, dissemination materials, among others	Publicising FAnGR through agricultural shows, media, billboards, dissemination materials, among others	Publicising FAnGR through agricultural shows, media, billboards, dissemination materials, among others	Ministries in charge of livestock Universities and research institutes Private sector	National budgets Education institutes Civil society NGOs Media

Table 25

Priority areas, actions and deliverables for the development of FAnGR in Africa

Priority	Short-term (1-2 years)	Medium term (3-5 years)	Long-term (>5 years)	By who	Remarks/Source of funding
Policy and legislation formulation and strengthening	Formulation and strengthening of FAnGR policies and legislation (crossbreeding, conservation, access and benefit sharing and use of biotechnology)	Formulation and strengthening of animal breeding policies and legislation	Legislation (Bill and Act)	Ministries in charge of livestock, Attorney-General, parliament; breeders' associations	National budgets Civil society NGOs; RECs can also support some of these initiatives
Strengthen capacity of value chain actors	Take stock of institutions, existing expertise training needs and strategies for greater outreach National training on FAnGR breeding, conservation, performance, recording and registration strategies (farmers'/breeders' associations/extension service providers)	Conduct regional training of trainers on genomics, breeding and conservation strategies (FAnGR specialists, geneticists, biometricians, AI technicians) National training on breeding and conservation strategies (farmers/breeders associations/extension service providers)	National training on breeding and conservation strategies (Farmers'/Breeders' Associations/Extension service providers) Conduct regional training of trainers on breeding and conservation strategies (FAnGR specialists, geneticists, biometricians, AI technicians) Establish network of skilled personnel	Ministries of livestock AU-IBAR ILRI RECs Universities and research institutes S-RFP NGOs	National budgets Civil society NGOs Universities NARS IARC
Institutional capacity	Strengthening existing university, research and extension programmes for evaluation and traceability, breeders' associations	Identification of Centres of Excellence Establishment of new institutions, for example, livestock recording and identification	Equip Centres of Excellence Establishment of new institutions, for example, livestock recording and identification	Ministries of livestock Finance AU-IBAR ILRI RECs Universities and research institutes S-RFP NGOs	National budgets Universities

Table 25

Priority areas, actions and deliverables for the development of FAnGR in Africa

Priority	Short-term (1-2 years)	Medium term (3-5 years)	Long-term (>5 years)	By who	Remarks/Source of funding
Establish sustainable breeding and conservation strategies for native and transboundary breeds in africa	Take stock of the breeds with/without improvement strategies Initiate/strengthen *in situ* and *ex situ* conservation of native and transboundary breeds Matching genotypes to environments (zoning)	Adjust the ongoing breeding strategies, and develop and implement new ones for the remaining breeds with exploring the formation of synthetic breeds from the mother populations	Measure genetic, phenotypic and social progress	Ministries in charge of livestock NARS Farmers RECs IARC	National budgets Breed societies RECs
Strengthen national and regional efforts in native breed characterisation and inventories	Publicise existing results of previous and on-going characterisation activities/ programmes to demonstrate their value to various actors and identify gaps for characterisation Establish national, regional and continental database (AAGRIS)	Harmonisation of inventory and characterisation tools and procedures/ protocols; undertake comprehensive characterisation of all the transboundary breeds and populations	Assess the level of breed inventory and characterisation	AU-IBAR RECs Universities and research institutes S-RFP	National budgets Breed societies RECs
Establish the African gene bank as a back up to regional and national gene banks	Prepare the protocols and customise existing data base to be used by the gene banks Develop the networks of the existing gene banks in Africa		Establishment of the continental back up gene bank	AU-IBAR RECs Ministries in charge of livestock S-RFP IARC	AU-IBAR

Table 25

Priority areas, actions and deliverables for the development of FAnGR in Africa

Priority	Short-term (1-2 years)	Medium term (3-5 years)	Long-term (>5 years)	By who	Remarks/Source of funding
Coordination mechanisms	Mapping of relevant institutions impacting on FAnGR Development of focal points, networks and platforms Partnerships between stakeholders (communities, government, private sector, among others Promotion of public-private-partnership institutional arrangements/platforms Establishment of the African task force and network (continental focal point) on breeding strategies, conservation and ABS	Harmonisation of approaches and units Operationalisation of the task force Coordination to factor in elements/issues related to access and benefit sharing (ABS)	Creation of departments catering for livestock and FAnGR Operationalisation of the network	AU-IBAR ILRI RECs Ministries impacting on FAnGR S-RFP NARS	AU-IBAR RECs ILRI
Harmonisation of policies and legislation; monitoring tools	Consultations on national and regional policies and legislation	Formulation or strengthening of identified national policies	Harmonisation of identified policies and legislation across regions Operationalise harmonised policies and legislation	Ministries in charge of livestock RECs	National budgets RECs
Establishment and Strengthening of information systems	Establish national, regional and continental database (AAGRIS) Training of staff on the functions of the information systems Operationalise AAGRIS			AU-IBAR ILRI RECs Ministries in charge of FAnGR S-RFP NARS	AU-IBAR National budgets Private sector RECs

Table 25

Priority areas, actions and deliverables for the development of FAnGR in Africa

Priority	Short-term (1-2 years)	Medium term (3-5 years)	Long-term (>5 years)	By who	Remarks/Source of funding
International cooperation and obligations	Technology transfer; sharing experiences; defend shared concerns; unpack and customise the international conventions and bring these to the attention of the Government so that they may be anchored onto individual country's legal framework to facilitate implementation; CBD, Cartagena, Nagoya, Pretoria and Malabo declarations			MS REC's AU-IBAR Development partners International organisations ILRI	AU-IBAR Development partners ILRI
Establish regional/ continental programmes to understand existing crossbred populations and creation of productive and resilient synthetic breeds	Develop project proposals on characterisation (phenotypic and molecular) existing crossbred populations	Evaluate the performance of crossbred populations	Develop composite breeds where appropriate	Ministries responsible for livestock (research) Universities ILRI	National budgets Universities ILRI



Brood of guinea fowl keets freshly hatched

Photo Courtesy: Ministry of Livestock, Niger

CHAPTER EIGHT

Overall Conclusions



A Fulani woman milking a camel
Photo Courtesy: Ministry of Livestock, Chad

The status and trends in FAnGR presented in the previous chapters can provide valuable guidance for policy and decision-making, both for governments and civil society. However, the lack of data and/or inaccuracies has to be recognised as a challenge, especially sharing information that is widely expected to be known, such as that on breeds and population numbers, and their unique attributes. The absence of such data shakes the very foundation of the understanding of what FAnGR are and how best to use them in positive and efficient ways, and to develop them further.

Africa needs to take some action to arrest the loss and prevent further erosion of the invaluable FAnGR biodiversity. The status and trends presented in this publication should be considered as the platform from which policy and decision-making can prompt actions on how to improve the management and development of FAnGR in Africa.

The analyses of the data from African countries have provided useful information on the state of FAnGR in the countries and have also highlighted pertinent issues on the diversity of species and breeds being used in the production systems. The trends in the use of exotic breeds in relation to indigenous breeds, and the promotion of crossbreeding as an intervention vehicle relative to conservation and genetic improvement efforts, were raised. Livestock keepers seem to prefer crossbreds with less recognition for indigenous breeds. Appropriate policy and legislative environments should be established to support and promote indigenous FAnGR. It is imperative to mainstream FAnGR issues into institutional thinking and ensure that the creation of conducive environments for the sub-sector to develop and to be well managed. From the data and information provided and analysed, it was observed that there was more justification to policy makers for the "improvement" of indigenous FAnGR through crossbreeding. In some cases, the requisite infrastructure have been put in place to support crossbreeding activities.

In the light of the above, it would be beneficial to have, in each country, a small team of experts to provide technical advice to policy makers and to highlight the negative impacts of crossbreeding on indigenous breeds. The technical advice could be, among others, on what breeding plans to adopt and what to do with F1 bulls. The technical team could also monitor and evaluate the processes to ensure that any proposed guidelines on crossbreeding are adhered to.

It would also be beneficial to promote, improve and/or develop FAnGR that can adapt to the vagaries of climate change and disease

prevention, among others. It is important that Africa accepts and utilises the biotechnological advances that have enabled genetic resources to be improved and conserved. Research and development (R&D) in FAnGR is critical for up-to-date evidence-based information and data on the usefulness and importance of African FAnGR. There should be national and regional monitoring mechanisms that will function as early warning systems particularly on breed populations. These should be put in place through the collaboration of national governments and RECs to ensure breeds at risk and transboundary breeds are monitored and populations restored when necessary.

Capacity building among field technical staff responsible for the collection of data at the breed and household levels should be provided. Additionally, the training of livestock owners/breeders and/or managers/herdsmen on how to recognise threats to indigenous FAnGR, and any other useful observations, is also important. The need for characterisation of FAnGR to determine their adaptive status and productivity should be prioritised. Therefore, there is need for the appropriate technical institutions responsible for characterisation to conduct mapping of FAnGR to determine what needs to be done on characterisation.

There is need to raise awareness through effective communication channels to highlight the importance and value of indigenous breeds. This will increase interest and hopefully manifest in investment in the sector. Correct and accurate information and data on breed numbers and populations will lead to the successful implementation of these actions and interventions on indigenous breeds. This requires effective communication and coherence between ministries responsible for FAnGR and other stakeholders in the sector. The methodologies and tools to undertake such interventions should be readily available. The AU-IBAR Genetics Project is currently developing some of the necessary methodologies and tools to address many of the needs identified and referred to in the preceding sections of this document.

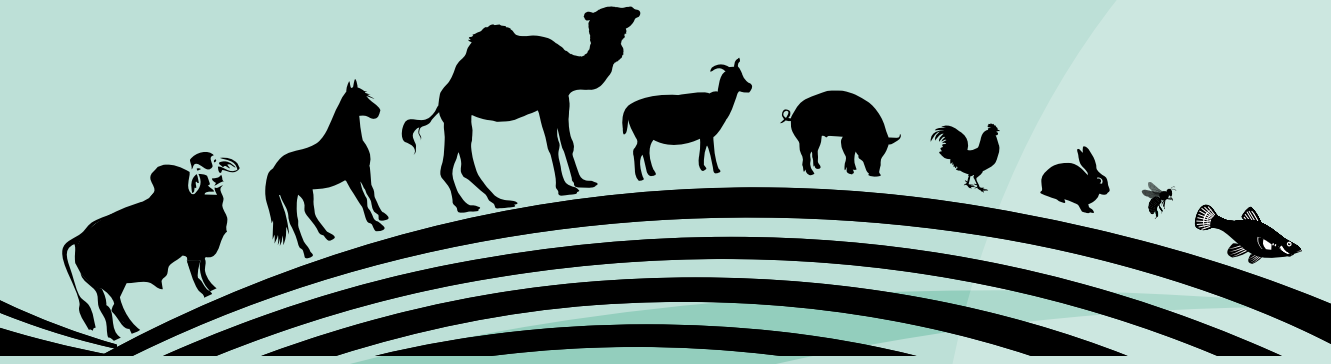
It is clear from the developmental interventions being conducted by some of the countries that there is need for greater inputs from governments, RECs and AU to reduce the number of breeds under threat and promote conservation efforts. This will result in the sustainable utilisation, management and development of FAnGR in Africa.



Characterization of the cane grass cutter using the Animal Genetic Resources Characterization, Inventory and Monitoring (AnGR-CIM) tool for Africa

PHOTO COURTESY: AU-IBAR

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Photo Courtesy: (ICIPE)

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African Heads of State and Governments endorsed the first ever 20-year Livestock Development Strategy for Africa (LiDeSA) in 2017. This strategy is coherent with the Comprehensive African Agriculture Development Program (CAADP) frameworks and is aligned to the Malabo Declaration and Agenda 2063. It calls to action an agricultural sector transformation agenda and underscores the importance of utilising animal genetic resources to address some of the continent's most pressing needs concerning food and nutritional security. The primary impetus is to promote the acceleration of agricultural growth and transformation across the continent.

Africa is home to diverse animal genetic resources displaying a vast range of Darwinian adaptations that continually evolve to match the ever-changing ecosystems. It is pertinent that the continent understands the expanse of her rich animal genetic resources' diversity and its potential to be effectively utilised and sustainably conserved for the benefit of, primarily, the livestock keepers and the continent as a whole.

This publication is the first of its kind to comprehensively document Farm Animal Genetic Resources (FAnGR) of Africa. It showcases some of Africa's unique animal breeds and provides an invaluable insight into their ecologically important traits. The publication highlights the diverse production systems found in Africa in addition to illustrating the distribution and population trends of various animal species. It further documents the primary threats to Africa's FAnGR and proposes effective genetic improvement and conservation strategies to manage these endangered breeds. The continent's policy and institutional frameworks are well articulated to better inform policy and other decision makers.

The State of Farm Animal Genetic Resources in Africa offers universal guidance to policy makers, scientists, animal associations/ societies, conservationists, national governments, Regional Economic Communities (RECs) and other stakeholders involved in the management, conservation and utilisation of African FAnGR.

The publication is a result of the combined effort of African animal scientists, animal breeders, directors of animal production and national experts drawn from Member States of Africa.

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