SDG Indicators 2.5.1 and 2.5.2 – Plant and animal genetic resources

Lesson 5: Animal genetic diversity for food and agriculture

Text-only version

The interactive version of this lesson is available free of charge at: https://elearning.fao.org

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

working for Zero Hunger

In this lesson

This lesson introduces the concept of animal genetic resources for food and agriculture and explains why it is important to conserve them. It describes the key threats to breed diversity and explains the three main ways to conserve breeds. It is the first of three lessons that focus on animal genetic resources.

Learning objectives

At the end of this lesson, you will be able to:

- explain the concept of animal genetic resources;
- explain the concept of an animal breed;
- describe the main threats to breeds;
- list the main strategies to conserve breeds.

Introduction

This is the first of three lessons that focus on animal genetic resources for food and agriculture.

Lesson 5 (this lesson)	**Lesson 6**	**Lesson 7**
Describes the importance of animal genetic resources and threats to them. It also describes how they can be conserved.	Goes into detail on Sustainable Development Goal (SDG) Indicators 2.5.1 and 2.5.2, focusing on what data should be reported and how to access it.	Explains how to retrieve data from FAO's Domestic Animal Diversity Information System (DAD-IS) and how to interpret the indicators. It also describes how to communicate about conserving animal genetic resources.

In this lesson, we will focus on **understanding what animal genetic resources are**. The lesson will highlight the animals that countries need to keep track of in order to calculate SDG indicators 2.5.1 (animal component) and 2.5.2.

You can find an introduction to the SDG indicators (including the plant component) in Lesson 1.

Let's start by following the conversation between Riza and Julian below.

Riza: *"Next month we will be submitting our annual update on animal genetic resources to FAO. To complete this report, I need to collect information and data on the animal genetic resources in our country. Could you please help me?"*

Julian: *"Absolutely Riza. Part of my job is to keep track of the animals in our country. So that I can help you, tell me which animals you refer to when discussing animal genetic resources. "*

Meet Riza and Julian

Riza works for the Department of Livestock at the Ministry of Agriculture. She is the Head of the Unit responsible for animal genetic resources. Her government has appointed her as **National Coordinator.** This means that she is responsible for providing information and data on animal genetic resources in her country to FAO DAD-IS.
Julian works for the Department of Agricultural Statistics at the Ministry of Agriculture. He is an agricultural statistician.

Animal Species for Food and Agriculture

Animal genetic resources are the animal species that are used for food and agriculture. They are an important part of many cultures and provide a diversity of services, including the provision of savings and exchange. They include:

- species that are widely used for food, such as cattle, chickens, pigs, sheep and goats (the "big five"). These also include animals that produce meat, milk and eggs.
- species that are important in certain regions or countries, such as buffaloes, vicuñas, yaks and ostriches.
- working animals, such as horses, camels, donkeys and dogs. For example, animals that pull ploughs and carts.

Types of Animals Covered

Each country decides which species it wishes to keep track of, since species vary across the world.
In Pakistan, the partridge is an example of a common animal used for food or in agriculture.
In Finland, the reindeer is an example of a common animal used for food or in agriculture.
In Chile and a few other South American countries, the vicuña is an example of a common animal used for food or in agriculture. Within a given **species**, **not all the animals are the same**. They are grouped into **different breeds**. In the next pages we will examine the breeds of the species that are monitored.

Definition of Breeds

All animal species that are used for food and agriculture have different subtypes, known as breeds.

Breeds may be **genetically distinct** and **look different** from each other. There is also a **strong cultural component** in how breeds are defined from one region to another. For example, the Arabian horse and the Exmoor Pony. Thus, **breeds can be defined in various ways**. In fact, organizations also have different definitions of breeds.

FAO definition of a breed

FAO considers a breed is to be *either:*

- a subspecific group of domestic livestock with **definable and identifiable external characteristics** that enable it to be separated by visual appraisal from other similarly defined groups within the same species;

and/or:

- a group for which geographical and/or cultural separation from phenotypically similar groups has led to **acceptance of its separate identity.**

Number of Breeds

Here are examples of animals with **various breeds**. Each breed has certain **characteristics,** such as size, appearance, colour, behaviour and adaptability. They also provide a range of **products and services**. Knowing the different types and the numbers of breeds is important for data collection.

Horses	There are a total of 845 horse breeds. **Arabian -** A versatile breed originally from the Arabian peninsula often used for racing and other sports. **Percheron -** A heavy draught horse from France, originally bred as a war horse. **Przewalski** - The only true wild horse breed, native to Mongolia, which has never been domesticated.
Pigs	There are a total of 628 breeds of pig. **Iberian -** A breed native to Spain and Portugal that forages for acorns in open oak woodlands. It is famed for producing a highly prized type of ham. **Lợn Ỉ -** The Lợn Ỉ (Lợn is Vietnamese for pig) is a small breed that briefly became popular as a pet in the West. From a population in the millions in the 1970s, its numbers have fallen dramatically; in 2010 there were just 120 left.
Cattle	There are a total of 1255 breeds of cattle. **Charolais -** A breed of cattle from France, now used for beef production. **Fulani -** A West African cattle breed of great importance to the nomadic Fulani pastoralists.

	N'Dama - This breed from West Africa is tolerant to trypanosomiasis. It can therefore graze in areas infested with tsetse flies.
Sheep	There are a total of 1392 breeds of sheep. **Shetland -** A small breed from the Shetland Islands, Scotland. It thrives on heather and seaweed. **Red Maasai -** A hardy breed in East Africa that is especially tolerant of internal parasites. **Rhoenschaf -** An ancient breed of sheep from the Rhoen hills in Germany, used to maintain the region's open landscape.
Goat	There are a total of 666 breeds of goat. **West African Dwarf** A small breed common in West Africa that tolerates trypanosomiasis and nematode infestations. **Black Bedouin** A small desert breed native to the Near East with a low metabolic rate that can tolerate low-quality, high-fibre feed, and can go for 4 days without water.
Chickens	There are a total of 1 592 breeds of chickens. **Rhode Island Red -** Originally from Rhode Island, USA, this egg-layer is now found throughout the world. **Leghorn -** A widespread breed of layer chickens originally from Italy. There are white, black and brown breeds.

FAO DAD-IS

Information and data on the types and number of breeds is collected through **FAO's Domestic Animal Diversity Information System (DAD-IS),** www.fao.org/dad-is/en/ **.** This is a service run by FAO and an important part of worldwide efforts to monitor animal genetic resources.

Being the only global database of its type, DAD-IS helps member countries to:

- monitor the status of their animal genetic resources;
- make informed decisions about breed management;
- make comparisons, with other countries so they can see how well they are doing.

It also has an early warning function that alerts countries to potential problems before they occur.

For many countries, it offers the only database containing the species and breeds that they have.

DAD-IS is crucial in helping countries to monitor their progress towards the Sustainable Development Goals and to implement the **Global Plan of Action for Animal Genetic Resources**.

Animal Species Covered by DAD-IS

DAD-IS divides animal species used for food and agriculture into **mammalian and avian species.**

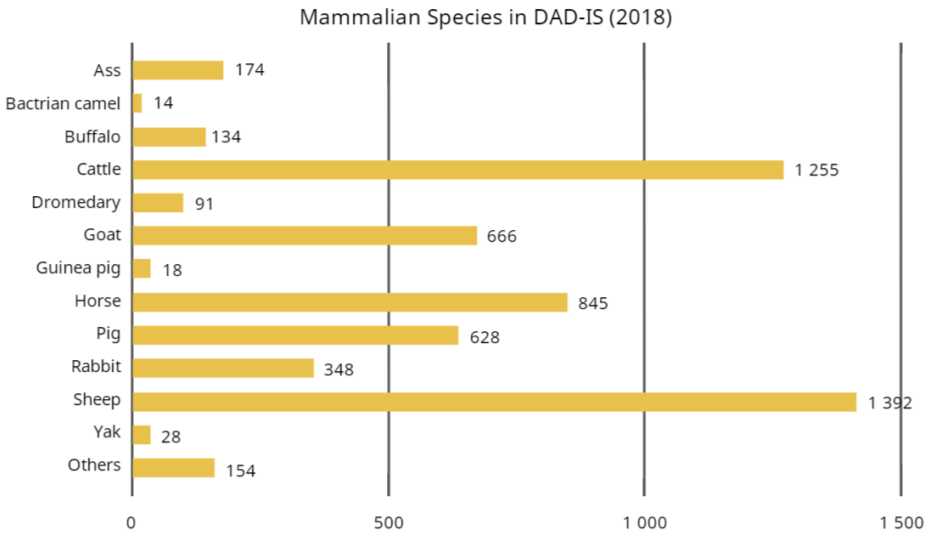
Mammalian species (20 species)	Avian species (18 species)
Alpaca, American Bison, Ass, Bactrian Camel, Buffalo, Cattle, Deer, Dromedary, Goat, Guanaco, Guinea Pig, Horse, Llama, Pig, Rabbit, Sheep, Working Dog (e.g. Border Collie), Vicuña, Yak, A cross between a Dromedary and a Bactarian Camel	Cassowary, Chicken, Chiean Tinamou, Duck, A cross between a Duck and a Muscovy Duck, Emu, Goose, Guinea Fowl, Muscovy Duck, Nandu, Ostrich, Partridge, Peacock, Pheasant, Pigeon, Quail, Swallow, Turkey

Number of Breeds in DAD-IS

DAD-IS currently holds information on about 8 800 breeds in 182 countries.

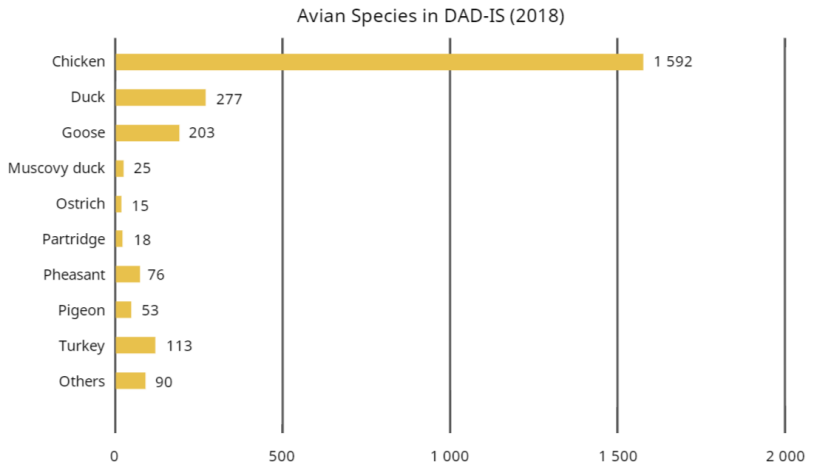
Mammalian Species (20 species)

As you can see from the graph below, cattle and sheep account for nearly half the **5 741 mammalian livestock breeds** registered with DAD-IS. Goats, horses and pigs account for most of the rest.



Avian Species (18 species)

As you can see from the graph below, chickens account for almost two-thirds of the **2 462 avian breeds** registered with DAD-IS.



Breed Classification

Breeds can be classified in various ways according to their:

- **Geographical Distribution**

  Breeds can be classified as being either **local breeds** or **transboundary breeds**, depending on whether they are found in only **one or more countries**.

- **Adaptation to a Specific Environment**

  Breeds can be classified as **locally adapted breeds** or **exotic breeds,** depending on **how long** they have existed in a country or region.

Local Breeds or Transboundary Breeds

Breeds classified by **geographical location** are described as **local breeds** or **transboundary breeds**. Local breeds occur **only in one country**, while transboundary breeds are found in **more than one country**.

- Local breed: The **Anoa** is an example of a local breed. It is a breed of miniature, wild water buffalo and is **only found in Indonesia**.
- Transboundary breed: The black and white **Holstein-Friesian** dairy cattle is an example of a transboundary breed. It can be found **all over the world**.

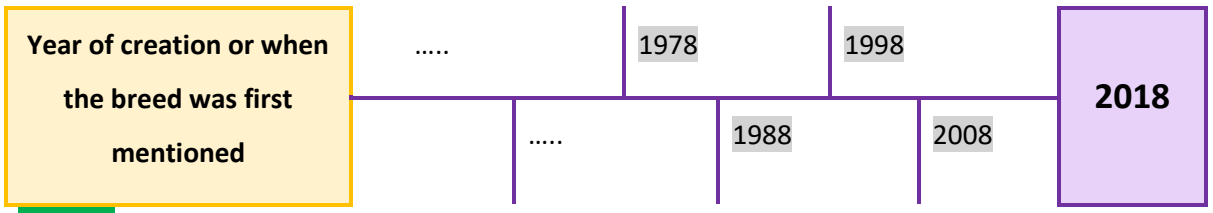
Regional transboundary breed

The Ankole cattle is a good example of a regional transboundary breed. Although it originated in Uganda and the surrounding countries of East Africa, it is now also found in several other countries.

Locally adapted or Exotic breeds

Breeds classified by their **adaptation to a specific environment** are described as locally adapted breeds, or exotic breeds.

Locally adapted breeds



Locally adapted breeds

- Ayam kampung, or **village chicken** are a native breed in **Indonesia and Malaysia**. They are small, hardy birds descended from jungle fowl, indigenous chickens and imported breeds. Many people in both urban and rural areas keep them free-range for their eggs and meat. The meat has better flavour than imported breeds, and fetches a higher price.
- Yak breeds such as the **Tibetan High Mountain yak** and the **Mongolian yak** are native to the mountains and plateaus of **Central Asia**.
  They are hardy and thrive on the sparse vegetation; their thick fur and physiology mean they can survive at high altitudes and in freezing conditions.
  - Yakutian cattle originate in the Republic of Sakha, north of the Arctic circle in eastern **Russia**. They can endure temperatures as low as minus 60 °C.
- The Texel sheep, a heavy meat breed, originated from the Dutch island of Texel. First imported into the **United Kingdom in the 1970s,** it has become very popular there and is known as the British Texel.
- The Merino sheep was introduced to **Lesotho** in the 1800s and crossbred with the indigenous fat-tailed sheep. The characteristics of the fat-tailed sheep have now virtually disappeared. A small strain of Merino is now the main breed used to produce meat and wool in Lesotho.

These breeds **have been in a country for a long time**, so have had become adapted to the traditional production systems or environment there. They are likely to have developed **specific adaptive features** and **cultural importance** in their countries.

We can expect **local breeds to be locally adapted**. An exception would be if a breed is imported into one country, but dies out in its country of origin.

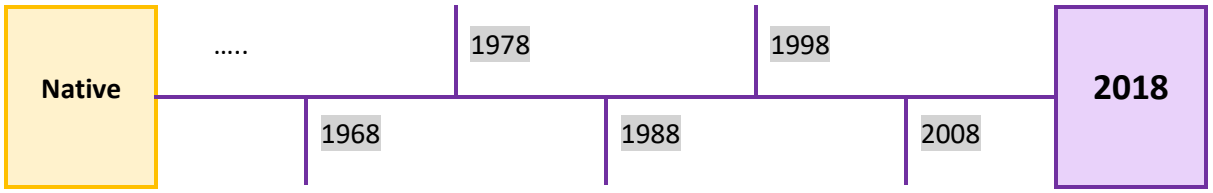
Indigenous or native breeds are included in this classification. They are breeds that have evolved (or been bred) in a particular environment, and are suited to a particular climate and management system.

They thrive on local types of feed and have developed resistance to pests and diseases that are common in the area.

Such local adaptations are very important. They enable the animals to **survive on poor feed**, **in extreme temperatures**, with little water, and **in areas with many pests and diseases.**

Many livestock keepers keep several different breeds of animals to spread risk and raise production levels so that if drought or disease strikes, at least some animals will survive.

Exotic breeds



Exotic breeds

These map shows two exotic breeds that are transboundary.

Dorper sheep were bred in South Africa as a cross between Dorset Horn rams and Blackhead Persian ewes.

A meat breed suited to arid areas, it has been introduced to many other countries, where it is popular and does well in normal conditions.

But in drought conditions these sheep are less hardy than local breeds and many die.

The well-known black and white **Holstein-Friesian dairy cattle originated in** the Netherlands, northern Germany and Denmark. The breed has since been introduced to over 160 countries around the world, due to its high milk production.

In some countries (such as the USA), this breed is regarded as locally adapted; in others (such as Kenya), it is seen as exotic.

In the tropics, Holstein-Friesian cattle have to be managed with care. This means that they need special feed, housing and veterinary care. If this is not provided the cattle it will not be productive and may succumb to the heat and diseases

Exotic breeds are breeds that **have been introduced recently into an area**.
They have not had time to adapt to the local conditions, so they may **need special management, housing, feed and care.** Some countries continually import breeding stock of exotic breeds, so these breeds cannot become locally adapted.
By convention, it is considered that it takes about six breeding generations, or about 40 years (depending on the species) for an exotic breed to become locally adapted.

Breed Classification

Breed classifications vary per country.
Each country decides whether a particular breed is a local **or** transboundary breed, and whether that breed is locally adapted or exotic. The distinction between these classifications is important because:

- A **transboundary** breed, such as the Holstein-Frieisan cattle, may be rare in one country but common elsewhere. In addition, this breed is classified as locally adapted in the USA, and exotic in Kenya.
- A **local** breed that is rare may be more at risk, because local breeds are found only in one country.

- At the same time, a breed might be locally adapted to one country and exotic to another.

Knowing how breeds in your country can be classified is important for maintaining animal diversity.

Breed Classification in DAD-IS

From the total of 8 800 breeds, DAD-IS classifies breeds according to their geographical distribution. **However, the data may be misleading**: it is possible that many breeds are more widely dispersed than the DAD-IS data indicate. Nonetheless, the geographical distribution of mammalian and avian breeds presented below shows that **globally, most breeds in DAD-IS are classified as local.**

Number of mammalian and avian breeds according to their geographical distribution, registered with DAD-IS, March 2018

	Local mammalian breeds
	Regional transboundary mammalian breeds
	International transboundary mammalian breeds
	Local avian breeds
	Regional transboundary avian breeds
	International transboundary avian breeds

Global geographical distribution of mammalian and avian breeds

Geographical Distribution Areas of Mammalian and Avian Breeds

North America	32%	6%	38%	7%	0%	18%
Latin America	48%	35	22%	16%	0%	11%
Europe	54%	55%	7%	29%	2%	3%
Near and Middle East	62%	2%	16%	17%	0%	2%
Asia	60%	3%	8%	25%	0%	4%
Africa	50%	8%	17%	19%	0%	6%
Southwest Pacific	32%	1%	38%	13%	0%	16%

Why do we need animal diversity?

As you now know, **each breed has a unique set of genes that makes it valuable**.

Indeed the breed classification shows how many breeds are especially suited for specific environments, such as a particular combination of climate, vegetation, pests, diseases and management. This makes them **potentially useful as a source of breeding stock**.

Julian: *"So why is it so important to conserve different breeds? "*

Riza: *"**Conserving different breeds allows us to have more animal diversity.** There are three main reasons that explain why animal diversity is important.*

- ***Economic Reasons for Animal Diversity***
- ***Environmental Reasons for Animal Diversity***
- ***Cultural Reasons for Animal Diversity***

Let's examine these groups next."

Economic reasons for animal diversity

Economic Reasons that explain why animal diversity is needed.

- **To provide food and income**

Different breeds have different uses. Modern breeds can be **highly productive under the right conditions**.

Traditional breeds are well adapted to the local environment, so are **vital sources of food and income** in such situations.

For example, locally adapted breeds of chickens scavenge for food in backyards around the world. They are a vital source of eggs, meat and money, **especially for women, who often take care of them**.

- **To provide a source of genetic improvement**

Breeds with **desirable traits** can be crossed with other animals to **improve** them.

For example, breeding organizations crossbreed the Monbeliard (a French dairy cattle breed) with the Holstein to improve its milk yield.

- **To cater to changing consumer demands**

Changing consumer demands lead to **shifts in the types of breeds needed**.

For example, after the Second World War, demand for lean meat rose. The Piétrain pig, a muscular breed originating in Belgium, became very popular as a parent of crossbred market animals.

Environmental reasons for animal diversity

Environmental Reasons that explain why animal diversity is needed.

- **To adapt to climate change**

Hardy breeds can be introduced in areas where the **climate is changing.**

For example, as northern Kenya and southern Ethiopia become drier, camels, which are more adapted to harsh environments, can replace cattle as milk producers.

- **To conserve landscapes and provide ecosystem services**

Some breeds prefer to graze on certain types of vegetation. They can be **used to control weeds and prevent the growth of woody plants.**

For example, goats used to browse on shrubs in the Alps, but very few are now kept. Most sheep eat only grass and herbs, but the Engadine sheep breed also munches on young shoots of shrubs. It is now helping to preserve centuries-old grassland.

For example, in Poland, Konik horses are used to control vegetation in the Biebrza National Park. Sheep cannot do this because they would be attacked by wolves.

Cultural reasons for animal diversity

Cultural Reasons that explain why animal diversity is needed.

- **To produce unique products**

Some breeds have **special characteristics**, such as fine wool, coloured hides, or tasty meat or eggs.

For example, criollo goats in Neuquén, Argentina, are raised by transhumant herders on the high rangelands of the Andes. They produce a meat prized for its taste.

- **To act as an important component of culture**

Many breeds are named after the ethnic groups that keep them. These **people's traditional lifestyles** would be unthinkable without their particular breed.

For example, in Tana Toraja, Indonesia, spotted water buffalo are highly valued. Each animal has its own attendant to care for it. Spotted and white buffaloes are especially important in traditional funeral ceremonies.

Main threats to animal diversity

Although local breeds are very valuable, many of them are **under threat**. This is because some breeds with valuable traits are being pushed aside since other breeds are considered to be more profitable, or are more fashionable. Here are some other reasons why animal diversity is under threat.

BREEDING

Introduction of exotic breeds: Livestock breeders are replacing their traditional breeds with animals that they hope will produce more.

Indiscriminate cross-breeding: Farmers often crossbreed local animals with exotic ones to improve their herd or flock. But the local breed may disappear over time if such indiscriminate crossbreeding continues.

Poor control of inbreeding: A breed with only a few animals may become too inbred, reducing its genetic base and making it susceptible to diseases, or less fertile.

ECONOMY

Low productivity: Even though they have desirable traits, local types often produce less than introduced breeds. This may make them unprofitable. Livestock keepers may find that high-yielding exotics are more profitable than their traditional breeds.

Market demands: Supermarkets have strict requirements for the products they buy and sell. Breeds that cannot produce a chop, fillet or egg of the right size will find no market.

Changes in production systems: Traditional production systems are being replaced by more intensive systems that require highly productive, often exotic breeds. Local breeds of pigs and chickens are being replaced by intensively raised breeds.

Draught animals, such as horses, donkeys, oxen and camels, are being pushed aside by tractors and lorries.

ENVIRONMENT

Climate Change: As areas become wetter or drier, native breeds are being pushed out or replaced. Pastoralists in southern Ethiopia are replacing their traditional Boran cattle with more drought-tolerant camels.

Loss of grazing lands: In many parts of the world, pastureland is being ploughed up to grow crops. There is nowhere left to graze the animals.

Pests and diseases: Disease outbreaks may wipe out rare breeds either directly, or because of policies to cull animals so as to contain the disease. Small-scale farmers cannot afford expensive biosecurity measures.

POLICY

Government policy: In an attempt to modernize their farming sector, some governments encourage farmers to adopt high-yielding breeds. Policies to support the maintenance and improvement of locally adapted breeds are often lacking.

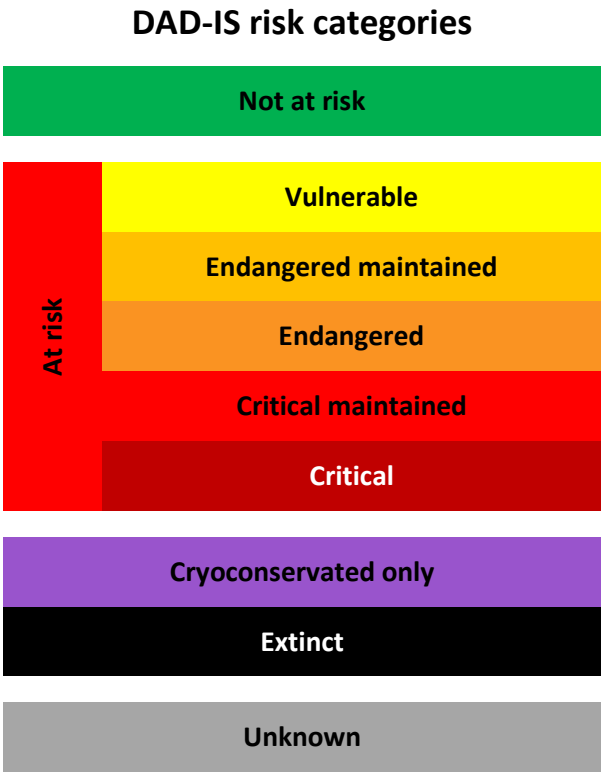
Current status of breeds

The threats that we have just examined help us to identify a **breed's level of risk of extinction** in a country. It is known that the threats we have examined make it hard to find purebred animals of many traditional breeds. Many breeds are on the verge of extinction while some have already become extinct. Many local breeds have valuable features, but have **never been classified or described**. The situation is similar to the conservation of wild biodiversity: we are in **danger of losing genetic diversity** before we even realize that it exists.

DAD-IS provides its own risk classification.

Current status of breeds in DAD-IS

DAD-IS provides a **classification of the risk of extinction for all breeds** in the database. Here is the current status of mammalian and avian breeds that are found in DAD-IS.

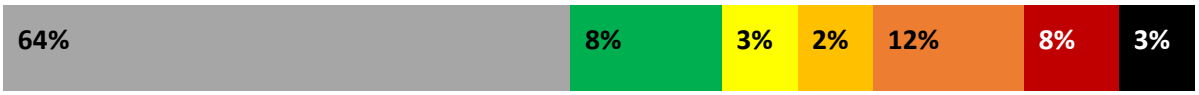


Number of mammalian and avian breeds at risk of extinction, registered with DAD-IS, March 2018

Total

Mammalian

Avian



More information on these risk categories is presented in Lesson 6.

In vivo conservation of animal genetic resources

www.fao.org/elearning/Course/SDG251-252/en/story_content/external_files/In%20Vivo%20Conservation%20of%20Animal%20Genetic%20Resources.pdf

In-situ and *Ex-situ* animal conservation

In order to keep breeds and encourage animal diversity, **conservation methods have been developed**. These methods are used to **create an active conservation programme** for animal genetic resources.

Here are the three conservation methods used for **animal genetic resources**.

- ***In-situ in-vivo***
- ***Ex-situ in-vivo***
- ***Ex-situ in-vitro***

In the next pages we will examine these conservation methods in detail.

In-situ in-vivo conservation

***In-situ in-vivo* conservation (animal)**

This is a conservation method that applies to **animals that are kept in their original location**, and **under the same management conditions** that they are used to. They eat

the same feed and are subject to the same pests and diseases as normal. **This is the most frequent strategy for conserving breeds.**

This method includes two types of management:

1. **Normal management**

Livestock keepers who raise their herds and flocks for the usual purposes apply this form of management.

Although they probably do not think of this as breed conservation, this form of management is important for **maintaining a large gene pool that represents the diversity within a breed**.

Boran cattle

The Borana people of southern Ethiopia and northern Kenya keep a shorthorned Zebu breed of cattle known as the Boran.

It is hardy, tolerates water shortages and poor feed. It can walk long distances and defend itself against predators. It is mainly used for meat. Physically, the males are much larger than the females.

2. **Active conservation**

Individual breeders, breed societies and breeding stations apply this form of management.

They **have conscious strategies to maintain and improve a breed.** These strategies include herd books and flock books that keep the records of progeny, pure lines that can be used for breeding, and programmes to select and inseminate certain animals.

Groningen white-headed cattle

Once very common in the Netherlands, the number of purebred Groningen white-headed cows has fallen to just 600.

Breeding groups are trying to revive it through a breeding programme and by producing cheese and beef for niche markets.

Boran cattle

The adaptive traits of the native Boran breed have led ranchers in Kenya to develop it further. These beneficial traits include its ability to tolerate water shortages, walk long distances and defend itself against predators.

The Boran Cattle Breeders Society maintains a set of breed standards, a studbook and an inspection system for this cattle breed.

Oxford Sandy and Black pig

The Oxford Sandy and Black pig is a rare breed from the UK. It has black blotches on a sandy hide, so is sometimes called the "Plum Pudding".

This is a hardy, docile pig suited for raising outdoors. The Oxford Sandy and Black Pig Society, www.oxfordsandypigs.co.uk/ , is dedicated to conserving the breed.

Advantages and disadvantages of *in-situ in-vivo* conservation

Advantages	Disadvantages
• The animals are kept as a living breed by livestock keepers to **provide food and services**. They are subject to everyday management, pests, diseases and stresses, so **continue to evolve and adjust to the changing environment.** • The breed's **performance can be improved** over time. • *In-situ in-vivo* conservation programmes can be highly effective in **raising awareness** of the value of a breed.	• The breed is **exposed to a range of risks**, such as environmental hazards (diseases or drought). • **Socio-economic problems**, such as loss of profitability or a decline in funding. • **Genetic problems** caused by genetic drift, loss of fertility or inbreeding.

Ex-situ in-vivo conservation

Ex-situ in-vivo conservation (animal)

This is a conservation method where the breed is **maintained outside its home area and usual conditions.** This environment is usually in **conservation centre or zoo,** which maintains a herd or flock of purebred animals.

In France, a regional eco-museum called the Écomusée du pays de Rennes, www.ecomusee-rennes-metropole.fr/ , **maintains flocks of rare local breeds.**

It also plays a major role in the preservation, knowledge and **awareness raising** of those breeds.

Turopolje pigs

When war broke out in former Yugoslavia in the 1990s, the local Turopolje pigs were on the frontline and soldiers killed them for food.

The SAVE Foundation, an NGO, removed some of the animals to a park in Austria, and marked others so that a herd book could be started.

The pigs are now maintained in the Lonjsko Polje Nature Park in Croatia.

Advantages and disadvantages of *ex-situ in-vivo* conservation

Advantages	Disadvantages
• If the breed is in immediate danger of extinction (for example in a conflict), *ex situ* conservation (either *in-vivo* or *in-vitro*) may be the **only way to conserve it.** • *Ex-situ in-vivo* conservation **introduces the breed and its value to a wider audience** outside the breed's home area. • It is **easier to manage** the genetics of a breed in a central location than if the animals are dispersed over a wide area.	• Keeping and breeding sufficient numbers of live animals to maintain a viable population is an **expensive, long-term undertaking**. • Keeping the animals in a small number of locations may **expose them to additional risks** -such as a disease outbreak. • The animals are subject to **different selection pressures,** and the breed may develop in a new direction. They may **lose the characteristics** that make them of particular interest.

Ex-situ in-vitro conservation

***Ex-situ in-vitro* conservation (animal)**

This is a conservation method that **preserves various types of tissue** by cryoconservation.

Cryoconservation of animal genetic resources is a process that deep freezes semen, embryos, eggs or other types of tissue in liquid nitrogen.

Semen is **easiest to conserve** in this way, and frozen semen is often used in breeding programmes. **Embryos, oocytes** (immature eggs) and other types of tissue can also be stored.

Cryoconservation has major potential for conserving animal genetic resources, but so far it **has not been as widely used as *in-situ in-vivo***. However, this is changing.

An increasing number of countries now have national genebanks for their animal resources.

Recreating a breed from cryoconserved materials

Recreating a breed from cryoconserved materials is likely to be a long and costly process. It requires a sufficient quantity of cryopreserved material, and the ability to regenerate viable animals from it. With semen, the main way to reconstitute a breed is through backcrossing. To restore the "original" genotype of the lost breed, at least four to five generations of backcrossing will be required. Cryoconserved embryos conserve the animal's entire genome, allowing the breed to be reconstructed in a shorter time (less than 5 years). But embryos are significantly more difficult and expensive to collect. And embryo transfer is not possible in all species of livestock.

Cryoconservation of animal genetic resources:

www.fao.org/elearning/Course/SDG251-252/en/story_content/external_files/Cryoconservation%20of%20Animal%20Genetic%20Resources.pdf

Examples of *ex-situ in-vitro* conservation

Hungarian Grey Cattle were once commonly used for draught power and meat, but fell into decline due to mechanization and replacement by other breeds.

In the late 1960s fewer than 200 animals remained. Cryoconservation and other conservation efforts by the Hungarian Government have since restored their numbers back to above 10 000. Hungarian Grey Cattle are now mainly a tourist attraction in their native Hungary. The **Gaur**, or Indian Bison, is a tall, wild species of cattle found in South and Southeast Asia. Its population has fallen dramatically due to poaching, hunting, loss of habitat and disease. In India, cryoconservation is used to conserve this species.

***Ex-situ in-vitro* conservation**

Advantages	Disadvantages
• Deep frozen tissues can be **transported easily** and **stored for extended periods**. • Cryoconservation **prevents genetic drift** by literally freezing	• Collecting samples and maintaining a cryoconservation laboratory requires skills, resources and **a long-term commitment**. • Freezing the genetic information **prevents a breed from evolving** in response to a changing environment.

the genetic information in the breed, conserving it for the future.	• Recreating a breed from cryoconserved materials is **complicated, expensive and time-consuming**. • When reintroduced to their home environment, the **animals may be unable to cope** with the changed conditions there.

Which type of conservation method should you use?

Selecting the type of conservation method to use **depends on the particular breed and situation**. In general, *in-situ* conservation is a good approach and should be used if possible. *Ex-situ* methods (*in-vivo* and *in-vitro*) are an important backup, for example in the event of a disaster.

Julian: *"I wonder if I could use a combination of conservation methods? "*

Scientists recommend a **combined approach, using both *in-situ* and *ex-situ* methods,** to conserve breeds. For example, in Indonesia scientists used a combined approach to preserve Gembrong goats.

Combined approach: Conserving Gembrong goats in Indonesia

The **Gembrong** (hairy) goat is a long-haired breed native to Bali, Indonesia. Fishers used to use its hair as fishing lures, but have now switched to nylon line.

The numbers of Gembrong has declined, and now only a few dozen remain. Conservations efforts include supporting the only surviving herd, managed by a farmer in eastern Bali (***in situ***), starting small herds in two other locations (***ex situ in vivo***) and collecting and freezing semen (**cryoconservation**).

Plans also call for inseminating females of the Kacang (another local breed) with Gembrong semen, and then backcrossing to create a pure Gembrong line.

It is beneficial to compare conservation methods. The next page will **compare conservation methods,** showing how you can use a combined approach to conserve a breed.

Comparing Conservation Methods

Conservation Objectives:	***In-situ in-vivo (on farm)***	***Ex-situ in-vivo (in conservation centre)***	***Ex-situ in-vitro (cryoconservation)***
Flexibility of genetic systems			

Insurance against changes in production conditions	YES	YES	YES
Safeguard against diseases, disasters, etc.	NO	NO	YES
Opportunities for research	YES	YES	YES
Genetic factors			
Continued breed evolution / genetic adaptation	YES	POOR	NO
Increase knowledge of breed characteristics	YES	POOR	POOR
Limit exposure to genetic drift	Depends on population size	YES	YES
Sustainable utilization of rural areas			
Opportunities for rural development	YES	POOR	NO
Maintenance of agro-ecosystem diversity	YES	LIMITED	NO
Conservation of rural cultural diversity	YES	POOR	NO

Source: FAO (2013). In vivo conservation of animal genetic resources, www.fao.org/3/a-i3327e.pdf FAO Animal Production and Health Guidelines. No. 14. Rome. Table 1.

Summary

Animal genetic resources for food and agriculture cover both species that we use for food and in agriculture, and the breeds within each species.

A breed is either a type of animal that looks or behaves differently from others, or a type that is generally recognized as distinctive by the people who keep them.

It is important to maintain diverse animal genetic resources because they are critical for food production, the economy, the environment, and cultural reasons. However they are under threat for various reasons.

The three main ways to conserve animal genetic resources are *in situ in vivo* conservation, *ex situ in vivo* conservation, and *ex situ in vitro* conservation.

It is best to use a combination of conservation methods.