Icelandic Country Report on Farm Animal Genetic Resources

Icelandic Submission to the FAO
"First Report on the State of the World's Animal Genetic Resources"

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Overview

Introduction

The following report is prepared as Iceland's official submission to the FAO First Report on the state of the World's Animal Genetic Resources. The object of FAO's report is to assess the state of genetic resources in livestock on a worldwide basis and evaluate their development in light of the importance of livestock breeding for food production in the world. Moreover, the objective is to assess the ability of the countries to secure their livestock's genetic resources and analyse the need for actions to enable this, both domestically and through international co-operation.

The report is compiled by a task force assembled by the Ministry of Agriculture for the project early in the year 2003. The members of the task force were Emma Eythórsdóttir, member of the research and teaching staff at the Agricultural Research Institute and the Hvanneyri Agricultural University College, Jón Viðar Jónmundsson, National Advisor on cattle and sheep breeding in the Farmers' Association of Iceland, and Ólafur R. Dýrmundsson, National Advisor on livestock farming and land use in the Farmers' Association.

The approach used in the compilation of the report is based on the guidelines published by FAO concerning content and arrangement of material, and the report falls roughly into two parts. On the one hand, an account is given of Icelandic livestock farming, conditions, livestock species and populations, with the discussion covering mammals and avians. On the other hand, an attempt is made to evaluate the prospective trends in livestock farming in Iceland in the near future and how these trends will affect the state of Icelandic livestock and the genetic resources they represent. Finally, proposals are submitted concerning the policy and actions which are necessary to ensure the sustainable utilisation and conservation of genetic resources in Icelandic livestock.

Attached to the report is an Annex containing tables that FAO requires each country to fill out. The information in the tables is based on official statistics and data from the database of the Icelandic Farmers' Association, as well as direct information from knowledgeable parties in each case.

1 Agriculture and livestock production in Iceland

Iceland is just over 103 thousand square kilometres in area. The country is an island in the Atlantic Ocean, far from the continents. Iceland is located close to the Arctic circle. Its climate, however, is milder than might be expected from its geographic location owing to the mitigating influence of the Gulf Stream. Precipitation varies from region to region but is generally in the range of 500-1200 mm a year. Approximately a quarter of the country is less than 200 m above sea level.

The country is one of the most sparsely populated countries in the world. The population in 2001 was just over 286 thousand, i.e. less than three persons per square kilometre. Recent years have seen a fall in population growth, which currently stands at just over 1% per year. In recent decades there have been considerable changes in habitation patterns in Iceland, and only about 7% of the nation currently live in rural areas.

Vegetated land represents just over half of the total area of the country. A very small percentage of this is cultivated, or only approximately 1.3% of the total area of the island. It is estimated that man-years in agriculture numbered about 4,650 in the year 2000, which corresponds to 3.3% of the total number of man-years in Iceland that year.

The share of the agricultural sector in domestic production in 2000 is estimated at 4%. Agricultural production leans heavily towards livestock production and probably close to 90% of the agricultural production are livestock products.

1.1 Livestock production

Agriculture production is carried out in the low-lying areas on the coasts around the country. The largest continuous agricultural areas are in the south and central north. The production of livestock products is sufficient to meet the domestic demand for the products produced in Iceland. There is some exportation of sheep products (meat, woollen goods, fleeces/hides) and live horses and, in addition, almost all fox and mink pelts are exported. The smallholder family farm is the dominant form of agricultural operation in Iceland. Mixed farming with cattle, sheep, and often horses, was for a long time the most common form of operation, although in recent years there has been a rapid trend towards increased specialisation and more uniform farm production. Trends in the size of operations have varied significantly between different types of farming. Cattle farms have increased significantly in size in the recent past concurrently with a steady and substantial decline in the number of producers. In sheep farming there has also been a great decline in the number of producers and, at the same time, a substantial reduction in the number of sheep in the country. The size of sheep farms, therefore, has not changed to any great extent in the most recent past. Most pig and poultry farming, however, is conducted in large units.

All cattle and sheep farming in Iceland is intended for the production of food and, in addition, wool is produced as a sideline in sheep farming. Most of the production from these sectors is marketed through the processing centres of the farming sectors in question. The same applies to products from pigs and poultry. Almost all the skin production from fox and mink farms is exported. In recent decades horseback riding has become one of the most popular recreational

pursuits in Iceland, with most of the horse stock utilised in this manner, while horse meat production has become a sideline. Other livestock species in Iceland (goats, ducks, geese and rabbits) are minimal and the production negligible with no organised product sales network.

Direct payments pursuant to production agreements between the Farmer's Association and the Ministry of Agriculture form a substantial part of farmers' incomes in dairy and lamb production.

1.2 Production patterns and production trends

There have been very clear trends in the direction of larger and fewer farms in the dairy production sector in recent years. The number of cattle has declined considerably concurrently with substantial production increases in the recent past. Farm sizes are fairly uniform in this production sector, with the average farm size just under 30 dairy cows. Partitioned tie-stall cow sheds were the norm until recently, but almost all sheds built in the past few years have been cubicle sheds (US: free stall barns). Milk production in Iceland has been regulated by a quota system for the past fifteen years. The milk production quota over the last decade has been in the range of 103-106 million litres of milk, and the annual production has only slightly exceeded the quota each time. The greater part of beef production is carried out as a sideline to dairy production. Farms that specialise in beef production are extremely few. Milk production in Iceland in 2001, based on deliveries to the processing centres, was 106,131 thousand litres and processing centres took delivery of 3,683 tons of beef.

Forms of sheep farming vary considerably. Three to four decades ago the most common form of farm operation in Iceland was either mixed sheep and cattle farming or exclusive sheep farming. There was a substantial and steady increase in sheep production until the close of the seventies. An increasingly larger part of the production was exported. At this time a period of decline in the consumption of lamb began in Iceland and prices fell on overseas markets. A period of extensive recession began. Controls of production quantities were initiated through the use of quota systems. Approximately ten years ago the production linkage with the quota system was ended ("decoupling") and the market position of lamb has been extremely tight. The relative increase in the number of persons engaged in sheep farming as a part of other subsistence has been substantial in recent years. The size of operating units in the sector, therefore, has not changed much and is in any case very variable. Those who are still engaged in sheep farming as a primary occupation generally operate farms with 300-600 winter fed-sheep, while other sheep farmers keep flocks that vary greatly in size. The quantity of lamb delivered to processing centres was 8,616 tons in 2001 and the quantity of delivered wool (unwashed) was 942 tons.

Almost all production of pork, eggs and chicken is carried out in a small number of large and very technically advanced farms. In recent years these sectors have seen a substantial decline in the number of operating units and, at the same time, a considerable enlargement of those who remain. The domestic market for pork and chicken has grown very fast. The production of pork was 5,284 tons in 2001, while and the production of poultry was 3,801 tons. Egg production was 2,750 tons.

1.3 Operating and social environment

Most of the farms in Icelandic agriculture are privately owned. In the very recent past there has been a trend toward the establishment of private limited companies for farming operations, *inter alia* as a result of tax reforms.

The majority of agricultural processing centres have until recently been co-operatives, very often engaged in mixed operations. The trend has been toward larger operating units in this sector in recent years; in particular there has been a significant reduction in the number of slaughterhouses, and at the same time a marked trend towards limited liability company operation.

The overall association of farmers is the Icelandic Farmers' Association (Bændasamtök Íslands, BÍ). The basic components of the Association are district agricultural associations, divided by region, and sectoral producers' societies which operate in the country as a whole. Organised breeding programmes in all farming sectors are managed by the umbrella association (BÍ) which keeps performance records for the sectors in which such programmes exist.

1.4 Utilisation of genetic resources and the conservation of livestock genetic material.

Since 1994, Iceland has been a formal member of the Rio Convention of 1992. The convention addresses the maintenance and sustainable utilisation of living resources where the member states undertake to maintain genetic resources in both wild and cultivated species. Biological diversity is seen as a common resource. Moreover, emphasis is placed on the exclusive right of nations to their genetic resources and, consequently, their responsibility to protect them when necessary. Thus, the object of the Convention is to preserve genetic resources and promote their sustainable utilisation, so that they may continue to be utilised in the long term.

The Livestock Breeding Act of 1989 provided for the appointment of a Livestock Genetics Committee. According to the Act the Committee was responsible for recording the biological diversity of livestock, freshwater fish and wild land animals. The committee was furthermore required to submit proposals for conservation actions. When the Livestock Breeding Act was replaced by the Agriculture Act in 1998, the provisions concerning the Genetics Committee were incorporated with minor amendments. Provisions concerning wild land animals were deleted. The activities of the Committee have not been extensive, but it is allocated a budget pursuant to the Agriculture Act Agreement. Allocations to the committee pursuant to the Agriculture Act Agreement amounted to ISK 3 million in 2002. Recently (in March 2003), the Althingi approved an amendment to the Agriculture Act which provides for the replacement of the Livestock Genetics Committee by the Agriculture Genetics Committee. According to the Act the primary responsibilities of the Committee are:

- to assume responsibility for domestic consultation in the conservation of genetic resources in agriculture,
- to promote research in the field of genetic resources in agriculture,
- to promote the dissemination of knowledge of genetic resources and their value, both through education and through the dissemination of information to the public,
- to provide interested parties and the authorities with expert advice on the conservation and utilisation of genetic resources in agriculture,

- to assume responsibility for communications with foreign organisations in this field in co-operation with Iceland's contacts in international organisations.

The Committee's terms of reference extend to all domesticated species in agriculture (i.e. livestock, cultivated plants, forests and fresh water fish). Further provisions concerning the activities of the Committee will be established in a regulation.

1.5 Trend patterns in agricultural production and breeding

Trends in agriculture have been shaped by increased productivity. In most sectors this has led to larger and fewer farms. Sheep production and horse breeding are the exceptions. These sectors have to an increasing extent evolved as a production sideline with other occupational activities.

1.6 Globalisation

Owing to the strict provisions governing the importation of genetic material, Iceland has not been a participant in the globalisation which has characterised cattle breeding in various parts of the world for over a decade. However, breeding activities involving pigs, poultry and furred animals are primarily non-Icelandic activities, as the breeding stock in these sectors is regularly and frequently imported.

2 Livestock farming and genetic resources

The trends observed in many neighbouring countries may also be seen in Icelandic livestock. The handling of the animals has changed dramatically and they are systematically fed with a view to increasing productivity beyond previous norms. The production capacity of the animals has also increased greatly as a direct result of systematic breeding. Products from each animal have increased substantially in comparison with earlier times. At the same time, the production lifetime of the animals has become shorter. This trend is probably most visible in dairy cows.

2.1 Trends in livestock farming

Icelandic farming and livestock enjoy rather a special position in comparison with other countries. For each type of livestock in the country, there is usually only one breed. In the principal sectors (cattle, sheep and horses), these are native breeds whose roots can be traced back to the settlement of Iceland and who are believed to have been subject to extremely limited cross-breeding with foreign breeds. Through the centuries the livestock has been subjected to considerable hardships which have taken their toll. There are various indications, however, that at the same time the breeds underwent a certain degree of cleansing of genetic material as shown, among other things, by the low frequency of all sorts of disease genes in this livestock today. The same applies to the Icelandic goat stock, which is also a native breed. In pigs, poultry and furred animals, however, the production is principally based on breeds that have been imported to Iceland over the past two to three decades.

There is organised, ongoing breeding work in cattle, sheep and horse farming, as well as record keeping in goat farming, with the overall control at all times under the exclusive authority of BÍ. As there is only one breed within each species, independent breeding associations for individual breeds have never formed in Iceland, as is the norm in other countries. Livestock breeding programmes have been subject to special legislation, notably the Livestock Breeding Act which was replaced by the Agriculture Act in 1998. This legislation has defined various rules of procedure for these programmes. It has also provided for financial support from the government to the breeding programmes. Although this support may not be extensive in terms of cash, it has undoubtedly been crucial for the activities of these programmes. It has involved both support to breeding centres and for the maintenance of breeding records for individual species.

2.1.1 Cattle farming

Evolution of the stock

The origin of the Icelandic cattle breed can be traced back to the settlement period of Iceland. Research has shown that it is related to native breeds in Scandinavia. Records from the 18th and 19th centuries contain references to importation, but all indications point to the impact on the stock being very limited. A distinctive feature of Icelandic cattle in comparison with many other cattle breeds is that the breeding work has never placed any emphasis on appearance factors, such as colour. The colour diversity in the breed in this respect is therefore considerably wider than seen in other bred species. On the other hand, one of the goals of the breeding programme has been to reduce the number of horned animals which are currently only 3-4% of the animals, as compared to 20% half a century ago. Dairy cows in Iceland numbered

26,240 in 2001 and the total number of cattle was approximately 70 thousand. The average yield of registered cows was 5,006 kg of milk in 2002.

In the 1930s there were plans to conduct experiments with animals belonging to meat breeds for monohybrid breeding. The tests were never carried out owing to diseases, although a Galloway bull calf was used and a stock of cross-breeds was formed on the basis of his descendants. Sperm from Galloway bulls was subsequently imported to Iceland in the 70s. Bulls of this breed have since been used for monohybrid breeding. In the 90s Aberdeen Angus and Limousin cattle were added through the importation of embryos, and these have been used in monohybrid breeding. In the past few years the use of semen from beef cattle breeds for monohybrid breeding has declined sharply owing to the more rapid renewal in the cattle stock than before.

Conduct of breeding programmes

Organised breeding programmes in cattle breeding began early in the 20th century. Cattle breeding associations were established across the country. Their role was twofold. They took responsibility for pedigree and product accounting for the stock and for jointly owned bulls in their membership area. Overall management of product record keeping has from the beginning been under the auspices of BÍ. Around the middle of the last century, supervision of the conduct of record keeping was transferred for the most part from cattle breeding associations to district agricultural associations, which by that time were operating across the country. Shortly after 1970 the records processing was transferred to electronic form. The cattle breeding databank contains a great deal of information on the traits of the Icelandic cattle stock. These include product information, the pedigree and origin of the cattle, and the recorded results of cattle inspections and also all artificial inseminations (AI) for cattle. Approximately 85% of the milk production in Iceland takes place on farms that keep product accounts.

Obligatory tag-marking of cattle will take effect in 2003. As a result, all cattle in Iceland will be registered in the cattle breeding databank. At the same time, a harmonised registration of diseases will be adopted, which has not been done before.

Cattle AI began in Iceland just before the middle of the last century. When the use of deep frozen semen was adopted around 1970, the use of AI became common throughout the country. AI is used on the majority of cattle farms in Iceland, although it is also quite common to use home bulls to breed heifers; it is probably safe to say that AI is used for approximately 80% of cows and heifers in Iceland. One bull centre is operated and serves the entire country.

From the time that AI operations became centralised for the whole country, the breeding programmes in cattle farming have been operated as a single unit. The programme aims at breeding with regard to a number of traits. Although products play the most important role, fertility, lifetime, udder health, udder and teat type, milking and temper are all aspects of the breeding aims of the stock. Care has always been taken to minimise inbreeding increases in the stock and this has been successful in comparison with larger cattle breeds in many neighbouring countries. Approximately 20 bulls are progeny tested each year. Breeding assessments are carried out in accordance with BLUP methods. This means, *i.a.,* that it is even more important than before to closely monitor inbreeding trends in the stock.

There is no joint record-keeping for the very few beef producing herds. There are no organised breeding programmes aimed at beef producing traits. The only available option is semen from beef cattle breeds for monohybrid breeding.

2.1.2 Sheep farming

Evolution of the stock

As in the case of other livestock species that have a long history in the country, the Icelandic sheep stock can be traced back to the settlement period. It is one of the sheep breeds that belong to the north European short-tailed sheep and therefore of a similar origin as native breeds in Scandinavia. The size of the stock has fluctuated tremendously in recorded history and this has no doubt had an impact on the stock. The 19th century and the early 20th century represent a continuous and dismal history of experimentation in importing foreign sheep breeds for breeding purposes or for the restoration of sheep farming in Iceland. These imports brought with them, more often than not, diseases that were previously unknown in Icelandic sheep. The Icelandic sheep often appeared to have little resistance to these diseases so the consequences were sometimes dire. The effects of this importation produced considerable fluctuations in stock populations and the fight against some of these diseases involved systematic culling in the course of organised restocking in large areas of the country. The most widespread sheep restocking operations took pace in the middle of the last century when sheep were culled and restocked in more than half of Iceland. The result of all this was a special sheep genetic pool in the country, created in many of the restocked areas. The impact of the infusion of foreign sheep breeds on the Icelandic sheep was, on the other hand, virtually non-existent.

Following the sheep restocking, the country has been divided into approximately 30 defensive zones and transportation of live sheep between zones is generally prohibited. Within the compartments there are also extensive restrictions on transporting live sheep between farms. This has had the effect of making AI a more important aspect of the distribution of genetic material within the stock than in most other sheep breeds in the world. The breeding work has placed limited emphasis on appearance traits, such as colour and horns, so the Icelandic sheep stock shows a greater range of such traits than many other breeds. The sheep stock in Iceland numbered a total of 473,535 winter-fed sheep in 2001; of these, 377 thousand were mature ewes.

Temporary breeding lines have appeared within the breed. Of particular note are leader-sheep, which is a particularly noteworthy line within the stock. These sheep have long been known for their special leadership characteristics, an unusual ability to find their way and greater intelligence than other sheep. Cross-breeding of leader-sheep and other sheep clearly shows that these traits seem to be completely dependent on heredity. These sheep may be found in flocks all around the country, usually one or extremely few individuals in each flock. The total number of leader-sheep in Iceland is slightly over one thousand. There are no comparable sheep anywhere else in the world.

Development of breeding programmes

Organised breeding programmes have long been in existence in sheep farming in Iceland and have, in many ways, been a model for other countries in setting up breeding programmes. The aim of the breeding programmes has always been to combine positive features in the stock with regard to all important traits. This has led to breeding objectives in the stock being very wide in scope. The primary emphasis, however, has been on traits relating to the production of lamb, i.e. fertility, conformation, growth capacity and the milk production of the ewes. Emphasis on wool traits has been much more variable. Pelt production was also, for a time, an important aspect.

Organised breeding programmes began early in the 20th century when harmonised judging of mature rams was introduced at ram shows. Judgement of live sheep has always been an important aspect of the implementation of the breeding programme. In recent years these judgements have almost exclusively been directed at lambs rather than mature sheep, as was previously the case. The use of ultrasonic scanning to measure the muscle thickness of live lambs, which began approximately ten years ago, has had a substantial impact on the development of the breeding programmes in recent years.

Organised keeping of performance records began in Iceland just before 1940 and by the middle of the century its scope was already substantial. A great deal of information on the stock is included in the records, which include records of animal pedigrees and also a registry of a large number of production aspects. In recent years, the participation of sheep farmers in record keeping has increased substantially and approximately 60% of the country's entire stock is currently registered in this manner. In 2001 the average produce from registered stock was 26.5 kg of lamb carcass. A breeding assessment is prepared for registered sheep and these results are extensively used in selecting sheep.

Sheep AI in Iceland began around the time that performance records started to be kept. Initially it was primarily seen as a part of the fight against sheep diseases (the distribution of individual sheep that showed high resistance to diseases). After the country was divided into defensive zones, following the sheep restocking around the middle of the century, AI became an extremely important tool in distributing genetic material between zones. It has subsequently become a more and more important aspect of breeding programmes. The scope of AI has increased dramatically in recent years with 25-30 thousand ewes currently being inseminated annually and over 40 rams being used at the stations at each time. The selection of donor rams has changed somewhat in recent years. They are younger than they used to be and the selection is rather more uniform with respect to meat quality traits than previously.

2.1.3 Horse farming

Evolution of the stock

The origin of the Icelandic horse can be traced through breed research to the original home of the Icelandic settlers, as is the case with the cattle, sheep and goats (Norway and Scotland). There are almost no references to cross-breeding with other horse breeds from that time. For centuries the horse was the primary means of transport in Iceland. The harsh weather conditions have without a doubt substantially shaped the stock. During the early part of the last century horses were the primary draught animals in Iceland and they were bred as such. With industrialisation in agriculture in the 50s this role ended and the number of horses in Iceland decreased considerably. From the mid 20th century the Icelandic horse has filled the role of riding horse. Equestrianism has become one of the most popular recreational activities among urban dwellers. The number of horses has therefore increased substantially in recent decades and a growing number can be found in urban areas, although the majority of the active breeding stock remains in rural areas.

A special trait of the Icelandic horse, as in the cattle and sheep, is its diversity of colour. Also, the Icelandic horse has five gaits. In recent decades the popularity of the Icelandic horse has increased steadily in various parts of the world and the export of riding horses has become an industry. The number of horses in Iceland in 2001 was 73,812, with 40,000 foals born annually, although the number of born foals has been falling.

Development of breeding programmes
Organised breeding programmes began in Iceland early in the last century when harmonised horse shows were established. During the early part of the century the horse was valued more as a draught animal than as a riding horse. From the mid 20th century the Icelandic horse has only been valued as a riding horse.

Shows and harmonised judging of horses have always been the most important aspect of the implementation of the breeding programme. The horse has been assessed as an all-round riding horse. The eighties saw work being carried out on organised record keeping of the horses in Iceland and this has become extremely widespread with approximately 90% of breeding stock horses in Iceland currently registered. An international recording system has been established (WORLDFENGUR) for the Icelandic horse, and is used to register Icelandic horses all over the world.

A harmonised breeding assessment was established almost two decades ago. In this respect Iceland has taken the lead internationally. Breeding objectives are both general and specific and it would be hard to find another livestock species where as much emphasis is placed on preserving genetic diversity for certain traits. Artificial insemination and embryo transfers have been used to a small extent in the most recent past but have as yet had little effect on the implementation of breeding programmes. Breeders' associations have existed for a long time in some areas (horse breeding associations), and have been responsible for the joint maintenance of stallions, which has had a substantial impact on the implementation of the breeding programmes.

2.1.4 Pig farming

Evolution of the stock
The pig stock which came to Iceland with the original settlers became extinct in the 16th century. The stock referred to as the Icelandic pig originated in importation which took place around 1900 and until some time after1920. Pigs belonging to the native Danish Landrace breed and the British breeds, Large Yorkshire and Berkshire were the principal breeds imported. There are some traces of Duroc and Hampshire traits and it has been maintained that illegally imported semen was crossbred into the stock.

There has been a substantial increase in pork production in Iceland over the past two decades. In 1994 the importation of Norwegian pigs intended for systematic crossbreeding was begun. Since then there have been repeated imports of other pig breeds, mostly from Norway and also from Finland. Cross-breeding with these imported pigs has been extensive and it is doubtful whether there are any purebred animals of the older stock anywhere in Iceland. At the same time, pig farms have been enlarged considerably and have decreased in number. The breeding is organised as a three-stock cross breed with a paternal line and a crossbred maternal line. The number of mature pigs in Iceland was estimated at 4,561 in 2001.

Development of breeding programmes
Almost no organised breeding programmes have been operated in Iceland. Record keeping for the sector was established approximately a decade ago. AI has also been used to some extent during the past decade. Genetic material in the production is based on regular importation of overseas breeds which are used in systematic cross breeding, as is the case in other countries and therefore there are no independent domestic breeding programmes.

2.1.5 Poultry farming

The production of eggs and chicken over the past decades has been shaped entirely by the needs relating to these products on the domestic market. There have been no major changes in egg consumption in recent years, but almost all the production has concentrated in the hands of a very small number of very large and highly specialised farms. The increase in the consumption of chicken has been substantial in recent years. This sector of farming is almost entirely operated in large units. Laying hens were estimated to be 128,241 in 2001 and broiler chickens were 28,733. There is no organised breeding programme in place in this sector of farming, although eggs from improved breeding lines are regularly imported for hatching, and production birds are produced in hatcheries for the farms involved in the production.

There exists in Iceland a breed of Icelandic chickens that can be traced back to protection measures started in 1974 on the initiative of the Agricultural Research Institute. These chickens can be found in various places around the country as domestic chickens in small units and have almost no significance for egg production in the country. The appearance traits of these chickens are as rich in diversity as in other domestic livestock. No reliable figures for the population level are available, although it is estimated that the population is between two and three thousand birds.

2.1.6 Farming of fur-bearing animals

The farming of fur-bearing animals in Iceland has been characterised by extreme fluctuations during the 20th century. During the depression of the 1930s minks were imported to Iceland, and at the same time fox pelt production was established. This type of farming completely disappeared just after the middle of the century.

Around 1970 the farming of fur-bearing animals began again and was based on the importation of both mink and fox. Development in this farming sector was extremely rapid owing, among other things, to the fact that there was political support for this type of farming to patch up the gaps that were forming in many places at this time owing to the decline in sheep farming. The operating environment of this branch of farming has proven unstable, although there has been some stability in recent years following a substantial reduction in the number of producers. All of the production is exported. The sector depends upon the regular importation of breeding stock. The farms conduct selection on the basis of judgements of the animals and pedigree information. Record keeping is currently widespread among producers. The mink population was 34,899 and the fox population 4,027 in 2001.

2.1.7 Goat breeding

Evolution of the stock

The Icelandic goat stock is believed to be pure back to the time of settlement. The stock is distributed around the country in small flocks and inbreeding is high. A stock protection grant from the State Treasury has been paid to goat owners for each winter-fed recorded goat since 1965. The number of goats in Iceland was estimated at 372 in 2001.

Actual breeding programmes are minimal in the stock. Records on the goats are maintained so that comprehensive information on relationship is available. Goats are subject to the same rules as sheep concerning the division of the country into defensive zones to combat the spread of disease and their transport between zones is prohibited. Inbreeding is significant in the stock,

which is a result, *inter alia*, of its division into small units with little or no contact between them. It is difficult to prevent further increases in inbreeding owing to restrictions on the transportation of animals between zones. Only one experiment has been made with AI, and experience of AI is therefore very limited.

2.1.8 Other farmed animals

There are no stocks of farmed animals, other than those already mentioned, which have a measurable significance for agricultural production in Iceland. It is quite common for ducks and geese to be kept in small flocks for home use. Information on the origin of these birds and the scope of this type of farming is very fragmented. There is one flock of turkeys for meat production consisting entirely of imported birds. Rabbits have quite often been imported to Iceland and can be found in many places in small groups. Rabbits have been imported for three reasons, as meat rabbits, as rabbits for the production of angora hair and, finally, as fur rabbits. The rabbit population was estimated at 791 in 2001. None of these forms of farming has become established as permanent enterprises in Iceland.

2.1.9 Protective measures for Icelandic livestock

The first protective measures for Icelandic livestock were taken in 1965, when provisions on the protection of the goat stock in Iceland were introduced into the Livestock Breeding Act. Since that time, goat owners have received a state grant for registered reared goats. They hand in records on their goat stock to the Farmers Association, which is responsible for all procedure in this regard. At the same time provisions on the protection of leader-sheep were introduced into the Livestock Breeding Act. No public funds have been provided for such protection. Sheep AI centres have assisted the owners of such sheep by making leader-rams available at all times.

When the centre for deep-frozen bull semen began operating in 1969, the decision was made to establish a gene bank which would preserve 30 sperm doses from each bull used at the centre and this has been done ever since.

The Agricultural Research Institute began collecting birds from the old chicken stock in 1974. The conservation was in the hands of the Agricultural Research Institute to begin with but was transferred to the Hvanneyri Agricultural College in 1985 and subsequently to individuals who have undertaken to maintain the stock and to sell chicks.

2.2 Results of breeding programmes

Domestic breeding programmes for cattle, sheep and horses are based on a well organised breeding programme of one breed for each species. There is no cross-breeding with other breeds. The breeding programmes of all these species are organised on an NGO basis. The programmes have been shaped by legislation and have enjoyed public funding to a certain degree. The implementation, therefore, has benefitted from good co-operation between farmers and the authorities, as all management has been in the hands of farmers' associations.

The effectiveness of the breeding programmes in all these sectors is unmistakable. In cattle farming, livestock with greater productivity has led to a substantial reduction in the number of animals in production in recent years and this has been accompanied by a substantial reduction

in the number of producers. Comparable changes in livestock numbers have not occurred in sheep farming, as this sector has shown a clear tendency to become a sideline with other work. As regards horses, the effectiveness of the breeding programmes is shown very clearly by the completely dominant position of horses born in Iceland in international comparisons of the Icelandic horse. The breeding programmes in this field have been an invaluable part of securing the market position for the exportation of Icelandic horses. Therefore it is clear that organised breeding programmes have, in these farming sectors, played an important part in increasing production efficiency and, as a result, the competitive position of the sector in question.

As regards pigs, poultry and fur-bearing animals, the breeding is based on regular importation of genetic material. The obvious effectiveness of these activities is unmistakable.

There are no organised breeding programmes in place for the production of other farmed animals in Iceland. Organised conservation operations for goats, in the form of direct grants, have been in place for decades and returned the desired results.

2.3 Production systems and livestock

Unlike some other countries, there are no examples in Icelandic livestock production of government decisions on production influencing the selection of animals for production. Rules have been set for minimum environmental requirements and conditions for animals in all livestock species. Adaptation to these rules has taken place without particular effect on production.

Organic livestock farming is minimal in Iceland and there is little indication of any major changes in the near future. These production methods do not enjoy conversion support in Iceland as they do, for instance, in the other Nordic countries.

The production agreement currently in effect between the Farmer's Association and the Ministry of Agriculture regarding sheep production provides for the adoption of quality control in the production in the next few years. The quality control requires a structured description of production processes on individual farms, traceability of the products and sustainable utilisation of pastures.

2.3.1 Feed production

Roughage is the basic feed given to Icelandic grazing animals, although the use of compound feed in the dairy industry has increased in recent years. The processing of roughage has changed considerably over the past two decades. During the course of this period the use of round bales has become the norm in processing roughage, a form of processing that was unknown in this country two decades ago. The quality of the roughage has improved considerably over the same period, both because of change in the processing methods used and the timing of harvesting. Moreover, diversity in the selection of roughage and the utilisation of green fodder has also increased in recent years.

Pasturage is of great importance as source of food for Icelandic livestock, which for the most part consists of grazing animals. In comparison with other countries, Iceland occupies a

somewhat special position in the utilisation of common pastures, both in the lowlands and in the highlands, particularly for sheep and horses.

Most of the raw materials needed for compound feed is imported. Iceland uses greater quantities of fish meal as protein feed in the production of compound feed than other countries do. During recent years there has been a great increase in the cultivation of barley, which was produced in negligible quantities just two decades ago. Most of the barley is used as feed for dairy cows although some is used as pig feed.

2.3.2 Environmental impact of agricultural production

Icelandic agricultural production is so widely dispersed that the polluting effects derived from agricultural production, which are a problem in other countries, are almost unknown in Iceland. However, there are many aspects of the trends in the past few years which indicate that this issue must be given more attention in coming years, particularly in intensive farming.

Land use issues, however, have long been a bone of contention. Over-grazing resulting from too heavy grazing in certain areas over the past three decades has been the subject of much public discussion in connection with farming. Such problems appeared when the sheep population was at its greatest approximately two decades ago, although the subsequent substantial decrease in numbers has eliminated this problem in many places. At the same time, grazing pressure from horses has increased substantially and localised problems in the lowlands are fairly common.

2.3.3 Livestock health

Livestock health in Iceland is generally good. Owing to the isolation and the geographical location of the country there are much fewer livestock diseases known in Iceland than in the countries on the continents. There are indications that this isolation has at the same time caused domestic livestock to be less resistant to destructive diseases which have not been found in the country. Experience has shown, more often than not, that diseases which are not considered serious in the land of origin of imported animals have posed serious problems for Icelandic livestock. Some of these have had a lasting effect on the development of the stocks in question and the cost to society in eliminating them has been considerable.

For these reasons it has been necessary to maintain strict legal conditions concerning the importation of animals, with all importation of animals being subject to the recommendations of the Chief Veterinary Officer and a permit from the Minister of Agriculture. The same views are reflected in rules governing the import of foodstuffs which may be animal disease carriers. Iceland's procedures in this respect are in compliance with the WTO agreement on Sanitary and Phytosanitary Measures (SPS-Agreement).

Livestock health-care in Iceland is good and is managed by a strong and active veterinary service. Organised supervision of food production, both dairy and meat, has ensured good food safety. Such supervision will be strengthened even further with the implementation of a regulation providing for individual identification in 2003. At the same time, a harmonised registration of livestock diseases in Iceland will be implemented.

3 Legal and institutional environment of the livestock production – Knowledge and competence

3.1 Government authorities and NGOs

3.1.1 Public institutions

The National Parliament (*Althingi*) is the legislative branch of government in Iceland, and all of Icelandic agriculture is shaped to a large degree by a wide range of legislative instruments. The Ministry of Agriculture is responsible for the supervision of agricultural matters and is responsible for a number of institutions which are, directly or indirectly, involved in the livestock breeding programmes and livestock production in Iceland. The office of the Chief Veterinary Officer is responsible for monitoring livestock diseases in Iceland and is also involved in the supervision of foodstuffs. The Icelandic Institute of Natural History is responsible for the implementation and follow-up of the Convention on Biological Diversity.

3.1.2 Farmers' associations

The Farmers Association of Iceland (Bændasamtök Íslands, BÍ) is an umbrella association for Icelandic farmers' organisations. According to the Agriculture Act, BÍ is entrusted with the overall supervision of livestock breeding programmes and is furthermore responsible for their implementation to a substantial degree. All harmonised record keeping of livestock performance in Iceland is handled by BÍ, which also operates a common bull centre for the country.

The sectoral producers' societies are independent farmers' associations within each sector of agriculture and are at the same time all members of the umbrella association (Bændasamtök Íslands, BÍ). The responsibility for a growing number of issues concerning individual farming sectors has in recent years been taken over by the sectional producers' societies. Individual sectoral producers' societies are the implementing body of livestock breeding programmes to a greater or lesser extent. Thus, the importation of embryos from beef cattle breeds is handled by the Icelandic Dairy and Beef Farmers' Association (Landssamband kúabænda, LK) which operates a quarantine centre for such purposes. The Icelandic Pig-Breeding Association (Svínaræktafélag Íslands) has been responsible for the importation of pigs, the development of organised cross-breeding programmes, the operation of quarantine facilities and AI services in the sector. Similarly, the Union of Egg Producers (Félag eggjaframleiðenda) and the Union of Icelandic Chicken-Farmers (Félag kjúklingabænda) have been responsible for the importation eggs and hatching and the increase in numbers of birds in the quarantine centre at Hvanneyri for the production of breeding lines of both egg-layers and broilers. The Icelandic Fur Breeders' Association (Samband íslenskra loðdýrabænda, SÍL) has handled the importation of breeding animals, both fox and mink.

The district agricultural associations are joint associations of farmers in particular areas. They are all members of the umbrella association (BÍ). They all maintain vigorous programmes of training and education and are involved in the implementation of breeding programmes in various ways. The implementation of cattle AI services is entirely in their hands. Sheep AI centres are operated by individual district agricultural associations or by co-operating associations. The horse breeding associations generally operate within the district agricultural

associations and have been extremely active in implementing breeding programmes in many areas within their sector.

3.1.3 NGOs

In recent years a few organisations have been established with the principal aim of protecting and conserving specific livestock breeds, populations or traits. The operation of these organisations has been very limited and has had little impact on the conduct of the breeding programmes in the farming sectors in question. The organisations in question are the following:

Icelandic Goat Breeders' Society
The Icelandic Leader-Sheep Society
Litfari, a society to support and conserve the roan colour of the Icelandic horse.
Búkolla, a society for the conservation of the native Icelandic cattle breed.

3.2 Knowledge

3.2.1 Education

The professional education of farmers is conducted in agricultural schools. There are three agricultural schools in the country at college and university levels, one of which specialises in horticulture. The schools operate in different fields, with one college specialising in education for the traditional farming sectors (including livestock farming). The number of students graduating from basic agricultural studies has ranged between 18 and 28 in recent years. In 2000, 34% of working cattle farmers possessed an agricultural education. Professional material relating to knowledge of sustainable breeding programmes for livestock and the value of conserving genetic diversity is not very prominent in the curriculum of general educational institutions in Iceland. Agricultural studies, however, include some education in such matters.

The Hvanneyri Agricultural University (Landbúnaðarháskólinn á Hvanneyri, LBH) offers agricultural education at the university level. The university has, for decades, offered a three-year B.Sc. programme in agricultural production and recently a four-year formal post-graduate programme was added. M.Sc. programmes are organised in co-operation with foreign or other Icelandic universities. Normally, 7-8 students will complete a B.Sc. degree each year in agricultural sciences from LBH. It has always been common for students to seek higher education in agriculture outside Iceland. Students have obtained their higher education in various countries, with the result that there is quite a broad base of knowledge in this field in Iceland. This situation has also led to good contacts between researchers in Iceland and foreign professionals, which is important for the secure flow of new ideas and knowledge to the country, which in turn serves as the driving force of progress in each sector.

LBH operates a continuous education department for farmers and consultants. A large number of seminars on various subjects concerning farming and farm operation are held annually by the department.

3.2.2 Research

Research on livestock is conducted mainly by the Agricultural Research Institute (Rannsóknarstofnun landbúnaðarins, RALA) and the LBH, with the institutions engaged in formal co-operation in policymaking. The Hólaskóli Agricultural College, which specialises in

horse breeding, is also involved in equine research, and research on livestock diseases is conducted at the Keldur Institute for Experimental Pathology of the University of Iceland.

Research has been focused largely on the feeding and breeding of sheep and cattle in Icelandic conditions, and research in the field of the genetics and breeding of Icelandic sheep is widely known outside Iceland. Also, research into sheep diseases in Iceland has attracted international attention. In recent years research has been done on the genetic diversity and the conservation value of cattle and sheep breeds in the Nordic countries under the auspices of the Nordic Gene Bank for Farm Animals (NGH) with the participation of Iceland.

3.2.3 Advisory services

Agricultural extension services are for the most part in the hands of BÍ on the national level, while the various activities in rural areas are largely in the hands of district agricultural associations. As revealed earlier, the implementation of the livestock breeding programmes is largely the responsibility of these same parties, with the result that the harmonisation of implementation and advisory service in the breeding programmes is better established than in many other countries.

3.3 Dissemination of information

The Farmers' Association of Iceland publishes the Farmers' News (*Bændablaðið* – a bi-weekly magazine), which includes news and professional material on agriculture. *Freyr* is a periodical for professional farmers, published monthly and featuring educational material and articles. RALA and LBH issue reports on their research results and a scientific journal (*Búvísindi-Icelandic Agricultural Sciences*) on agriculture and related matters is published in co-operation with other institutions. Information is also disseminated on the web sites of these organisations, which, among other things, feature collections of articles and all relevant information concerning the results of studies and the effectiveness of the livestock breeding programmes. Posters with photographs of Icelandic livestock emphasising the diversity of colours have been published by BÍ and other organisations. Also, there is substantial dissemination of information to farmers and the public at meetings where professionals in the field of agriculture give talks.

3.4 Capacity to secure livestock genetic resources.

In general, the state of knowledge and capability in livestock breeding in Iceland is good, as revealed above. However, there is reason to emphasise still further the importance of conservation and sustainable utilisation of livestock in educational material, both in organised agricultural studies and seminars connected with agriculture. One of the functions of the new Agriculture Genetics Committee will be to engage in the dissemination of knowledge of the value of genetic resources, both through education and through public information.

4 International Co-operation

4.1 Nordic Co-operation

The Nordic Council of Ministers (NMR), established in 1971, serves as a forum for co-operation between Nordic ministers on an intergovernmental basis. The Council of Ministers published in 2001 its "Strategy for the Conservation of Genetic Resources in the Nordic Region 2001 – 2004" (*Strategi för bevarande av genetiska resurser i Norden 2001 – 2004*), which describes the Council's strategic plan concerning the conservation of genetic resources in agriculture in the Nordic countries. The declaration covers all genetic resources in livestock, cultivated plant species and forests. The idea is to engage in visible activities in Nordic co-operation with regard to conservation and the sustainable utilisation of genetic resources, which can be referred to the course of political discourse. In the wake of this strategic planning, a Nordic co-operative council on genetic resources was established (*Nordisk Genresursråd*), composed of representatives from the Nordic Agricultural and Environmental Ministries. The role of the council is to provide the Council of Ministers with professional advice concerning this issue.

Nordic Gene Bank for Farm Animals (NGH)

The Nordic Gene Bank for Farm Animals (*Nordisk Genbank Husdyr*) was established in 1984 by the Council of Nordic Ministers. The NGH operates as a forum for Nordic co-operation and is not defined as a Nordic institution, unlike the Nordic Gene Bank for plants. The role of the NGH is to maintain a record of livestock breeds in the Nordic countries and serve as source of information on the genetic diversity of livestock in these countries. The NGH is intended to promote research and the pursuit of knowledge concerning the genetic base of livestock in the Nordic countries, develop effective conservation measures and promote sustainable breeding programmes. In recent years the activities of NGH have expanded and received increased attention as a result of its work programmes. Funding for the operation has at the same time increased substantially.

During the initial years of operation, attention was primarily focused on conservation measures, as various small breeds found in these countries were considered to be in danger of extinction. In the two most recent work programmes, emphasis has been placed on the actively producing livestock in the countries. The points of emphasis are the following:

- Increased education concerning the value of sustainable development and conservation of livestock genetic material.
- Promotion of collaboration projects between research institutions, breeding associations and government agencies which promote the sustainable utilisation and conservation of genetic resources.
- Engaging in research and development activities in this field.
- Promotion of awareness and understanding among politicians to allocate funds to the conservation of livestock genetic material.

Co-operation with the Baltic countries has been increased, both in the field of research and in organising conferences on this issue.

4.2 FAO

Like a large number of other countries, Iceland takes part in the recording of information on national livestock into the FAO databank, DAD-IS. There is regular interaction with the activities of FAO in the field of livestock genetic resources and the national co-ordinator for Iceland attends meetings with the national co-ordinators of other European countries whenever possible.

4.3 EAAP

Iceland is party to the activities carried out by the European Association for Animal Production (EAAP). This association has from the beginning been very active in the discussion of the conservation of genetic material and has for a long time maintained a joint database, located in Hannover, of livestock breeds in Europe.

4.4 Need for foreign co-operation in the future

Iceland has participated actively in Nordic agricultural co-operation from the beginning and will without a doubt continue such co-operation, particularly through participation in the activities of NGH. The activities of NGH have in many ways been groundbreaking in international co-operation in the field of livestock genetic resources, and meshed well with the activities of FAO. It is extremely important to continue to maintain good relations with FAO.

International co-operation is very important for the conservation and sustainable utilisation of genetic resources in Iceland, particularly in the research required to improve assessment of the traits and special characteristics of Icelandic livestock breeds. Moreover, it is natural to maintain relations with parties who breed Icelandic livestock overseas in light of the common interest in the conservation and maintenance of the stocks.

5 Assessment of past and future trends in livestock breeding and the need for genetic material

In this chapter an attempt is made to point out some aspects which could have an impact on the development of livestock production in Iceland in the coming years. This is examined in particular with regard to whether changes in the production environment will result in changed requirements for genetic traits in livestock in the country.

The development of Icelandic livestock breeds is closely linked to the country's history. For centuries, Icelandic livestock was the principal source of food and clothing for the inhabitants, as well as playing a role as draught animals and means of transport. In recent years, most of the livestock farming in Iceland has been for food production, in addition to wool and hide production. Almost the only exception is the growing role of the horse in connection with recreational pursuits and leisure. There are few indications that livestock farming in Iceland in the near future will be pursued for purposes other than food production.

State aid to Icelandic livestock production is among the highest of the OECD countries, both as regards market protection and domestic support. Direct payments in dairy and lamb production have a decisive effect on operating conditions in these production sectors. International agreements, particularly those involving the World Trade Organisation (WTO), are likely to have an increasing impact on the operating environment of Icelandic agriculture in the future. A new round of negotiations is currently underway within the WTO which seems to be heading in the direction of placing on the shoulders of the parties to the agreement still further commitments regarding increased market access and decoupling. The way in which these challenges are met will have a significant bearing on the operating environment of agriculture. It is important, in this context, for the results of any prospective negotiations within the WTO to take extensive account of issues which are not of a purely commercial nature and pay some heed to the complex role of agriculture. Moreover, it is possible that future support to the agricultural sector may to some extent take account of the conservation of unique livestock breeds.

The consumer demand for cheaper domestic products, have been prominent in recent years and this pressure may be expected to continue in the near future. Considerable success has been achieved in the direction of more efficient production of livestock products and this has resulted in lower food prices in recent years; there are still unused opportunities in this area.

If the overall trend regarding the market issues of livestock products were to prove adverse for Icelandic livestock producers the consequences could be a rapid decline in livestock production. It is also possible that requests for more efficient production could lead to the Icelandic livestock being unable to maintain its position as production breeds owing to the importation of other higher performance livestock breeds. The importation of foreign cattle breeds, a subject of discussion in recent years, would completely change the position of the Icelandic cattle stock and its breeding in the future. Altered conditions of this sort would lead to a need for organised protection for Icelandic livestock breeds which are currently sustainable.

The principal market opportunities for Icelandic livestock products in overseas markets are based on the purity and quality of the products. Here, external conditions are in many respects positive. The state of livestock diseases is positive in comparison with other countries. The open spaces and extensive production methods in Iceland make problems connected with pollution from livestock production seem remote in comparison with many neighbouring countries. In most farming sectors systematic work is in progress on establishing production quality systems intended to promote positive trends in these matters. Clearly, therefore, the ability to maintain and strengthen the positive image of the quality and purity of the products is very important for livestock production.

Livestock breeding for purposes other than food production primarily involves horse breeding. It is probable that equestrianism in Iceland will in the next few years continue to strengthen as regards professionalism. The Icelandic horse plays a growing role in the increase of tourism in Iceland. At the same time it is important to continue to maintain strong efforts in horse breeding so that Icelandic breeding continues to play a leading role in the breeding of Icelandic horses. Not only does Iceland have a duty in this respect, as the country of origin of the Icelandic horse, but it is also a key issue that horses from Iceland should continue to be the source of progress in breeding activities in other countries.

There could be favourable conditions for the strengthening of furred animal farming in Iceland. If so, such farming would in any case be based on imported genetic material and will not, therefore, be discussed further here. It is difficult to see that the changed points of emphasis and changed use of livestock which may be observed and which is discussed in other countries will have any significant impact on trends in Iceland in the coming years.

The development of speciality products based on the uniqueness of livestock breeds does not have the same possibilities in Iceland as in other countries where there are many breeds within each species. However, there may be possibilities, both in the special position of the Icelandic breeds, as discussed later, and the development of speciality goods linked to localised production and, e.g., tourism in rural areas. The regulatory infrastructure of the food sector has not, however, taken account of these production methods as yet.

In many neighbouring countries livestock production under the banner of organic farming has been growing rapidly. No comparable developments have occurred in this country. There are many indications that there is not a comparable market for organic livestock products in Iceland, perhaps because of the positive image that livestock faming has in Iceland in general and because it is so close, in most cases, to meeting the criteria for organic products. The division of the market under such circumstances could also have negative aspects, but in any case this trend will primarily be driven by consumer demand.

Livestock farming for household use, mainly sheep, was very common in urban areas in many parts of the country well into the last century but has for the most part disappeared, with no signs of any impending return to such practices. Experience shows that such livestock farming, however, is particularly well suited for the maintenance of livestock diversity, and smallholders are often active in direct conservation activities. Many owners of Icelandic goats and chickens are good examples of this.

Generally speaking, it may be assumed that the issues dealt with here will not result in any changed demands regarding livestock breeds in the nearest future.

It is worth consideration whether the uniqueness and smallness of the domestic livestock could, in the future, become a source of genetic resources. In light of their singular breeding history, isolation and almost no cross-breeding with other livestock breeds for centuries, these stocks are in many ways unique in the global context. Studies show, moreover, that they have preserved a genetic diversity and in some cases special traits. This may, in coming years, be a growing source of material for research and even utilisation. Increased knowledge may also create possibilities for the development of special products for as yet undiscovered markets. The very smallness of the production environment could also create potential market opportunities in the future for particular goods or products from Icelandic livestock.

6 Points of emphasis concerning the utilisation, breeding and conservation of Icelandic genetic resources

Work relating to the protection of livestock and the maintenance of genetic diversity in livestock differs from many other forms of conservation in that it is carried out on living livestock populations which are scattered, under dispersed ownership and therefore also subject to the control of numerous entities. On the basis of international agreements, government authorities have entered into certain undertakings with regard to activities in this field, which entail obligations to conserve domestic genetic resources.

Icelandic livestock may be roughly divided in two categories. On the one hand there is livestock which has survived in the country for as long as it has been settled, possessing a breeding history which is closely linked to the history of the Icelandic nation. As regards these breeds there are no doubts as regards the obligation to conserve. On the other hand there are a few livestock species where all production is based on recently imported breeds and relies on the regular importation of new genetic material. As regards these breeds and species there is hardly any question of Icelanders having an impact on developments in their breeding. The Icelandic authorities, therefore, are not perceived as having any obligations as regards the conservation of the genetic diversity and genetic material of these species.

6.1 Conservation and sustainable utilisation of livestock genetic material

6.1.1 Sustainable utilisation and protection

The utilisation and breeding of the domestic livestock in Iceland today must be seen as sustainable and has been so for a long time. The stocks of both sheep and horses in the country are so large that even if some reduction in the number of livestock in these species were to occur in the future this should not become a problem as regards the protection and maintenance of the genetic diversity of these stocks. A substantial reduction in the cattle population in the country could cause problems with regard to the maintenance of the stock, and it is clear that the breeding programme in its current form would be difficult to carry out in a population substantially smaller than the current one. The importation of other dairy breeds is yet another possibility that could place the protection of the stock in a different position. There are, therefore, many things that recommend the formulation of a clear plan for the protection of the Icelandic cow.

The Icelandic goat stock is a very special example of how it has been possible to maintain a livestock population which is very small and where there is, moreover, considerable inbreeding within the stock.

6.1.2 Breeding objectives and breeding plans

The breeding objectives for Icelandic livestock breeds of dairy cows, sheep nd horses, are broad and comprehensive. There are no signs that the genetic diversity of these stocks is anything but well maintained. It should be noted, for instance, that they are unique in their greater diversity of traits, such as colour, than other livestock breeds.

Owing to the limited scope of livestock farming in Iceland, it is extremely important that awareness of the importance of maintaining the genetic diversity of the stocks should be kept alive. This is, in fact, more important for the protection of these stocks than organised conservation plans. It should be noted that the introduction of more efficient selection methods than before (BLUP) further increase the likelihood of selecting related animals. For this reason it is more important than ever to monitor carefully the inbreeding trends in the stocks and take appropriate measures if they prove necessary.

6.2 Conservation measures

Goats are the only livestock in the country where direct aid has been used to protect the stock. These conservation measures have achieved their aims. It is anticipated that such direct support for this unique and small stock will continue to be necessary.

Semen from bulls in the Bull Centre of BÍ is collected in an organised manner into a gene bank and this work is expected to continue in the future. There is good reason to investigate whether it might be appropriate to set up a comparable gene bank for both sheep and horses. An organised registration of all genetic material placed in storage needs to be established. Currently, this principally involves deep-frozen semen, but there are also DNA samples from cows and sheep which are collected in connection with research projects. The next few years may see the introduction of livestock biosample banks which are broader in scope.

6.3 Responsibility and organisation

To date, the Livestock Genetics Committee has been responsible for implementation and surveillance in matters concerning the maintenance and conservation of genetic diversity in Icelandic livestock. A new legal provision on the Agriculture Genetics Committee has now taken effect, and the responsibilities of the Livestock Genetics Committee have been transferred to a new committee with broader terms of reference. The activities of the committee will be further defined in a regulation.

The Althingi has recently approved a parliamentary resolution instructing the Minister of Agriculture to begin an immediate review of legislation concerning the importation of animals in order to increase the weight of conservation views in the legislation. It is suggested that new legislation should include provisions for a separate conservation impact assessment in connection with all applications for the importation of livestock.

There is a need to prepare organised conservation and protection plans for the Icelandic livestock. In the event of substantial and sudden changes in the external environment of the production, it is imperative that such plans should be in place. In all probability, the most likely example of such changes would be the importation of foreign livestock in the near future. The experience from the importation of pigs in the last decade shows that changes under such circumstances can progress extremely rapidly. It would be reasonable for the new Agriculture Genetics Committee to take the initiative in preparing plans for the conservation and utilisation of Icelandic livestock.

ANNEX

to the Report on the Genetic Resources in Icelandic Livestock

Tables based on FAO Specifications

Ministry of Agriculture
2003

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Chapter 1. Introducing the Country

Justification and Use

The purpose of this chapter is to get basic information on the livestock sector in general (livestock population, livestock holders and their land resources, livestock contribution to major food products). We expect, from the information gathered in this chapter, to have a clear idea on major use of land, especially for livestock, availability of animal feed resources, and the contribution of the livestock sector in satisfying consumption demands of animal products.

Table 1.1 Importance of livestock to the gross domestic product in agriculture (millions of $US)

Activity	$US (millions)	Data from Year
Livestock production (official statistics)	$203	2000
Other agricultural production (official statistics)	$24	
Best estimate of additional value of livestock	NI	

Comments:

- Best estimate of additional l value includes the value of all perceived contributions of livestock to agricultural services, other than food production, e.g. value of fertilizer from animal production, draught and transportation, forage production, etc., which usually are not costed in standard calculations.
- Livestock includes domestic ruminants, non-ruminants, and birds used for food and agriculture.

Table 1.2 Land use and current trends (1000 ha)

Category	Area (1000 ha) 1990	Area (1000 ha) 2000	Current trend
Arable land	148	129	
Permanent crops	0	0	
Permanent pastures	4942	4661	
Agricultural area	5090	4790	
Land area	10100	10100	
Total Area	10330	10330	

Comments:

- Arable land: land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. Data for "Arable land" are not meant to indicate the amount of land that is potentially cultivable.

- Permanent crops: land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber; this category includes land under flowering shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber.

- Permanent pasture: land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).

- Land area: total area excluding area under inland water. The definition of inland water generally includes major rivers and lakes.

- Total area: the total area of the country, including area under inland water.

- Indicate current trends in relation to the latest available year (-- = strongly decreasing, - = decreasing, 0 = stable, + = increasing, ++ = strongly increasing).

Table 1.3 Land use for livestock and current trends

Category	Area (1000 ha) 1990	Area (1000 ha) 2000	Current trend
Cropping for food			
Cropping for feed	150	126	
Cropping for food and feed			
Natural pasture	4500	4200	
Improved pasture	2	3	
Fallow			
Forest			
Non-agricultural			
Total	4652	4329	

Comments:

- Natural pastures are the ones grown without any external inputs, while improved pastures may be cultivated, semi-cultivated, fertilized, etc.
- Fallow is a non-cultivated cropping land put on rest.
- Indicate current trends in relation to the latest available year (-- = strongly decreasing, - = decreasing, 0 = stable, + = increasing, ++ = strongly increasing).

Table 1.4 Land tenure for livestock production

Category	Area (1000 ha)	%
Private	2814	65
Government and communal	1515	35
Total	4329	100

Comments:

- Private includes the private sector and the long term leasing.
- Include all land for which the primary purpose of its use is livestock production.

Table 1.5 Farm structure and distribution

Category	Number of farms / households	%	Number of farms / house-holds with livestock	%
Landless		0		0
> 0 to 2 ha	20	1		0
> 2 to 10 ha	60	2	20	1
> 10 to 50 ha	120	3	80	2
> 50 to 100 ha	200	5	180	5
> 100 to 500 ha	1660	42	1620	43
> 500 ha	1940	49	1900	50
Unknown		0		0
Total	4000	100	3800	100

Table 1.6 Livestock population, number of owners/house-holders and employment by species

	Livestock population (1000)	Number of owners / householders	Number of persons additionally employed	
Species			**Fully**	**Partially**
Cattle	70	1399		
Sheep	474	3352		
Goats	0,4	42		
Horses	74	5255		
Pigs	5	36		
Chicken	157	196		
Turkey	0,5	1		
Ducks	0,8	75		
Geese	0,3	22		
Rabbits	0,8	12		
Mink	35	26		
Foxes	4	18		

Table 1.7 Human population in the country

Year	Total (millions)	Rural or Farming (%)	Urban or Non Farming (%)	Total
1990	0.256	9	91	100
2000	0.285	8	92	100
Average annual growth rate %	1			

Comments:

- Rural/Urban and Farming/Non Farming populations will be defined depending on the commonly used terminology for demography. For example in developed countries it is meaningful to consider farming and non-farming populations and in the developing world, rural and urban populations.

Table 1.8 Major livestock primary production (1000 tonnes/numbers)

	Meat (1000 t)		Milk (1000 t)		Eggs (1000 t)		Fiber (1000 t)		Skin (No./1000)	
Species	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**
Cattle	3,2	3,8	107	106					NI	NI
Sheep	9,8	8,9					1	1	600	500
Goats										
Horses	0,6	1,1							NI	NI
Pigs	2,5	4,8								
Chicken	1,5	3,0			2,7	2,9				
Turkey										
Ducks										
Geese										
Rabbits										
Mink & Fox									172	103

Table 1.9 Major livestock primary product imports (tonnes)

	Meat (tonnes)		Milk (t)		Eggs (t)		Fiber (t)		Skin (No.)		Animals (No.)	
Species	**1990**	**2000**	**1990**	**2000**	**1990**	**1999**	**1990**	**1999**	**1990**	**1999**	**1990**	**1991**
Cattle	0	4,3	0,0	0,1								
Sheep	0	0,0										
Goats	0	0,0										
Horses	0	0,0										
Pigs	0	0,0										
Chicken	0	11,4										
Turkey	0	0,0										
Ducks	0	6,7										
Geese	0	0,0										
Rabbits	0	0,0										

Table 1.10 Major livestock primary product exports (1000 tonnes/numbers)

	Meat (t)		Milk (t)		Eggs (t)		Fiber (t)		Skin (No./1000)		Animals (No.)	
Species	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**	**1990**	**2000**
Cattle			0.3	0.3								
Sheep	2.0	1.3					1.2	0.6	600	500		
Goats												
Horses	0.1	0.6									1623	1897
Pigs												
Chicken												
Fur animals									172	103		

Chapter 2. The State of Production Systems

Justification and Use

The purpose of this chapter is to get a clear picture on the distribution of livestock species and their role by major production systems. Changes in major production systems over time for major species are monitored. Production systems are defined according to the level of inputs used.

Table 2.1 Distribution of livestock by production system (%)

	Production systems			
Species	**Low input**	**Medium input**	**High input**	**Total**
Cattle			100	100
Sheep			100	100
Goats			100	100
Horses			100	100
Pigs			100	100
Chicken			100	100
Fur animals			100	100
				0

Comments:

- Assign a percentage based on thorough analyses of data available.
- **Production System**: all input-output relationships, over time, at a particular location. The relationships will include biological, climatic, economic, social, cultural and political factors, which combine to determine the production of a particular livestock enterprise. Also termed **Production Environment**. Production systems range from areas where there is very little husbandry or human modification of the environment, to very intensive management systems where feed, climate, disease and other factors are controlled or managed by farmers. The level of animal husbandry or intervention varies enormously from region to region and from farm to farm. Thus, a common way to classify production environments is to group them according to the level of human intervention as:
    - **High-input Production System:** a production system where all rate-limiting inputs to animal production can be managed to ensure high levels of animal survival, reproduction and output. Output is constrained primarily by managerial decisions.
    - **Medium-input Production System:** a production system where management of the available resources has the scope to overcome the negative effects of the environment, although it is common for one or more factors to limit output, survival or reproduction in a serious fashion.
    - **Low-input Production System:** a production system where one or more rate-limiting inputs impose continuous or variable severe pressure on livestock, resulting in low survival, reproductive rate or output. Output and production risks are exposed to major influences, which may go beyond human management capacity.

Table 2.2 Changes in the distribution of production systems during the last 20 years

	Production systems			
Species	**Low input**	**Medium input**	**High input**	**Total**
Cattle			++	0
Sheep			+	0
Goats			0	0
Horses			++	0
Pigs			++	0
Chicken			++	0
Ducks			0	0
Geese			0	0
Rabbits			0	0
Fur animals			++	0

Comment:

- Assign a score based on thorough analyses of data available (-- = strongly decreasing, - = decreasing, 0 = stable, + = increasing, ++ = strongly increasing).
- Definitions of production systems are given at the bottom of Table 2.1.

Table 2.3 Type of livestock farm by production system for cattle (%)

Type of operation	**High input**	**Total**
Subsistence		0
Smallholder		0
Small-scale-commercial	100	100
Large-scale-commercial		0

Comments:

- **Subsistence:** less than 50% of production is marketed.
- **Smallholder:** small family farms with more than 50% of production marketed
- **Small-scale-commercial:** medium family farms with more than 50% of production marketed
- **Large-scale-commercial:** large farms or companies with all production marketed
- Definitions of production systems are given at the bottom of Table 2.1.

Table 2.5 Type of livestock farm by production system for sheep (%)

Type of operation	**High input**	**Total**
Subsistence		0
Smallholder	5	5
Small-scale-commercial	95	95
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.6 Type of livestock farm by production system for goats (%)

Type of operation	High input	Total
Subsistence	100	100
Smallholder		0
Small-scale-commercial		0
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.9 Type of livestock farm by production system for horses (%)

Type of operation	High input	Total
Subsistence	25	25
Smallholder	25	25
Small-scale-commercial	50	50
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.11 Type of livestock farm by production system for pigs (%)

Type of operation	High input	Total
Subsistence		0
Smallholder		0
Small-scale-commercial	25	25
Large-scale-commercial	75	75

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.12 Type of livestock farm by production system for chicken (%)

Type of operation	High input	Total
Subsistence		0
Smallholder		0
Small-scale-commercial	25	25
Large-scale-commercial	75	75

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.14 Type of livestock farm by production system for ducks (%)

Type of operation	High input	Total
Subsistence	50	50
Smallholder	50	50
Small-scale-commercial		0
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.15 Type of livestock farm by production system for geese (%)

Type of operation	High input	Total
Subsistence	50	50
Smallholder	50	50
Small-scale-commercial		0
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.16 Type of livestock farm by production system for rabbits (%)

Type of operation	High input	Total
Subsistence	50	50
Smallholder	50	50
Small-scale-commercial		0
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Table 2.17 Type of livestock farm by production system for other species (%)
Fur animals (Minks and foxes)

Type of operation	High input	Total
Subsistence		0
Smallholder		0
Small-scale-commercial	100	100
Large-scale-commercial		0

Comments:

- Definitions of production systems are given at the bottom of Table 2.1.
- Definition of farm type given at the bottom of Table 2.3

Chapter 3. The State of Genetic Diversity

Justification and Use

The purpose of this chapter is to identify the status of the diversity of breeds within species, in terms of total number of breeds, breeds at risk of being lost, and degrees of their characterization.

Table 3.1 Breed Diversity (Number of Breeds)

	Number of breeds									
	Current Total		At risk		Widely used		Others		Lost (last 50 yr)	
Species	**L**	**E**	**L**	**E**	**L**	**E**	**L**	**E**	**L**	**E**
Cattle	1	3			1			3		
Sheep	1				1					
Goats	1		1							
Horses	1				1					
Pigs		3				3				
Chicken	1	2	1							
Turkey		1						1		
Ducks										
Geese										
Rabbits		3						3		

Comments:

- L = Locally Adapted or Native; E = Exotic (Recently Introduced and Continually Imported).
- Breeds at risk are those with total number of breeding females and males are less than 1,000 and 20, respectively; or if the population size is less than 1,200 and is decreasing.

Table 3.2 Number of breeds for which characterization has been carried out (Number of breeds)

	At population level				At individual level		
Species	**Baseline survey**	**Genetic distance**	**Breeds and crosses evaluation**	**Valuation**	**Performance recording**	**Genetic evaluation**	**Molecular evaluation**
Cattle	1	1			1	1	
Sheep	1	1			1	1	
Goats	1						
Horses	1				1	1	
Pigs	1						
Chicken	1						
Turkey	1						
Ducks							
Geese							
Rabbits							
Mink	1						
Fox	1						

Comments:

- Consider breed characterization during the last ten years.
- Baseline survey summary data describing the identification and observable characteristics, location, uses and general husbandry of the AnGR for each species used in the country for food and agricultural production.
- Genetic distances among breeds computed from molecular analyses.
- 'Breeds and crosses evaluation' refers to estimation of direct and maternal additive genetic, and heterosis effects.
- Valuation = description of the extent to which market values of AnGR predict their 'real' or 'fair' value, accounting for all goods and services they may provide to current and future generations of humankind. In the case of market failures, market prices will differ from the value that society attaches to AnGR
- Performance recording is based on individual animal data for milk yield, growth, reproduction, etc.
- Genetic evaluation refers to estimation of breeding values.
- Molecular evaluation includes information of markers, DNA, blood type, protein alleles, etc.

Chapter 4. The State of Utilization of AnGR (Use and Development)

Justification and Use

The purpose of this chapter is to identify the main use of animal genetic resources available in the country, especially the number of breeds that are really active in contributing to food and agricultural products. In addition, it focuses on the status of development of AnGR, their current breeding strategies, gaps and needs, and the involvement of different stakeholders in developing breeding systems.

Table 4.1 Relative importance of livestock products and services within species (%)

Species	Milk	Meat	Eggs	Fiber	Skin	Risk management	Fertiliser manure	Draught	Culture	Recreation	Fuel	Feather	Environmental management	Total
Cattle	92	8												100
Sheep		90		8	2									100
Goats		100												100
Horses		10								90				100
Pigs		100												100
Chicken		60	40											100
Turkey		100												100
Ducks		50	50											100
Geese		50	50											100
Rabbits		45		45	10									100
Mink & Fox					100									100

Comments:

- Think of the food and agricultural outputs as products that have a relative contribution to national production. Therefore, assign relative contributions for the important products listed below, based on a thorough analyses and valuation of data available in the country (sum of each species = 100).

Table 4.2 Relative importance of species within livestock products and services (%)

Species	Milk	Meat	Eggs	Fiber	Skin	Risk management	Fertiliser manure	Draught	Culture	Recreation	Fuel	Feather	Environmental management
Cattle	100	16			NI								
Sheep		38		100	35								
Goats		NI											
Horses		5											
Pigs		24											
Chicken		17	100										
Turkey		NI											
Ducks		NI											
Geese		NI											
Rabbits													
Mink & Fox					65								
Total	100	100	100	100	100	0	0	0	0	0	0	0	0

Comments:

- Assign relative contribution values for each product as a % of total output of that product, based on a thorough analyses of data available in the country (sum of each column = 100).

Table 4.3 Number of widely used breeds with breeding strategies (No. of breeds)

		Breeding strategies		
Species	Total number of breeds	Purebred selection	Cross-breeding	Both
Cattle	1	1		
Sheep	1	1		
Goats				
Horses	1	1		
Pigs	3		3	
Chicken				
Turkey				
Ducks				
Geese				
Rabbits				
Mink	1			
Fox	2			

Table 4.4 Number of breeds with current breeding strategies and tools being used (No. of breeds)

		Breeding strategies		Tools				
Species	**Breeding goals**	**Designed**	**Designed and implemented**	**Individual identification**	**Recording**	**AI**	**ET**	**Genetic evaluation**
Cattle	1		1	1	1	1	1	1
Sheep	1		1	1	1	1		1
Goats				1				
Horses	1		1	1	1	1	1	1
Pigs					1	1		
Chicken								
Turkey								
Ducks								
Geese								
Rabbits								
Mink								
Fox								

Comments: AI = Artificial Insemination; ET = Embryo Transfer.

Table 4.5 State of the art of technologies / methodologies used in breeding strategies

	Used for:	
Technology or Methodology	**Research**	**Breeders**
Multi-trait selection index construction	100	100
Optimization tools for breeding plans	60	60
Electronic database related to recording schemes	100	100
Genetic evaluation Software for: phenotypic selection breeding values	100	100
Reproductive technologies (AI, ET, etc)	100	100
Microsatellite linkage maps for QTL identification for Marker Assisted		
DNA genoptypings (scrapie)	20	2

Comments: Assign a percentage to indicate the extent that the technology or methodology is being used at research institutions or by breeder's associations in the country.

Table 4.6 Role of stakeholders in the implementation of tools for the development of AnGR

Stakeholders	Breeding goals	Individual identification	Recording	Artificial insemination	Genetic evaluation
State Government	3	5	3	3	3
Local Government					
Breeder's associations	5	5	5	5	5
Private companies					
Research inst./Universities	3				3
NGO's					

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) based on thorough analyses of data available, to indicate the role of involvement of each stakeholder on the implementation of tools that support the development of AnGR.

Table 4.7 Involvement of stakeholders in activities related to the development of AnGR

Stakeholders	Legislation	Breeding	Infrastructure	Human	Farmer's
State Government	5	3	3	2	1
Local Government	1	1	1	1	1
Breeder's associations	3	5	5	5	5
Private companies	1	1	1	1	1
Research institutions/universities	1	3	1	1	1
NGO's	1	1	1	1	1

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) based on thorough analyses of data available, to indicate the degree of involvement of each stakeholder on activities that support the development of AnGR.

Table 4.8 Stakeholders preference for animal genetic resources

Stakeholders	Locally adapted breeds	Imported exotic breeds
State Government	3	3
Local Government		
Breeder's associations	5	5
Private companies		
Research	4	4
NGO's	4	2

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) based on a thorough analyses of data available, to indicate the degree of preference of the various types of AnGR by stakeholders.

Table 4.9 Priority of needs for utilization of technologies for the development of AnGR

Technology	Needs			
	Knowledge	Training	Financial resources	Breeder's organization
Recording	3	1	1	1
Genetic evaluation	3	1	1	1
AI / ET	3	1	1	1
Molecular techniques	3	3	3	1
Breed organisation techniques				

Comments:

- AI= Artificial Insemination; ET= Embryo Transfer
- Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the priority of solving specific needs in order to use technologies to support the development of AnGR.

Chapter 5. The State of Conservation of AnGR

Justification and Use

The purpose of this chapter is to identify activities in in-situ and ex-situ conservation programmes, the degree of involvement of stakeholders and future needs for such programmes.

Table 5.1 Current number of breeds in managed conservation programmes

	Number of locally adapted breeds at risk			
Species	**Total**	**Managed *in situ***	**Managed *ex situ***	**Both (*in* and *ex situ*)**
Cattle				
Sheep				
Goats	1	1		
Horses				
Pigs				
Chicken	1	1		
Turkey				
Ducks				
Geese				
Rabbits				

Comments:

- *In situ* conservation: includes all measures to maintain live animal breeding populations, including those involved in active breeding strategies in the agro-ecosystem where they either developed or are now normally found, together with husbandry activities that are undertaken to ensure the continued contribution of these resources to sustainable food and agricultural production, now and in the future.
- *Ex situ* conservation: genetic material within living animals but out of the environment in which it developed (*Ex situ in vivo)*, or external to the living animal in an artificial environment, usually under cryogenic conditions including, *inter alia*, the cryoconservation of semen, oocytes, embryos, cells or tissues *(Ex situ in vitro)*. Note that *ex situ* conservation and *ex situ* preservation are considered here to be synonymous.

Table 5.2 Current number of breeds receiving incentives and for which various tools for management of *ex situ* conservation programmes are used

	Incentives			Tools				
Species	**Gov.**	**NGO**	**Market**	**Semen storage**	**Embryos storage**	**DNA/Tissue storage**	***In vivo***	**Monitoring system**
Cattle								
Sheep								
Goats								
Horses								
Pigs								
Chicken								
Turkey								
Ducks								
Geese								
Rabbits								

Comments:

- In vivo, such as zoological garden, farm park, etc.
- Incentives means any kind of support (human and financial resources, tax waving, higher prices, etc.) that stimulates conservation programmes of AnGR
- Monitoring system refers to the number of schemes in which more than 10% of population size is conserved.

Table 5.3 Current number of breeds receiving incentives and for which tools for *in situ* conservation programmes are used

	Incentives				Technical tools			
Species	**Gov.**	**NGO**	**Market**	**Private**	**Recording**	**AI**	**ET**	**Others**
Cattle								
Sheep								
Goats	1				1			
Horses								
Pigs								
Chicken								
Turkey								
Ducks								
Geese								
Rabbits								

Comments:

- AI = Artificial Insemination; ET = Embryo Transfer.
- Incentives means any kind of support (human and financial resources, tax waving, higher prices, etc.) that stimulates conservation programmes of AnGR.

Table 5.4 Stakeholders involvement in the management of conservation programmes

Stakeholders	*In situ* Conservation	*Ex situ* Conservation
Government	4	3
Breeder's associations	3	3
Private companies	1	1
Research institutions/universities	2	1
NGO's	2	1

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) based on thorough analyses of data available, to indicate the degree of involvement of each stakeholder on conservation programmes.

Table 5.5 Priority of needs for utilization of technologies for *in situ* conservation programmes

Technology	Needs			
	Knowledge	Training	Financial resources	Technology
Recording				1
Genetic evaluation				1
AI / ET	4	4	4	4
Molecular techniques	1	1	1	1
Breeder improvement techniques				

Comments:

- AI= Artificial Insemination; ET= Embryo Transfer
- Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the priority of solving specific needs in order to use technologies to support conservation programmes.

Chapter 6. The State of Policy Development and Institutional Arrangements for AnGR

Justification and Use

The purpose of this chapter is to identify policies related to the use, development and conservation of animal genetic resources. It summarises needs and identifies the main priorities to be considered in policy development for animal genetic resources management.

Table 6.1. Effects of existing policies and legal instruments on the utilization (use and development) of AnGR

	Rural production	
Species	Industrial systems	Small-holder systems
Cattle		3
Sheep		3
Goats		3
Horses		3
Pigs		1
Chicken		1
Turkey		1
Ducks		1
Geese		1
Rabbits		1
Mink & Fox		1

Comments: Assign a score (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the extent that existing policies and legal instruments support the use and development of AnGR.

Table 6.2 The focus of current policies on activities related to the utilization (use and development) of AnGR

	Activities			
Species	Use of exotic breeds	Use of locally adapted breeds	Training, research and extension	Organization of breeders/farmers
Cattle	4	3	4	4
Sheep	1	3	4	5
Goats	1	3	3	3
Horses	1	5	4	5
Pigs	4		3	4
Chicken	4	2	3	4
Turkey	4		1	4
Ducks	1		1	1
Geese	1		1	1
Rabbits	2		2	1
Mink	4		3	4
Fox	4		3	4

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the extent that current policies support activities related to the utilization of AnGR.

Table 6.3 Prioritising the needs to enable the development of AnGR policies

Needs	Immediately	Medium term	Long term
Financial		x	
Human resources (knowledge)			x
Organizational		x	

Comments: identify the main needs for policy development and specify if it is critical (immediately required) or important in the medium or long term.

Table 6.4 The priority of future needs in policy development for AnGR conservation programmes

Species	Policy development related to:				
	Technology	Infrastructure	Human resources	Financial resources	Organizational structures
Cattle	2	2	5	5	5
Sheep	2	2	5	5	5
Goats	2	2	3	3	3
Horses	2	2	5	5	5
Pigs					
Chicken	2	2	5	5	5
Turkey					
Ducks					
Geese					
Rabbits					
Mink					
Fox					

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the priority for the development of policies to support AnGR conservation programmes.

Table 6.5 The priority of future needs in policy development for the utilization (use and development) of AnGR

Species	Policy development related to:				
	Technology	Infrastructure	Human resources	Financial resources	Organizational structures
Cattle	2	2	4	4	2
Sheep	2	2	4	4	2
Goats	2	2	4	4	4
Horses	2	2	4	4	2
Pigs	2	2	4	4	2
Chicken	2	2	4	4	4
Turkey					
Ducks					
Geese					
Rabbits					
Mink	2	2	4	4	2
Fox	2	2	4	4	2

Comments: Assign scores (1 = none, 2 = little, 3 = regular, 4 = more, 5 = high) to indicate the priority for the development of policies to support the utilization of AnGR.