Gene flow:

Farm animals travel the world

Awassi sheep – here a herd near Beer Sheva, Negev – have become rare in Israel since the more fertile Assaf sheep entered the market.
Photo: Tobias Rummel

The second half of the twentieth century witnessed a significant increase in the exchange of breeding animals all over the world. The main impetus for this came from progress in biotechnology; in particular, developments were accelerated by artificial insemination and the cryo-conservation (deep-freezing) of sperm and embryos. Gene exchange takes place most intensively among dairy cattle and pigs, two sectors which are both heavily commercialised.

The most important factor influencing the international exchange of genes in the field of agricultural livestock is the economic one. In comparison with the commercial sector, development cooperation projects are of secondary importance in the impact that they have on gene flow.

Direction determined by the market

The industrialised countries have engaged in the scientifically-based breeding of animals for more than 100 years. The aims of the process have adapted to changing economic requirements over the course of time. In Germany, for example, breeders of seventy or eighty years ago strove to produce a cow that yielded both milk and meat and could also be used as a draught animal; breeders today focus on either the high-yield milk cow or the well-muscled bullock for meat production.

Commercial interests also determine the direction of the gene flow, which travels either from one industrialised country to another or from an industrialised country to a developing one. It is rare for internationally sought-after livestock genes to come from a developing country. That normally happens only if the developing country has livestock with genetic characteristics that are found nowhere else in the world. An example of this is the export of Boran and Tuli cattle from eastern and southern Africa to Australia and the USA.

In the cattle sector commercial breeders are concentrated in the industrialised countries. Where pigs are concerned, however, the growth of professional breeding organisations has taken place partly in developing countries, where it is linked to strong processes of concentration and commercialisation.

Trade restrictions not always useful

Trade restrictions control gene flow. The observance of high hygiene standards increases a country's opportunities for exporting its farm animal genetic resources and for marketing them globally. At the same time, these standards restrict the import of genes from countries where standards are lower and thus limit access to resources from abroad. Overly strict import and export regulations can lead to the illegal transfer of animals or genetic material in developing countries. In some situations this can have a damaging effect on national breeding objectives.

National policies in developing countries also affect the gene flow. They may do this through trade and market regulation or through subsidies for imports and government control of the regional distribution of animals. Very occasionally there may also be subsidies for breeding programmes (see also Hiemstra et al.).

Economic efficiency and the reduction of poverty are not always matching goals

To improve agricultural productivity all developing countries have a need for new breeds – not only of cattle but also of pigs, sheep and goats. One way of meeting this need is through the import of breeding animals.

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From Awassi sheep to Assaf sheep

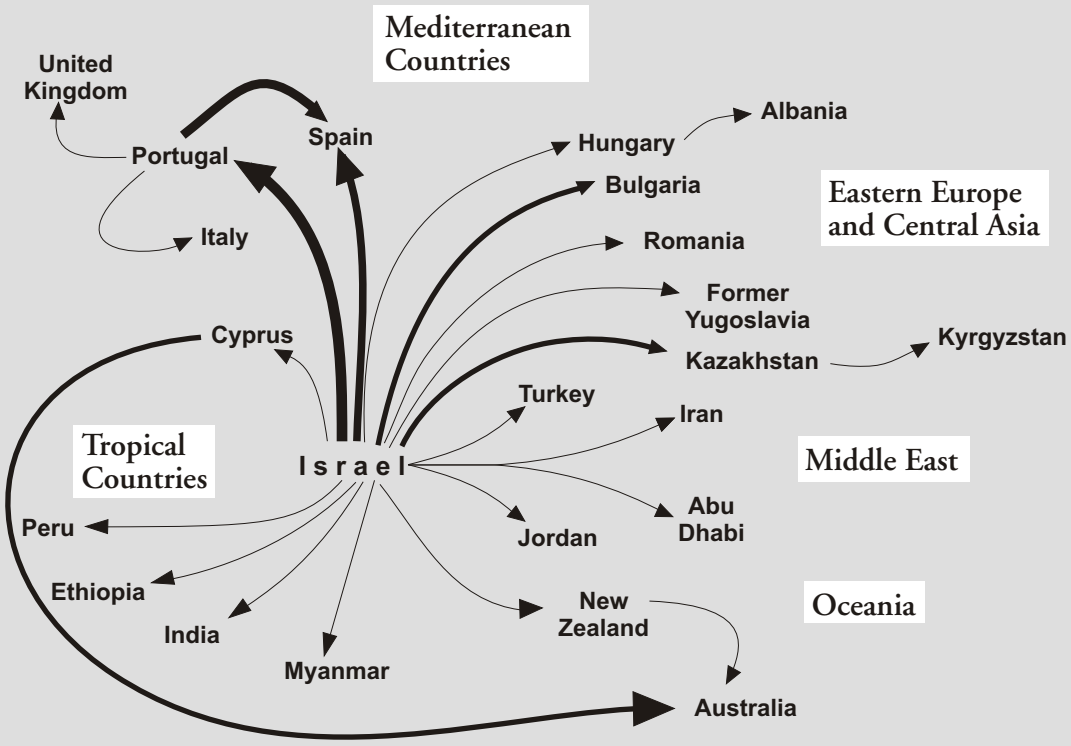
In the early 20th century, Jewish sheep breeders in Palestine began to select for increased milk and meat yield among the Awassi sheep, a breed that was kept at the time by the local Bedouin. The result was the Improved Awassi sheep with a higher milk yield. In the 1960s this breed was crossed with East Friesian milk sheep from Germany. This produced the Assaf sheep with improved fertility, which has by now almost completely replaced the Improved Awassi in the intensive milk sheep sector in Israel. Twenty years ago the Booroola gene, an important fertility gene, was imported from New Zealand and crossed into both the Improved Awassi and the Assaf sheep. This resulted in two new lines, the Afec Awassi and Afec Assaf lines.

The gene flow of the Improved Awassi sheep from Israel in the years since 1965 has been well documented. Twenty-eight gene transfers took place in 15 different countries. This corresponds to a cumulative purchase price of more than 2 million US dollars. In total, 5,433 lambs, 1,100 portions of frozen sperm and 143 embryos of the Improved Awassi were exported from Israel. Around one-third of these transactions took place as part of development cooperation projects; two-thirds were commercial transfers. Breeding material from the Improved Awassi sheep was exported to southern and eastern Europe, to Central Asia and to Australia. The transfers to Ethiopia, Burma and India took place within a project context. In the Middle East a total of 1,113 lambs were exported to Jordan, Iran, Abu Dhabi and Turkey; most of these were used to improve the yield of local stocks of Awassi sheep.

The gene flow of the Assaf sheep began in 1977. A total of 687 lambs, 11,354 portions of frozen sperm and 260 embryos worth some 333 million US dollars were exported from Israel in ten transfers to seven different countries. Most of these were imported commercially (not as part of development cooperation work), principally by Spain and Portugal. In these countries the Assaf sheep is now the predominant milk sheep, with a population of more than 1.2 million pure-bred and cross-bred animals.

Assaf breeding material has been sent from Portugal to England and Italy.

Worldwide gene flow of the Improved Awassi and Assaf breeds of sheep from Israel:



Gene flow takes on particular importance if the local livestock population has been decimated by war to the extent that there is no longer a sufficient base from which stocks can be re-established. In this situation a decision must be made between starting to revive the population with high-yield breeds from temperate climatic zones or using indigenous breeds from neighbouring regions (cf. the Issue Paper "Agrobiodiversity and Emergency Response").

However, the economic success of an imported animal breed depends not so much on the quantity of imported material but on whether the animals are suited to the new environment and local production systems and on whether they meet the cultural and social requirements of the animal keepers.

If the new breed is suitable and if the import serves to increase the productivity of the domestic industry, the result is an improvement in the living conditions of smallholders and in the country's economy. These benefits are particularly likely to ensue if environmental conditions permit the keeping of high-performance animals, a market – perhaps in a city or town – is available for the products, and the production potential of the local breeds is low and cannot be improved sufficiently quickly by pure-breeding. Imported high-performance breeds are, however, often only suitable for specialised facilities, and in this case no benefit accrues to the poor rural population.

Nevertheless, the state has the means to help smallholders share in the benefits of economic development. Ways of doing this include supporting local breeding organisations, not providing one-sided subsidies for imports, or letting smallholders have access to imported breeds and the means to work with them. An example of this approach is the development of the dairy industry in the East African highlands – in Kenya, Ethiopia, Uganda, the Kilimanjaro area and southern Tanzania.

Farm animal imports influence agrobiodiversity

If a breed is unsuitable, it will be unable to become established in its new environment and will therefore have no effect on the local breeds – at least in theory. In practice things often work out somewhat differently. If an imported breed continues to be promoted by the government or through development cooperation projects despite obvious unsuitability, this can have a harmful impact on local smallholders and animal keepers. The imported genes may mix with those of the local breeds, so that the indigenous breeds disappear or are completely supplanted. Yet it is precisely these local breeds that are important for smallholders when they are left to continue working without government or project subsidies. Furthermore, indirect loss is suffered through the destruction of genetic resources that might be required in the future. The importing country suffers the greatest loss of farm animal genetic diversity if the introduced breed is an economic success. Yet many marginal areas, such as deserts, scrubland or mountains, can only be utilised with locally adapted breeds. If these breeds die out, large areas effectively become wasteland and can no longer be used for food production. Along with this, many farmers and shepherds lose their livelihood. On the other hand, there is no recorded case of local animal populations dying out in such areas as a result of the import of breeding animals. Such an extinction is more likely to arise as a consequence of the emigration of impoverished groups.

An imported breed can also contribute to the diversity of farm animal genetic resources, provided that it complements the local breeds and is systematically integrated into them.

Boran and Tuli cattle – and the benefit-sharing dispute

The Boran cattle, which comes from southern Ethiopia, and the Tuli cattle from Zimbabwe are perfectly adapted to the dry pastures of these countries. This is the result of breeding by local animal owners and of natural selection. In the 20th century English settlers in Kenya improved the yield of the Boran cattle, while in Zimbabwe the Tuli cattle underwent development through government breeding and research programmes.

Both breeds are fertile and provide excellent meat, and they therefore attracted the attention of international researchers and commercial beef producers. In 1988 Australian researchers imported the first embryos of Tuli and Boran cattle from Zambia and Zimbabwe. In 1991 embryos of these breeds were exported from Australian research stations to the USA, in particular to Nebraska and Texas, where the world's largest breeding programme for beef cattle was based.

In both Australia and the United States, however, these two breeds play only a subsidiary role in beef cattle production. This is borne out by the figures. In Australia in 2000 there were only 161 Tuli and 26 Boran head of cattle, among a total of 26 million beef cows. The picture in the USA is similar. In 2004 there were some 500 Tuli cattle in the country; details of the Boran were not available. The total number of beef cattle in the United States is at least 95 million.

Despite these sobering figures, the study shows that the beef cattle sector has a need for genetic material with adaptive characteristics and special meat qualities.

The export of genetic material from Africa gave rise to heated discussion of how the profit from the sale of farm animal genetic resources could be shared fairly with livestock breeders in developing countries from whom these resources had originated, and in particular with indigenous communities who do not keep animals commercially.

The ever-increasing concentration of both cattle and pig breeding companies tends to lead to a reduction in the diversity of the genetic resources of these animals that are traded internationally. When the risks are considered of changes in animal husbandry, the expansion of large-scale commercial livestock husbandry, or the increasing number of people who abandon animal husbandry or pastoralism, it will be seen that the developing world may become a hotbed of breed loss in the 21st century.

Recommendations for development cooperation

Indigenous genetic resources are essential for adaptation to changing economic and environmental conditions. Their preservation secures the livelihoods of smallholders and pastoralists in marginal locations now and in the future. Plans for the conservation of farm animal genetic resources must take account of the genetic distance between individual breeds (the greater the genetic distance, the smaller the degree to which the breeds are related to each other), as well as of their genetic potential, their economic performance and their social and cultural utility.

The importing of livestock breeds must not take place at the expense of impoverished smallholders and pastoralists, nor at the expense of agrobiodiversity. The same applies to the conservation of local breeds. If they are threatened by economic developments, the state should intervene to support them, for example by withdrawing subsidies for the import of farm animals or in exceptional cases by paying subsidies to the animal keepers. It is also important to foster indigenous knowledge, to help animal-keeping communities organise, and to promote the management of animal genetic resources belonging to such communities.

Farm animal genetic resources are part of the global biological diversity; they are both a product of our culture and also unique raw materials that are sought after by animal breeders, breeding companies and governments worldwide. Before any transfer commences, it is therefore essential to establish who owns these resources and to agree who should profit from their sale and the later value generated by them. The parties to an agreement must define how risks and benefits are to be apportioned and shared, and must abide by statutory rules adopted or yet to be defined in connection with the Convention on Biological Diversity.

Without local breeding organisations it is not possible for smallholders in developing countries to be involved in breeding activities on a permanent basis. In the breeding of goats and sheep a two-fold structure is emerging, similar to that which already operates in the rearing of cattle and pigs: there is a modern strand and a traditional one. In the long term modern, intensive production will increasingly supplant traditional, extensive production. Local breeding and marketing organisations should receive government support to enable pastoralists and smallholders who have no alternative source of income to participate in commercial animal breeding. Where appropriate states should also consider making direct payments to farmers for their contributions to conserving the environment and agrobiodiversity. In the area of plant genetic resources there are already moves to acknowledge these contributions (cf. the Issue Paper "Farmers' Rights" in this series). A similar discussion process is under way in the field of animal genetic resources.

The Issue Paper series "People, Food and Biodiversity" aims to:

- stimulate an interest in the conservation and sustainable use of biological diversity,
- present quickly and clearly concrete actions and experiences,
- explain new concepts and issues relating to the topic of biological diversity,
- encourage and stimulate the mainstreaming of this topic within development cooperation projects and programmes.

We look forward to your suggestions and experiences so as to enable us to improve this series.

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