THE EVOLUTION AND ADAPTATION OF THE VARIOUS TYPES OF INDIGENOUS CATTLE OF ETHIOPIA TO THEIR RESPECTIVE ENVIRONMENT

Evolución y adaptación de los diversos tipos de vacuno indígena de Etiopía en relación con su medio ambiente

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ETHIOPIA

Even if the country is located near the equator, vast areas of the Ethiopian highlands provide reasonably cold environments where dairy farming could be easily undertaken if other necessary conditions were present. Unfortunately, this is not the case and furthermore, extensive areas of Ethiopia are inimical to cattle production to such an extent that only the highly adapted and resistant local cattle breeds can continue to play the extremely important role in the economies of these areas that they have there at present.

Ethiopia has an area of about 1,221,900 km², fifty-three percent of which are permanent pasture, eleven percent cultivated land and eighteen percent barren desert or swamps. The rest are rivers, lakes or forests. Of the estimated population of 27 million, ninety percent live in rural areas. Of these, the larger majority lives in densely populated agricultural areas along the highland plateau and the rest is composed of semi-settled pastoral people and nomads herding their animals throughout the rangelands. Ethiopia has 27 million head of cattle, 23 million goats, 17 million sheep and 1 million camels (HAILE-MARIAM, 1975). In spite of this, the estimated contribution of livestock production to the gross agricultural output amounts only to 25%, mainly through the export of hides and skins (LIVESTOCK AND MEAT BOARD, 1971-72). The main reasons for such an abnormal situation are: 1) extensive overstocking and overgrazing, 2) low planes of nutrition, 3) insufficient water supply, 4) lack of adequate marketing and transportation facilities, 5) poor animal husbandry and breeding development and 6) the widespread incidence of various contagious and parasitic diseases.

THE INDIGENOUS CATTLE OF ETHIOPIA

Ethiopia has the largest cattle population of Africa and one of the largest in the world. In spite of this, the Ethiopian indigenous cattle have never been properly studied, their numbers and
distribution recorded by a census, and the different breeds and
types identified, classified and evaluated. The first step in
this direction has recently been taken by ALBERRO and HAILE-
MARIAM (1982).

The Ethiopian cattle are the result of the following histori-
cal and evolutionary process (EPSTEIN, 1971). *Bos primigenius* or
Hamitic longhorn were present in Ethiopia at least since the 2nd
millenium BC. *Brachyceros* or short-horned cattle also reached
Ethiopia, but little trace remains now of them in eastern Africa.
Ethiopia received two Zebu introductions from the east, the first
with the semitic invaders from Arabia in the first millenium BC, when these Zebus interbred with the earlier Hamitic longhorn to
form the Sanga cattle. The second Zebu introduction reached its
peak at the time of the Arab invasions which started in 669 AD.
These Zebis displaced the Sanga breeds from large areas of Ethio­
pia and all the way through eastern and central Africa down to the
Zambezi River. In some regions they could not completely absorb
the Sangas and formed instead intermediate breeds Sanga-Zebu. A
classification of the Ethiopian cattle breeds based on the above
evolutionary process is given in Table I. The geographical loca-
tion of the different breeding areas is shown in Fig. 1.

EVOLUTION AND ADAPTATION OF THE VARIOUS TYPES OF ETHIOPIAN CATTLE.

Very different types of cattle have evolved and adapted to
the also widely different ecological and climatological environ-
ments of Ethiopia. The most striking example can be seen within
one single region, Eritrea.

THE CATTLE OF ERITREA

There are no forests in Eritrea, and the grasslands greatly
depend on rainfall which is often very low. This is compounded
by periodical droughts that cause substantial mortality and mar-
ked loss of weight in the surviving animals. Eritrea can be divi-
ded into three ecological regions and the location of the three
cattle breeds found in this province follows exactly these three
areas.

Eastern lowlands: Arab cattle.-
The eastern lowlands by the sea are very hot, with mean tem-
peratures of 34°C maximum and 26°C minimum, and precipitations
averaging 100-200 mm per year. The coastal vegetation reflects a
high concentration of salt in the soil.
The cattle found in this area are the very small type of Ze-
bu calle Arab, with an average height of 106 cm and 160-230 kg of
liveweight. They number some 10,000 head. These animals are kept
for the little milk and meat they can produce under this adverse
environmemt.
Central highlands: Arado cattle. -
Altitude between 1,500 and 3,000 m. Climate: semi-arid (in some years close to sub-humid). The average annual temperature is 17°C. The daily maximum and minimum temperatures may differ in periods of clear weather as much as 22°C or even more. The rainfall ranges from 450 to 650 mm per year. Natural vegetation: this area was previously covered by evergreen forests but has been altered to the present steppe vegetation with perennial under-shrubs, herbs and grasses or low thorny shrubs that are remains of overgrazing, overbrowsing and ecological degradation. Socio-economic environment: densely populated, with intensive agriculture and agro-industries.

In these cold highlands is found an intermediate Sanga-Zebu, the Arado, a small (average height 111 cm) but sturdy and docile animal which is very much appreciated for ploughing and for the little milk that it can produce. The Arado have a very thick skin and this is one of the main distinctions between this breed and the Barcas of the western lowlands of Eritrea. The Arados show great strength and adaptation to the highlands where the Barcas are known to be unable to thrive. There are some 500,000 head of this breed.

Western lowlands: Barca cattle. -
This is a low plateau located west of the Eritrean highlands, gradually grading into the Sudanese lowland plains. Altitude: 550 to 1,000 m. Climate: dry sub-humid. Rainfall: low, ranging between 500 and 700 mm. Temperatures: mean maximum temperature is 28°C. Natural vegetation: most of the area is a wooden savannah. The most common grass is Hyparrhenia spp. Socio-economic environment: livestock production followed by crop farming.

The best grazing areas of Eritrea are located in these western low lands where the Barca cattle, a Zebu breed, mostly kept by the Beni-Amir nomadic tribes, have water available during the dry season from shallow wells in or near river beds. In response to the better environment, the Barcas are not only the best milk producers in Eritrea but perhaps of Ethiopia as a whole. They are tall, long, strong and bony animals with long and strong legs that enable them to walk long distances in their search for the best available pastures. The udder and teats in females are well developed. Barca cattle are of a very nervous disposition. Average carcass yield for steers is 48% and their meat is tender and often marbled. There were about 1,000,000 Barca animals in 1960. Their present numbers are unknown.

DANAKIL (ADAL OR AFAR)
The large Danakil territory is formed by the steppes and semidesertic areas between the eastern fringes of the Ethiopian highlands and the Red Sea. This is a very harsh, hot and dry terrain, where water is scarcely available. In the centre of this area, below sea level, is located the extremely hot Danakil depression.

The area is sparsely populated. It is a flat lowland inha-
bited by nomadic pastoralist, the Adal or Afar tribes. Altitude: 300 to 500 m. Climate: average annual temperature, 28°C. Rainfall: low mean annual precipitations distributed bimodally and connected with altitude, 350 mm, at 500 m above sea level and thus decreasing down from the foothills to the plains. The most severe dry is May to June, with ambient diurnal temperatures well above 40°C, with a longer, but often less severe dry season from November to March. Most of the rains fall in the form of heavy tropical thunderstorms. Evapo-transpiration rates are over 2,000 mm per year. Hydrology: a number of small rivers cross the area in a west east direction. Only a few are perennial. In several of the dry river beds water is stored in the sand up to several months and is easily accessible through shallow wells. Other than from these rivers the Afars have also water from wells and springs. The sub-desert steppes have herbs, grasses and shrubs. Acacia bushland and grasslands along the escarpments, and poor, dry scrub verging into lava desert farther out in the plains. The best grazing season is September-November after the heavy rains.

Socio-economic environment: Pastoral livestock production (cattle, sheep, goats and camels), in one of the most inhospitable areas of Ethiopia. This production system displays a high degree of coherence but, even so, perturbations occur with unpredictable frequency, often posing problems of sheer survival (an extensive drought and famine that in 1973 killed 90% of the cattle, 50% of the sheep, 30% of the camels and 25 to 30% of the human population reflects the difficult and often erratic climatic conditions). Livestock products: meat and milk consumed directly and a varying proportion of livestock products exchanged for maize and sorghum. Human population density: 1.6 to 2.0 persons per km². The nomadic movements are of two types, short daily movements from the grazing areas to the rivers to water the animals and seasonal movements up and down along the rivers from the dry season pastures in the foothills to the wet season areas of the plains. Husbandry methods: cattle are herded by older boys and younger men; one herder tends 200 cattle. Pasture and water are free, while individual rights are claimed to important trees like Acacia tortilis, whose protein-rich seed pods provide an important feed supplement for livestock in the dry season. Livestock constitutes the main productive asset of the Danakil people.

The Danakil cattle are a Sanga type of light colours, with a slender but strong body and very long horns, lyre or crescent-shaped. They have a straight head profile, long thin legs and an almost straight back with a sloping rump. Their average height is 125-135 cm and their liveweight is 250-375 kg. They are kept for milk production, a daily average of 1.5 litres during a lactation period of 4-6 months. The Danakil cattle are extremely resistant and well adapted to the adverse conditions of the area. They are perhaps the only type of cattle able to survive in this region where milk production plays a considerable role in the traditional economy of the nomadic people for which milk is the staple food. As a matter of fact, the Danakil survive the last months of the
dry period by consuming milk, their only food at that time.

Raya-Azebo.

This is a variety of the Danakil cattle which has evolved in the fertile district of the same name on the eastern side of Lake Ashangi where some Galla tribes have settled as agriculturalists. This is a clear example of how a cattle breed can be developed and improved by providing a better environment with better feeding and management.

The area is formed by a valley system ranging from 1,500 to 2,500 m. in altitude. The soils are rich, with a clay loam texture. The surface of these alluvials is high in organic matter and rich in phosphorus, potassium, calcium and magnesium. Hydrology: this area is well supplied with water from drainage rivers and by the relatively high rainfall. Climate: mild, the zone is classified as sub-humid.

The Raya-Azebo animals are larger, heavier, taller and have a much better body conformation than the original Danakil, even if they are basically the same type of Sanga animals. They are maintained for ploughing but also produce meat and milk. Raya-Azebo animals are now found all along the north eastern boundaries of the Ethiopian highlands, and their numbers seem to be holding.

ABIGAR (NUER)

The Abigar cattle, a variety of the Sudanese Nilotic, are a Sanga type bred by the Nuer tribes in the sub-province of Gambela in western Ethiopia bordering Sudan. The area is a flat plateau approximately 700 m in altitude with lower ground in the various river valleys and a few scattered hills. The area is infested with tse-tse flies. This region covers some 1,000,000 ha of which, 800,000 ha are annually flooded. Dominant grass is Panicum maximum. Climate: mean annual temperatures are 23.6°C maximum and 22°C minimum. The rainfall is 1,200 mm per year. Rainy season from May to December and completely dry the rest of the year.

Socio-economic environment. The river banks are traditionally sown with maize in late May and sorghum in late October or early November. Apart from this, the Nuer depend entirely on livestock breeding (cattle, sheep and goats). The animals, especially the cows, are for the Nuer the main source of subsistence and also provide them with security, prestige and a means for dowries, bartering, etc.

Husbandry methods. The pagan Nuer are famous as cattle breeders and cattle is their most precious possession. They are semi-nomads. During the rainy season they stay in their homelands in the higher grounds on both sides of the Ethiopia-Sudan border and cultivate maize, sorghum and other crops. When the rains stop and the pastures become dry and scarce they form large herds of up to 1,000 head of cattle and start to move along the various river banks to provide their cattle with water and the best available pastures. When the rains come again and with them the flooding they go up once more to their quarters on the hills.
The Abigar cattle are kept for their milk production which is the Nuer's staple food (their main dish is a porridge made of ground maize boiled and mixed with milk). The Abigar cattle are very tall and harmoniously built animals with a straight head profile, long horns, small cervico-thoracic humps and an excellent conformation which includes a straight top line, level rump, good heart girth, deep body and flanks, and long, straight legs. Light colours are typical, white with red or black patterns. They have a docile temperament and their meat is tender. They produce three to five litres of milk per day. Their numbers have been estimated in 400,000 head and appear to be static.

ARSSI

The region of Arssi is a mountainous area located in the central highlands south of Addis Abeba. Mount Chilalo has an altitude of 4,306 m and there are several other summits nearing this height. The area has a problem of high density of cattle population with an over abundance of good pastures during part of the year and a marked scarcity of grazing areas during the dry season. The Arssi people are sedentary Gallas who are cultivating more and more areas to the detriment of the animals.

Geomorphology. The area can be divided into Alpine (> 3,000 m), highland (2,500-3,000 m), medium altitude (2,000-2,500 m) and a smaller part at lower altitudes. Topography: rolling plains to slopes of the mountain masses. Climate: annual means, maximum 15-20°C and minimum 0°C in December. Rainfall, mean annual precipitation of 1,370 mm. The evaporation is low. Vegetation: the area is largely deforested. Grasslands at high and medium altitudes show a high percentage of coarse and unpalatable grasses such as Pennisetum schimperi and Setaria strata. Nevertheless, many valuable grasses and legumes are found.

Husbandry methods. Cattle herds are grazed extensively by day and returned in the evenings to the homestead or encampment for protection against predators and thieves. Often, long distances have to be travelled for watering. Fallow land and the areas near the arable plots are grazed in times of shortage. During the dry season the animals are forced to roam over increasingly larger distances and their condition deteriorates. Pastures conservation, hay or silage, is not practiced.

The Arssi cattle are a small type of Zebu which seems to have evolved from the heterogeneous group of Abyssinian Short-horned Zebus of the central highlands. They gave an average height of 110 cm at withers and are thickset but well proportioned, mostly red in colour and extremely active but temperamental and often very aggressive. The head is long and carried low, with a straight profile. The body is deep and the rump sloped. The legs are thin and short but strong. They are well adapted and able to graze in the steeply sided mountain sides and are used for milk and meat. A few years ago their numbers were estimated at around 99.
1,000,000 head. Unfortunately, due to extensive crossbreeding and other factors, the Arssi cattle are rapidly loosing their identity as a separate entity.

BORANA

The place of origin of the famous Boran Breed, or Borana as it is called in Ethiopia, is the area Borana-Arero in the Ethiopian region of Sidamo located in the south of the country, bordering Kenya and Somalia. This semi-arid area has vast grazing lands with excellent pastures that can not be fully utilized because of chronic lack of water. These southern rangelands constitute one of the most important livestock producing areas of Ethiopia.

Altitude: 1,250 to 1,500 m. Climate: semi-arid. Mean temperatures, maximum 26°C and minimum 12.5°C. Rainfall, 692 mm per year. Seasons, October-February very dry and two rainy seasons, one covering the second half of July, August and the first week of September, and one in March-April. Rains fall with intensity and short duration. Evaporation rate is higher than the precipitation the whole year. This pattern is often converted into one of prolonged droughts or semi-droughts. Vegetation, scrub savannah with few flat-topped Acacia trees, or steppes and scattered grassland with dense grass cover. The area shows vast deforestation, signs of erosion and ecological deterioration partly as a result of overgrazing and wood cutting to make charcoal.

Socio-economic environment. The area is sparsely populated by 3,200 nomad families tending one million head of cattle. Animal husbandry and breeding methods. The Borana cattle show high responsiveness even to the smallest improvement in management conditions. The breeders use a simple system of selection based in the type and production of the animals. The nomads are especially interested in females and milk production. Inferior bulls are culled and fattened or sold as draught animals. The Borana tribesmen, to overcome to a certain extent the acute lack of water, use very deep wells from which they fill troughs to water their animals.

The entire Borana pastoral system, well organized and highly sophisticated, is centered around the control, access, utilization and maintenance of these deep wells. The regulation of access to the wells and the organization of labour to work the wells are very complex. The labour demand to operate the wells is extremely high: some of the deeper wells require from 18 to 21 men to work each one of them at any given time and this in shifts for an extended number of hours. A single chain of men (16 of them inside the well proper or shaft and 4 or 5 collecting water from them to fill the troughs) usually maintain a continuous water flow that can be as high as 50 to 60 litres per minute. This indeed requires a tremendous input.

The complex and highly structures social organization of the Borana has reached an accurate understanding of the fundamental necessity to manipulate and maintain a strict balance between people, livestock numbers, grassland and water. The latter is the limiting factor.
FIG. 1

GEOGRAPHICAL LOCATION OF THE MAIN CATTLE BREEDING AREAS OF ETHIOPIA.

(Also, besides the breeds outlined in the map, many animals belonging the heterogeneous group collectively called Abyssinian Zebu are found throughout the entire Ethiopian territory).
As a result of the distances between the grazing lands and the wells the stock are normally watered every third or fourth day.

The Borana cattle are Zebu animals with a very good size and conformation and high perspectives for beef production in arid and semi-arid areas. Their headquarters are well developed, with thick buttocks. Average carcass yield is 52% under slightly improved conditions. Their rate of gain and performance in feed-lots is impressive. They also have milk production potential. The number of head seems to be diminishing. They have very light colours, usually white or light grey, but also light brown, fawn, light red and pied occur. The skin has black pigmentation and is thin, loose and pliable. These light colours and the good pigmentation and quality of the skin, together with a sleek coat and short hair, probably help the Borana cattle to withstand the intense solar radiation and high ambient temperatures of the area. Their most important characteristic is the way that they are able to cope with the chronic lack of water and to survive on dried pastures during the long dry season or during the frequent cases of extended droughts.

FOGERA

The Fogera animals originate from the area around Lake Tana, north of Addis Abeba. The area is agriculturally rich, and water and grazing pastures are abundant. The main problem is that of the annual floodings resulting from the main rainy season (June-October when the cattle have to be taken up to the hills, to be brought back when the floods have subsided. This implies a semi-nomadic life for the cattle owners. The pastures, when not flooded, are lush and green for several months. However, the last two months of the dry season are very hard on the animals, the pastures being scarce and dry. The annual flooding of the plains is largely responsible for the extremely high incidence of lives flukes (Fasciola spp.) which are spread by the ubiquitous snail.

The Fogera plains are located at high altitudes (1,800 m). Climate: sub-humid, with temperatures in the summer often very high. Mean, maximum 27°C and minimum 9°C. Relative humidity 77%. Seasons: wet June-September, the rest of the year mostly dry. Annual rainfall is 1,500 mm with 80-90% of the precipitation falling in August-September. The soils are fertile, even if drainage is a problem. The vegetation is formed by treed savannah with patches of grassland and moist forest and also swamps dominated by papyrus. There are extensive areas of edaphic grassland which is seasonally waterlogged.

The Fogera cattle, tall and strong animals with long legs and deep body, are well adapted to the conditions of the area and considered good for draught, meat and milk production. They are docile animals with large size, sloped rump and deep chest, barrel and flanks. Their barrel is short and they are flat-sided, with poorly sprung ribs. Their dairy potential appears to be encouraging. They number some 800,000 head but their numbers are rapid-
ly dwindling. This is primarily to the fact that the peasants in the area are steadily increasing the size of land under cultivation and they feel that they need now a smaller type of cow to graze in the reduced pasture lands. To achieve this purpose, instead of reducing the number of animals, they are crossing the Fogeras with a dwarf strain of Zebu common in a neighbouring area (Somada).

**HORRO**

The Horro cattle derive their name from the sub-province of Horro Gudru, a region with relatively good soils and pastures. They are much larger than the Ethiopian average and their carcasses and hides command higher prices in the market. In the areas at high altitudes the animals are sedentary. During the rainy season and the first part of the dry season the animals are kept near the villages. When the peasants start to burn dry bushes and grasses the animals are taken down to the lower valleys.

This area is located on the western part of the central highland plateau in north-west Ethiopia. It is sub-equatorial, at 2,200 m of altitude. Hydrology: good water resources due to high rainfall, lakes, ponds and streams. Rivers drain into the Blue Nile. The climate is sub-humid. Severe temperatures with high probability of frosts and also very windy during parts of the year. Average annual temperature, 17°C. Average annual rainfall, 1,400 mm. Seasons: dry October-February, light rains March-April and heavy rains May-September. The natural vegetation is that of a tree and shrub steppe.

The Horro cattle are uniform in colour and body conformation. They have a relatively large size with deep bodies and flanks, wide chest and well sprung ribs, a straight top line and a small but well-shaped udder. They are considered to be good for beef, easy to fatten, and produce tender meat. Their potential for milk production is also promising. This is an evident case where a better habitat has produced during the course of centuries an intermediate type of Sanga-Zebu with a better conformation and production potential than that of the Abyssinian Zebus of the vicinities. These cattle have adapted well to their environment and are somewhat resistant to the most common problem in the area: the widespread incidence of liver flukes. The approximate number of Horro animals has never been properly estimated but it is a sad fact that this type of cattle is clearly disappearing due to the negative effects of droughts, overstocking, crossbreeding and other various factors.

**CONCLUSION**

It is an obvious fact that completely different types of cattle have evolved in the different ecological and climatological areas of Ethiopia. These various types of cattle are well adapted to the often adverse environment where they are bred, and they play a paramount role in the rural economies of the respective areas.
Within one single region, Eritrea, three different types are found in the three completely different areas: the small Arab cattle in the lowlands by the coast, the sturdy Arado in the high lands, and the larger and more developed Barca in the better pastures of the western lowlands.

The light Sanga cattle of the fiercely hot and dry areas of the semi-deserts in the east of the country, the Danakil, are markedly able to withstand these very harsh conditions. At the same time, a variety of the Danakil, the Raya-Azebo, has developed a larger size and better body conformation by being kept on a sedentary form in a more favourable environment. The other type of Sanga, the Abigar, also reflects the better care and management, and the better feeding and watering facilities available to them throughout the year: they are clearly well developed animals with a good body conformation.

Regarding the Zebu types, the Borana is well known to be able to support the heat stress and chronic lack of water common in the semi-arid area where it originates. It certainly has an unusual ability for water retention and well developed temperature regulation mechanisms. Another Zebu, the Arssi, is a small type of animal capable of grazing in the extremely steep slopes of the high mountains of the area where it is bred.

The two intermediate Sanga-Zebu types, Fogera and Horro, also show how cattle can naturally develop under a given environment or climatic zone and how cattle can acquire resistance or tolerance against internal parasites and other health problems.

The relationship between breed type and environment is a subject that merits a much deeper investigation in Ethiopia, especially in terms of climate and vegetation. Regarding topography, it is clear that the cattle mountain breeds of this country (Arssi, Arado, various strains of the Abyssinian Zebu and the brachyceros Sheko) are clearly smaller in height than the cattle found at medium altitudes and in the lowlands. The morphological characters of the breeds (external conformation, shape and size of horns, coat colour, etc.), have perhaps developed more as a result of human selection than from any other influencing cause. Some of these external features are not necessarily related to the physiological characteristics of adaptation that these breeds have developed through the years as a result of natural selection within their specific environment. Extensive migrations and movements of people have taken place in the area since immemorial times. Thus, it would be necessary to investigate the matter of breed distribution not only from geographical but also from historical viewpoints.
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In general, the Ethiopian types of cattle show how they have developed substantial tolerance or resistance against heat stress and solar radiation, high altitudes, parasites and diseases, chronic lack of water, seasonal scarcity and low quality of food and other unfavourable conditions. These indigenous breeds are still absolutely necessary for livestock production in the areas where they are bred and where higher levels of performance can not be attained with the present level of husbandry, which is inevitably low due to the prevailing conditions. Unfortunately, due to indiscriminate crossbreeding, lack of international leadership in the management of livestock resources and lack of support and conservation programmes, among other factors, some of these well adapted breeds are now rapidly disappearing or on the verge of extinction. This would constitute a loss of genetic resources of incalculable magnitude.
SUMMARY

Ethiopia has an extensive territory with several eco-zones which greatly differ in climate and vegetal cover due to their different altitudes and other factors, and 27 million head of bovine that constitute the highest cattle population of Africa and one of the highest in the world. In spite of this and of the paramount role that these cattle play in the rural economies, this cattle population has never been adequately studied. These indigenous breeds are now studied within the context of the different eco-zones where they have evolved and adapted themselves. These eco-zones are often very adverse and the cattle had to develop substantial levels of tolerance and resistance against heat stress and solar radiation, diseases and parasites, seasonal lack of water, and deficient husbandry and feeding methods. The mountain breeds are smaller in height than the cattle of the lowlands. Moderately improved breeds or strains developed in some cases as a response to better environments. Some of these indigenous breeds are still the only type of cattle able to produce and reproduce in their breeding areas, where the introduction of selected stock is not yet possible. Due to the lack of conservation and improvement programmes, and to indiscriminate crossbreeding, some of these breeds might come to the point of extinction.

RESUMEN

Etiopia posee un vasto territorio con varias zonas ecologicas que varian grandemente en clima y cubierta vegetal debido a las diferentes altitudes y otros factores, y 27 millones de bovinos que constituyen la mayor poblaci'on vacuna de Africa y una de las mas altas en el mundo. A pesar de esto, y del papel fundamental que la ganaderia bovina juega en las economias rurales, esta no ha sido aun dibidamente estudiada. Se estudian ahora estas razas indigenas dentro del contexto de los medios ecologicos en que evolucionaron y se adaptaron, a menudo muy adversos, por lo que hubieron de desarrollar niveles sustanciales de tolerancia y resistencia ante el stress por el calor y radiacion solar, enfermedades y parasitos, escasez de agua, y alimentacion y manejo deficientes. Las razas de montana son mas bajas de estatura que el ganado de las tierras bajas. Como respuesta a mejores medios en algunos casos se desarrollaron razas o estirpes ligeramente mejoradas. Varias de estas razas indigenas son aun las unicas capaces de producir y reproducirse en dichas zonas, donde aun no es posible introducir animales mejorados. Debido a la falta de programas de conservacion y mejora, y a los cruzamientos indiscriminados, algunas de estas razas podrian llegar a desaparecer.

REFERENCES