PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN THE TROPICS

CONSERVATION OF THE KENANA BREED IN SUDAN

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1. INTRODUCTION

Sudan is the largest country in Africa. It has approximately 20 million people, 20 million cattle, and a GNP per head of population of $500. At present growth rates, the population will double in the next 30 years. The country therefore faces enormous challenges in the most fundamental element of economic development - food supply.

In meeting this challenge, the development of the potential of the cattle population is a major factor. The various cattle breeds and types in the country have so far been relatively untouched by modern crossbreeding, immigration or selection practices. They have, on the other hand, been subjected to natural selection in a domesticated environment for many centuries. The two best defined breed types within the national population are the Kenana and Butana. These breeds will inevitably be subjected to substantial pressures from outside genetic sources in the coming decades. The Government of Sudan therefore faces the same difficult task as confronts authorities in other countries in the developing world: how to balance conservation of the undoubted merits of these breeds with the opportunity and necessity for rapid economic development. To help in the resolution of these questions, FAO commissioned a study of the alternative strategies for the conservation of these breeds in 1983, and this report is based on the results of that study. The report concentrates on the Kenana breed, because it was considered to be most immediately in danger.

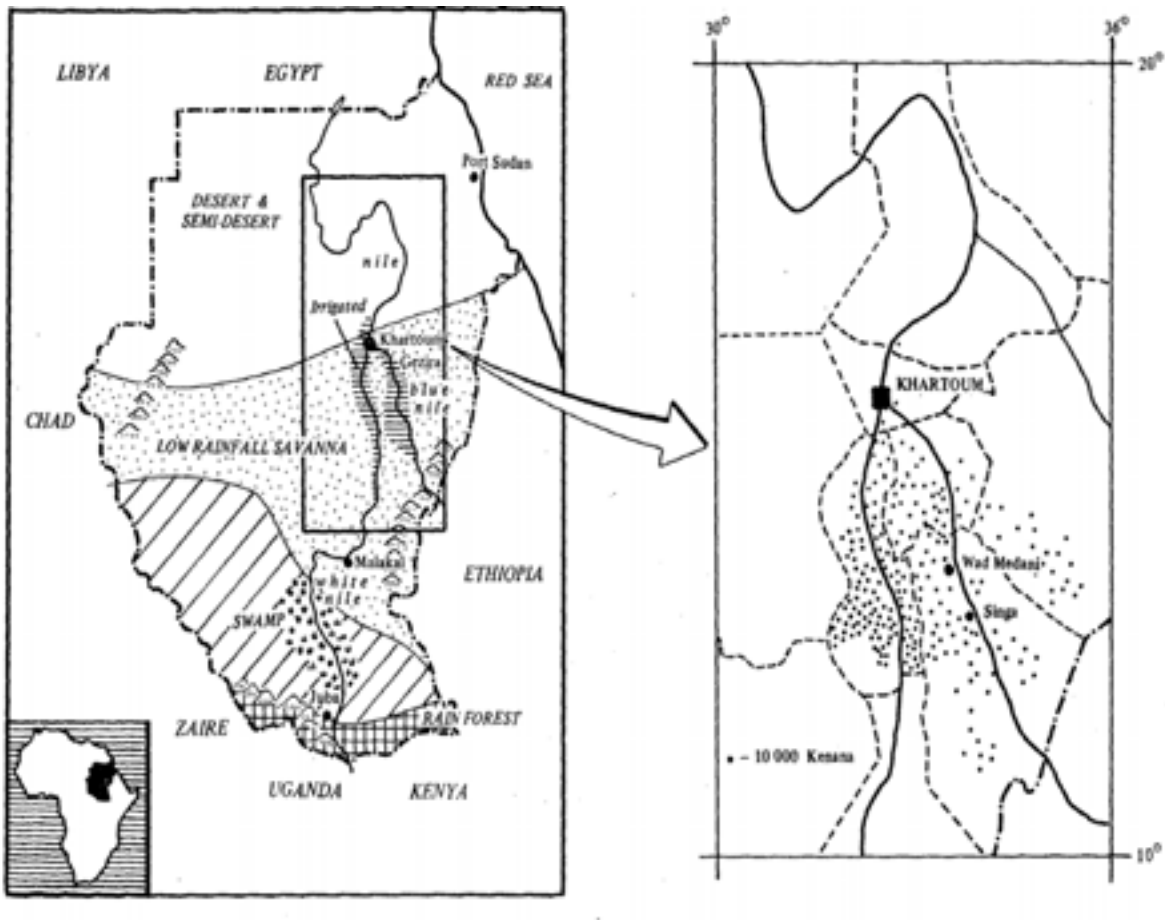
2. THE KENANA BREED

There are estimated to be about 3 million Kenana-type cattle. This definition includes populations known locally as White Nile type. They are found largely in their traditional areas of origin, the plains adjacent to the White and Blue Nile rivers, in an area stretching south from Khartoum to the Ethiopian border (Figure 1). This ecological zone is typically a low rainfall savannah area, with high temperatures and low humidity. Traditional cattle systems in the area involve seasonal migration, though not to the extent of the true nomadism found further west in Sudan. Since the 1920s, about 1 million hectares of irrigated land has been developed in the area, largely for cotton production. The availability of crop residues and the growing of forage crops have led to greater stability in the cattle population. in the last two decades, the rapid expansion of Khartoum, Omdhurman and Wad Medani has increased the local demand for milk, and stimulated the initial development of commercial milk production. This has led to some crossbreeding, mainly with imported Holstein-Friesian semen.

The Kenana is a true Bos indicus or zebu type. Its origins are not known, but it has been suggested (Boyns, 1947) that they were introduced many centuries ago with migrants from Asia.

The location of the Kenana area within Sudan, and the estimated breed distribution are both shown in Figure 1.

Fig. 1.LOCATION AND ESTIMATED DISTRIBUTION OF KENANA CATTLE IN THE SUDAN.



Production data on the breed in its native environment are difficult to find. The Agricultural Research Council (1975) reported that a sample of the population contained 82 percent females and 18 percent males. The percentage of cows in milk was found to be 37 percent, and average daily production was estimated to be 2 kg. The calving rate was given as 70 percent and mortality was estimated at 5 percent in adults and 10 percent in calves.

The fact that the environment is extremely limiting was illustrated by the work of El-Khidir et al., 1979. They reported that a control group of Kenana heifers had a daily gain of 138 g and calved at 47 months, while a parallel group given extra nutrition had a gain of 470 g per day and calved at 32 months.

The most extensive recorded performance data come from research stations of the Animal Production Research Administration, Nishishiba (near Wad Medani) and Umbenein (near Singa). These data have been summarized and analysed by Fangaly (1980) and some of his results are given in the following table.

Table 1 AVERAGE MILK YIELD, CALVING INTERVAL AND AGE AT FIRST CALVING IN KENANA COWS IN TWO STATIONS (Fangaly, 1980)

Station	No. of Records	Mean	C.V. %
Milk Yield (kg)			
Umbenein	1920	1359	60
Nishishiba	882	763	89
Calving Interval (days)			
Umbenein	1539	434	24
Nishishiba	639	413	26
Age at First Calving (months)			
Umbenein	471	45.0	18
Nishishiba	331	51.5	17

3. PRODUCTION SYSTEMS

Conservation or development plans must be considered in the context of the production systems in which they are to be implemented. In the case of the Kenana breed, it is clear that more than one system will apply in the future. At one end of the spectrum, there are Kenana cattle involved in pure nomadic systems, in very stressful environmental circumstances. At the other end, there is the development of a relatively modern milk production sector to service the urban requirements of the country. This range of production systems is categorized in Table 2. In each case, appropriate breeding systems are also indicated.

Table 2 CATTLE PRODUCTION SYSTEMS IN SUDAN

	Production System	Breeding System
1.	Intensive high-capital dairy production	Importation of Holstein-Friesians, Brown Swiss, or Jerseys - possibly using embryo transfer.
2.	Existing city-supply producers	Grading up to Holstein-Friesians, Brown Swiss, or Jerseys. Alternatively, use of 1/2 and 3/4 exotic bulls leading to development of a synthetic population.
3.	Settled producers, now beginning milk production	Possibly as for (2) above. Opportunity to use system of grading up to F1 bulls.
4.	Settled, traditional systems	Opportunity to develop an improvement programme using station plus owners' herds.
5.	Transhumant systems	Crossbreeding (particularly of exotic breeds) to be discouraged.
6.	Nomadic systems	Interference in existing breeding practices not recommended.

From experience in other countries, and also in Sudan, it is clear that breeds like the Kenana will not be used in their pure form in the more intensive dairy production systems. Most existing city supply producers, even in considerably less intensive production systems, are at present involved in crossbreeding, largely with Holstein-Friesian. In these circumstances, some producers will continue grading up to the exotic strain, while for many

the use of half of three-quarter bred exotic bulls will permit the development of synthetic grades, usually more than 50 percent exotic in genetic background.

In the third level, there are many settled farmers in the Khartoum and Gezira areas now beginning to produce milk for sale, though in conditions where cow nutrition and management are often poor. In these circumstances, some will continue to use Kenana cows, but the tendency is to involve some exotic genes also.

Developments in all three of these levels of milk production threaten the existence of the Kenana. Since these populations are largely crossbred, it is impossible to base a conservation programme for Kenana on them. Kenana genes will, of course, survive for some generations in the crossbreds. If synthetic populations are developed, some of the genetic material of the native breed may survive in this form indefinitely. However, even in this case, planned conservation of genetic background of the native breeds is not possible.

At the other end of the scale, large numbers of animals are involved in true nomadic systems. Imposing any kind of external selection programme on animals involved in such systems is extremely difficult for a number of reasons. Because the environment is demanding, and food supply irregular, overall reproductive rates tend to be low. Because animals are so much on the move, regular contact with the herds and their owners, necessary for any kind of consistent selection scheme, is difficult to maintain. Finally, it is questionable if the selection goals of higher milk or meat output from individual animals are desirable in such populations, since the primary requirement is the physiological resilience to cope with the demands of the system. While amelioration of the environment (e.g. by control of parasites and disease, and by improving the feed supply) is highly desirable, it is difficult to envisage the operation of a useful breed improvement programme within the population.

Where the environment is somewhat less stressful, many cattle are involved in systems which are a mixture of settled and migratory patterns. Thus, in the Singa area, some of the stock migrate seasonally to areas where crop residues are available. As with the nomadic systems, these transhumant patterns of farming should also be based entirely on indigenous breeds. For the same reasons, but in a lesser degree, it is difficult to see a development or selection programme operating in such circumstances.

Finally, there are large numbers involved in what are essentially settled farming systems, but systems which are still largely traditional in many respects. They are not involved in commercial milk sales through organized channels. Productivity levels are not particularly high, and the feed supply situation is not likely to permit rapid changes from that position.

It is in this sector, where the indigenous breeds have a relatively secure place in traditional though settled production systems, that the best opportunities lie for introducing a conservation and development programme.

4. CONSERVATION PLAN

The scheme proposed for the Kenana population is outlined in Figure 2. Its essential elements are a consistent selection programme carried out within the herd at Umbenein Research Centre, combined with an annual round of selection from village herds. Technically, this kind of structure is known as an open nucleus system (James, 1977). The primary selection goal should be milk production, defined as yield of fat-corrected milk per lactation. Attention will also need to be given to weight for age, udder conformation, and beef potential. Prior to the commencement of the scheme, a written, agreed definition of the breeding goal will need to be developed.

5. SELECTION IN THE FIELD

Since no records are kept by the herd owners, this selection will have to be on the basis of inspection, together with perhaps some on-the-spot measurement of milk output. These selections should be carried out by a

qualified officer of the Ministry. Since a large element of judgement will be involved in these selections, it is essential that consistency is maintained in the judgements exercised.

The procedure envisaged is as follows. In each season, a campaign of visits to village herds would be planned. The aim of the campaign would be to select and purchase for recruitment to the Umbenein herd approximately 20 outstanding cows. Some number between 20 and 50 village herds would need to be visited. In each village, the bulk of the cows can be fairly readily inspected as they move out to grazing in the morning. The officer would identify a few cows (perhaps 3) which he regarded as the best, and during the day would make contact with the owners of these cows. As the herd returns in the evening, his assistants could be preset at the milking of these particular cows, and weigh the milk produced. Some objective measurements (e.g. wither height) would be taken, and on the basis of all the information available to him, the officer would attempt to purchase the best one or two animals. In making these selections, attention would be concentrated on cows in the first three lactations.

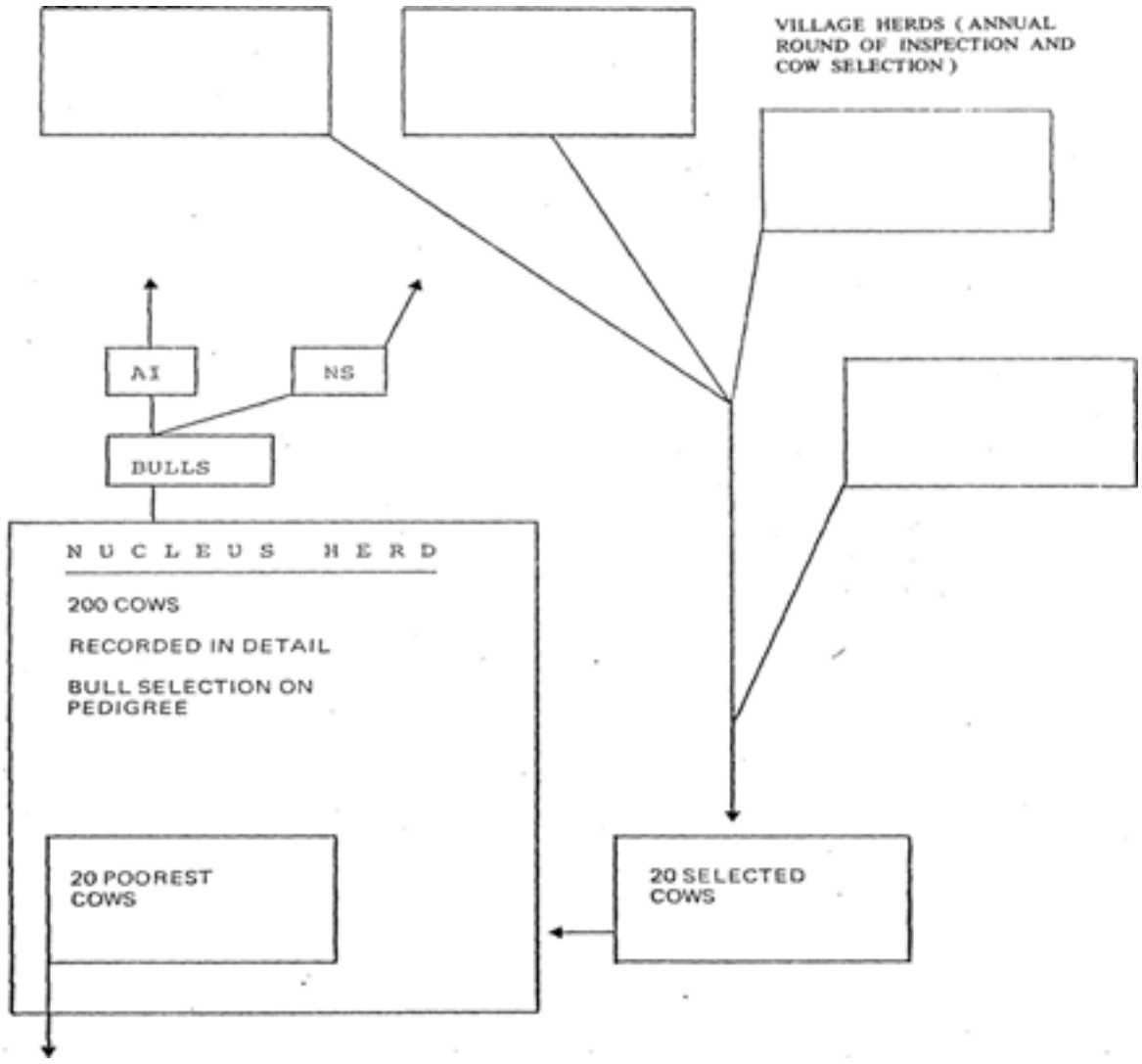


FIGURE 2: SELECTION SCHEME INVOLVING VILLAGE HERDS AND GOVERNMENT STATION.

In operating this scheme, there are several imponderables. Since the selection is largely a matter of judgement, it is difficult to predict how effectively it will identify superior cows. However, similar schemes applied consistently in the early days of the formation of the European dairy breeds appear, in retrospect, to have been reasonably successful. It is also difficult to know in advance what success there will be in persuading herd owners to sell (or lease) their animals. A process of trial and error may be necessary to develop a procedure which works well.

6. SELECTION IN THE STATION

While the selection in the field must be done entirely without documented performance records, the opposite is the case in the research station. Here, the necessary scientific and technical personnel are available, together with any equipment required, and the primary purpose of the Centre is the assembly and use of objective data on the cattle herd. Detailed records can therefore be kept of all aspects of reproduction, growth, production and behaviour of all animals. The protocols at present in operation in the herd cover the obvious and immediate requirements (gestation length, birth weight, body weight at suitable intervals, mortality together with causes, breeding age, age-at first calving, milk production, and subsequent lifetime reproductive and production records). In order that the substantial commitment to the new development and conservation programme is justified, it will be necessary to review all of these procedures to ensure that suitable levels of precision are aimed at in the different measures, and that absolute reliability of. data can be guaranteed. In addition, there should be provision for extending the range of characters measured to include suitable metabolic indicators, and, as may be feasible, records of response to parasitic infections both internal and external, together with various tests related to disease resistence. Furthermore, objective measurements of temperament and dairy conformation, dairy traits (particularly udder functionality), such as have been developed for dairy breeds elsewhere in the world, should be applied.

Most of these secondary traits will play a minor role in the selection programme, and it is not therefore an essential point that they should be fully developed in the first few years of the programme. Nevertheless, since the primary motivation for the conservation of the Kenana breed is the presumption that it has some advantageous physiological differences from other breeds, and since there is a great lack of information on such characters in this breed, and in zebu cattle generally, the encouragement of physiological and metabolic studies on the herd is strongly recommended.

The selection goal in the herd should be the same as that in the field programme, albeit with more detailed and objective measurements on which to base selection. Again, an agreed, consistent selection goal needs to be defined in advance, and the criteria and levels of selection also need to be predetermined. Since milk production will be the most important trait in this selection goal, it is possible to draw on studies elsewhere to make some advance estimates of the likely rate of improvement for this major trait. in a closed herd of adequate size to minimize inbreeding effects, annual rates of improvement of between 1 and 2 percent are achievable. In an open nucleus structure, as proposed here, the rate of improvement could be significantly greater.

As is suggested below, some additional studies to guide the selection procedure, and to explore the way in which it depends on the herd and population structure, are justified.

While it is unlikely in the years immediately ahead that any extensive use of embryo transfer techniques can be used in the herd, it should be kept in mind that at some future date the introduction of these techniques could significantly assist the programme. The primary benefit to be derived from the introduction of embryo transfer would be the intensification of selection on the female side which it makes possible. Since each selected cow can, under embryo transfer, provide multiple calves per year the selection exercised on the cows can be that much more stringent. This has particular relevance in the Kenana breed, since it is female performance which is the main criterion for selection.

One of the great difficulties experienced in Umbenein, and indeed in similar stations in other tropical countries, is that because of inadequate and uncertain forage and feed supplies, growth of heifers tends to be very slow, with age at first calving frequently exceeding five years of age. The same causes lead to long calving intervals. The net effect is that too few females are reared in relation to the herd size to permit much selection either in the incoming females, or among the cows in the herd. The statistics of the Umbenein herd in recent years indicate that, as at present operated, it would have some difficulty in carrying out an effective selection programme. It

will therefore be essential that a new regime of feed and fodder supply be developed for the station. The work of El-Khidir et al., 1979 has clearly shown that growth and puberty rates can be dramatically improved with adequate feed. In the new provisions, therefore, adequacy and security of fodder and feed supply will be essential.

7. SUPPORTING STUDIES

There are considerable deficiencies in the data base required for the development of future breeding plans for the Kenana breed. The following are some areas which require further investigation:

a. Estimates of population size, sex and age distributions in the Kenana population are tentative. In addition, field productivity is not well documented.

b. Information on migratory patterns in the Kenana population is limited and becoming out of date.

c. The evolutionary and historical background of the breed is relatively unknown. It would be worthwhile to measure the genetic similarity between Kenana and Butana, and to compare both breeds with other zebu and non-zebu cattle populations. Such a study could be undertaken using electrophoretic techniques, and perhaps DNA hybridization techniques also.

d. A critical comparison of the production potential of the Kenana and Butana would clarify which population merits greatest attention in the future.

e. A further study is required of the possible rates of genetic change achievable in the open nucleus type of structure proposed here.

f. Since inevitably a section of the Kenana breed will be involved in crossbreeding with European-type cattle, some systematic experiments are required to measure the additive and heterotic differences between Kenana and the selected European breed.

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CROSSBREEDING CATTLE IN LATIN AMERICA

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The economic efficiency of cattle production may be improved by the appropriate choice of breeds, mating system and selection of individuals within breeds, to obtain increased product yield or quality per unit of input resources (land, labour, capital).

Experimental results on the comparative performance of cattle breeds and crosses in tropical Latin America indicate that, in general, crossbreds outperform purebreds both for beef (Madalena, 1977; Hernandez, 1981; Plasse, 1981, 1983) and for dairy production (Vaccaro, 1979; Wilkins et al. , 1979; Muñoz and Deaton, 1981; Madalena, 1981; Madalena et al. , T983b; De Alba and Kennedy, 1985). Crossbreeding allows exploitation of heterosis, maternal effects and complementarity between breeds but the appropriate strategy depends on the characteristics of the production system considered.

1. PRODUCTION SYSTEMS

Tropical cattle production systems in Latin America were described by several authors (Plasse, 1976; Wilkins et al., 1979; Paladines, 1980; Madalena, 1981; Ruiz, 1982; Cubillos, T9"82; Sere and Vaccaro, 1984; CIAT, 1985). In general, beef cattle herds are kept in ranches and dairy cattle in smaller properties, but there is also a wide range of dual purpose systems. Coarse pastures/roughages limit nutrient intake, aggravated by periods of drought or flooding. Other constraints to cattle performance are: mineral deficiencies, incidence of diseases, ticks, torsalo grubs and gastrointestinal parasites, heat, humidity and solar radiation. Natural service is common, controlled matings and artificial insemination being practised at a minority of farms. Socio-economic constraints such as absentee ownership and low education level of rural populations are important background factors causing poor farm and herd management. It should be recognized that wide variations exist between and within regions, with many examples of good farming based on modern husbandry techniques.

2. MATCHING CATTLE GERMPLASM TO PRODUCTION SYSTEM

Latin American cattle breed resources may be conveniently grouped into four classes:

i. the founder Criollo naturalized initial populations, now mostly graded up;

ii. zebu breeds;

iii. the modern European breeds selected for high performance in temperate regions; and

iv. new breeds derived from crosses between European and adapted breeds, like the Santa Gertrudis, Canchim and Ibage for beef production and the Jamaica Hope, Pitangueiras and Siboney for milk production, to mention some examples.

Modern European breeds may be utilized only in the more intensive production systems with no important climatic constraints, but are totally unfit for the harsher environments. Criollo and zebu breeds are adapted to harsh environments because of their heat tolerance, low metabolic rate and disease and parasite resistance but have comparative low performance in improved environments. For a wide range of intermediate environments, complementarity between higly productive and adapted breeds results in superior overall performance of crossbreds.

Our own results on crossing red and white Holstein-Friesian (HF) x Guzera (G) in Brazil may be used as an example of this situation (Madalena, Lemos, Teodoro and Monteiro, in preparation). Milk yields, calving intervals and milk yields per day of calving interval of six crossbred groups (grades) are shown in Figures 1, 2, 3 The six HF grades were: 1/4, 1/2, 5/8, 3/4, 7/8 and > 31/32 or HF. The halfbreds were f1 out of G dams by HF sires. The 1/4 and 3/4 were first backcrosses of F1 dams to, respectively, G and HF sires. The 7/8 were second backcrosses to HF sires, and the 5/8 were obtained by inter se matings of 5/8 sires and dams.

Animals were produced at an experimental farm and distributed to 66 cooperator farmers at mean age 22 months, to measure dairy performance under a wide range of commercial practices. Cows were milked in the presence of the calf, which suckled after milking, according to the generalized practice in the region. However, no milk was intentionally left for the calves on recording days. Farms were grouped into high and low management level classes for purpose of analysis. Figure 1 is based on 921 observations and Figures 2 and 3 on 699.

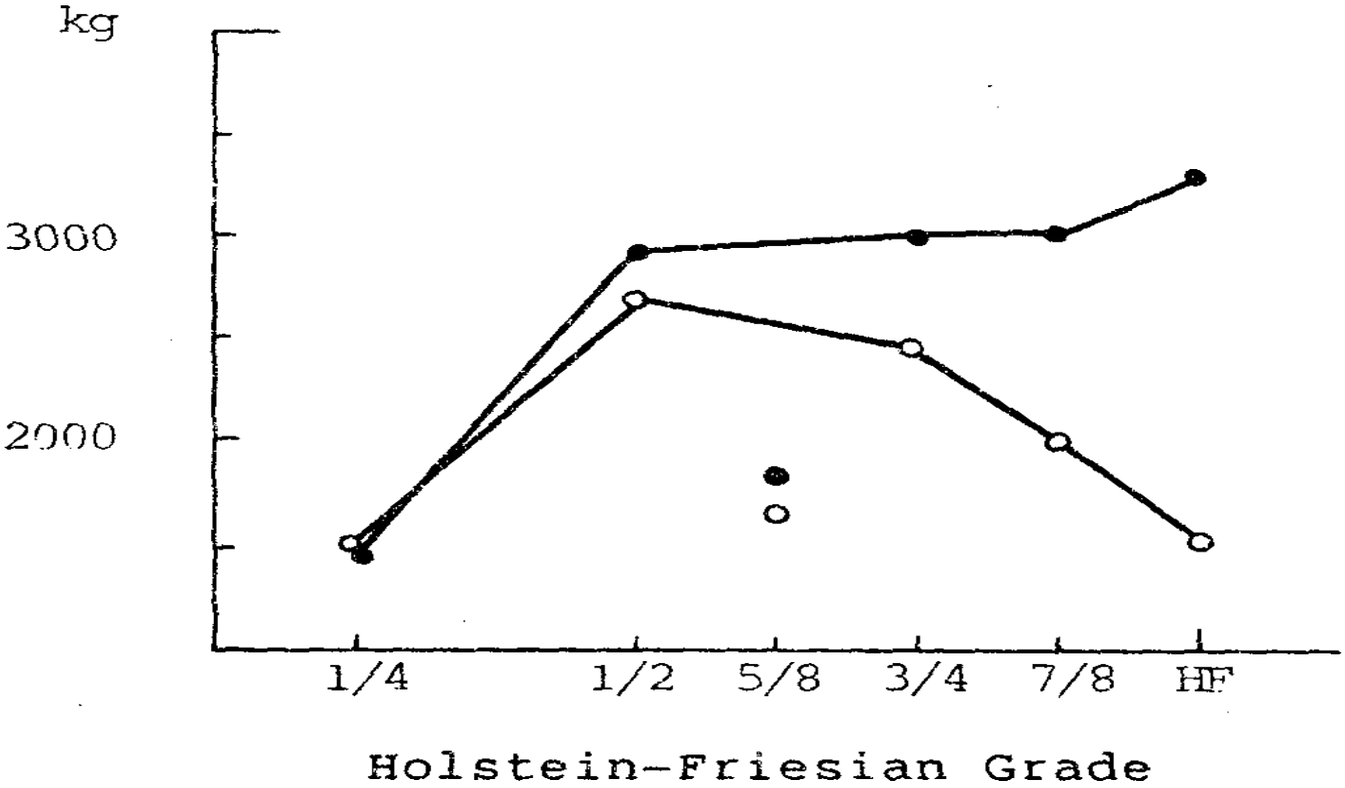

Figure 1 Lactation milk yields for six Holstein-Friesian x Guzera grades at high (*) and low (°) management levels.

Cunningham (1981) described the situation depicted in Figures 1 and 3 as a double interaction of additive breed difference and heterosis by environment, the additive effect becoming more important and heterosis less important as the level of environmental stress is reduced. Results from another farm with mean milk yield of 9.8 kg per day of calving interval indicated no differences in this trait for grades 3/4, 7/8 and HF in HF x Gir crosses (Madalena et al., 1983a). Cuban results are in agreement with this conclusion (Ponce de Leon et al. , 1982).

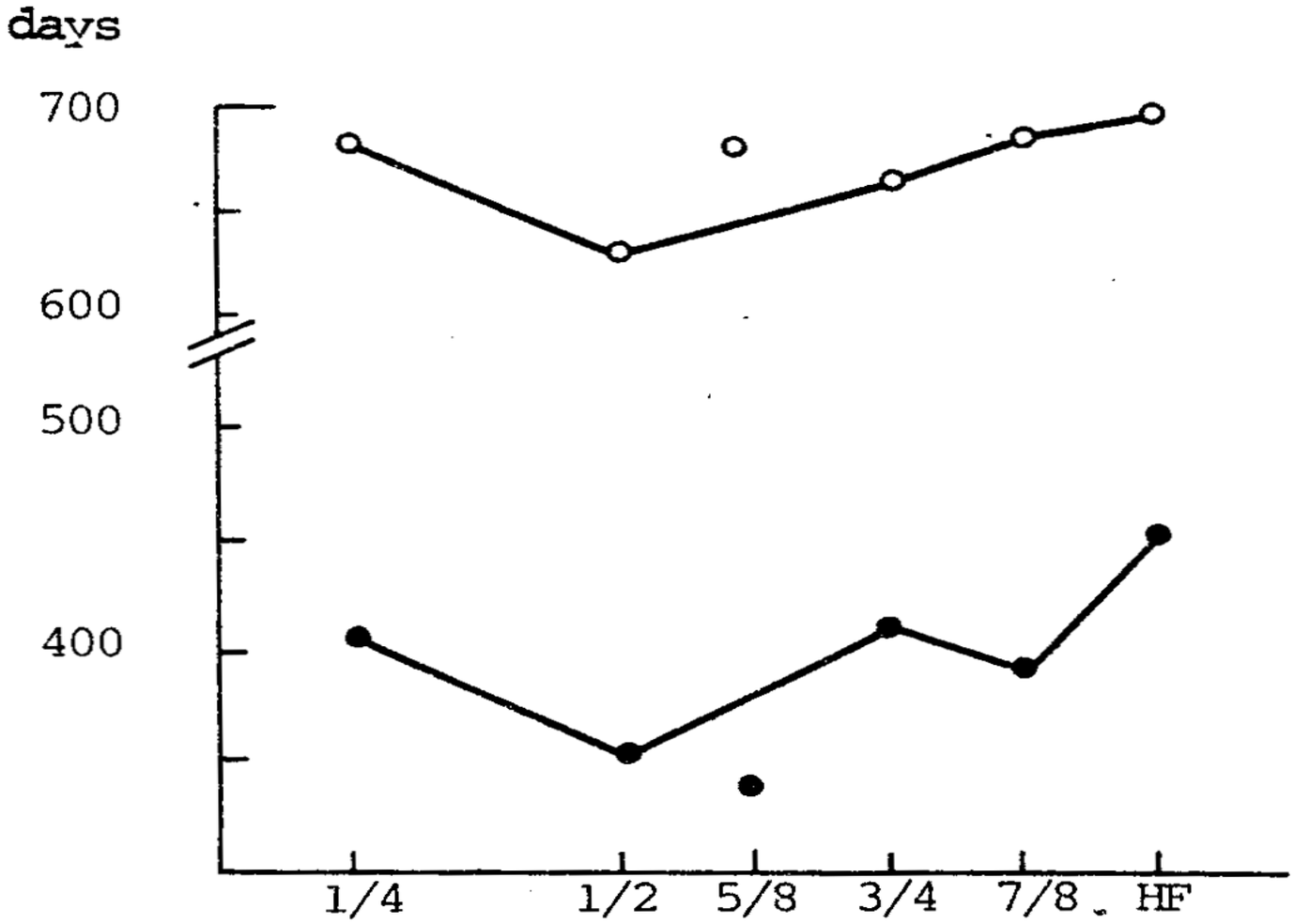

Figure 2 Calving intervals for six Holstein-Friesian x Guzera grades at high (*) and low (°) management levels.

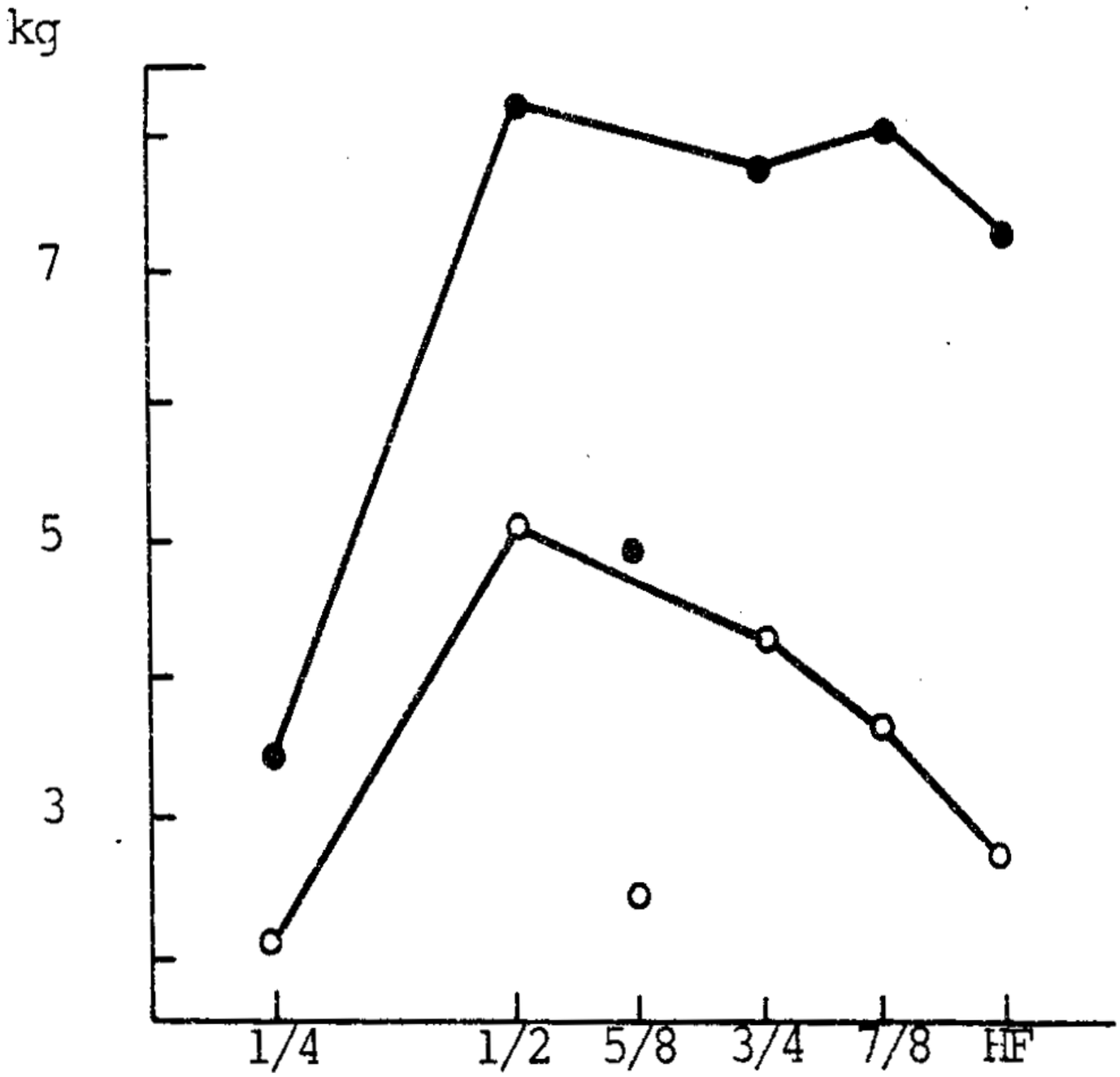

Figure 3 Milk yield per day calving interval for six Holstein-Friesian x Guzera grades at high (*) and low (°) management levels.

Another example of genotype x environment interaction - perhaps an obvious one - is shown in Figure 4, where tick (Boophilus microplus)field burdens are shown for heifers of the six HF x G grades at 12 different occasions (Lemos et al ., 1985). At the low levels of infestation, differences between gradles in tick resistance were small, but they amplified at higher infestation levels. The economic values of the genetic tick resistance of zebus and Criollos (Ulloa and De Alba, 1957) depends on level of infestation, and would become irrelevant should ticks

be controlled by pasture spelling (Sutherst et al., 1979) or, in the future, by vaccination (R.W. Sutherst, personal communication).

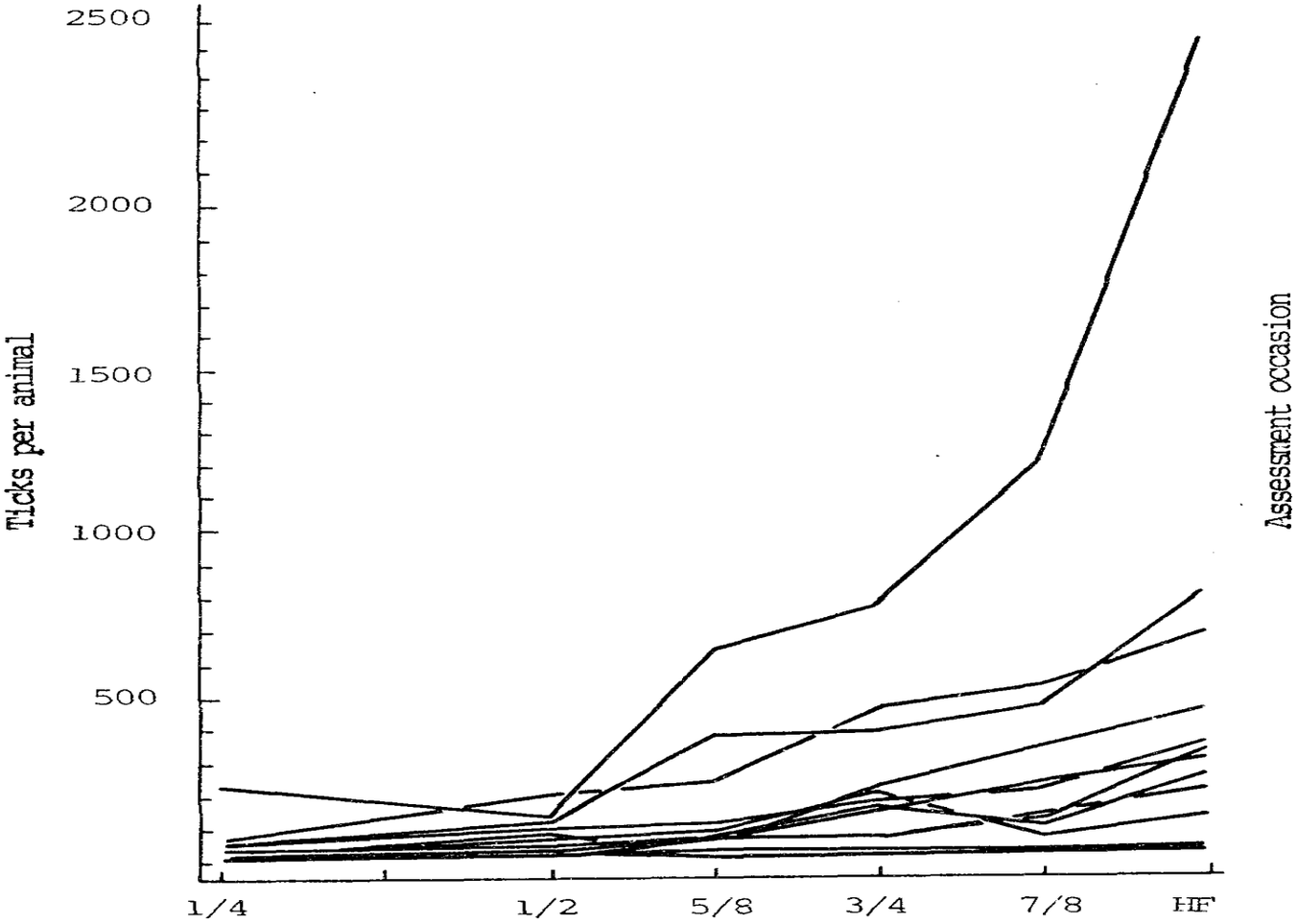

Figure 4 Average tick count per heifer for six Holstein - Friesian: Guzera grades at twelve assessment occasions.

3. CROSSBREEDING STRATEGIES

The HF x G results presented above belong to an experiment designed to compare the following crossbreeding strategies (Madalena, 1981):

1. Grading up to HF (represented by the HF group).
2. Creating a new breed (represented by the 5/8 group).
3. Crisscrossing, or rotation in each generation of HF and G sires.
4. Modified crisscrossing, repeating the HF sire breed for two generations, followed by G sires.

The latter procedure was suggested by Madalena (1981) to maintain the crossbred population at higher European grades (3/7, 5/7 and 6/7) than would be possible by crisscrossing (1/3 and 2/3). Mean performances for these two strategies were estimated from predicted means of the resulting grades under a breed additive difference and heterosis model (Dickerson, 1973). The results for milk yield per day of calving interval are

shown in Table 1. F1 were taken as a reference because they had the highest performance of all six groups (Figure 3).

Table 1 MEAN MILK YIELD PER DAY OF CALVING INTERVAL FOR SEVERAL CROSSBREEDING STRATEGIES OF HOLSTEIN-FRIESIAN (HF) X GUZERA (G), RELATIVE TO F1- PERFORMANCE

Crossbreeding strategy	Management level	
	High	Low
F1 Crisscrossing	100	100
HF-HF-G	98	85
HF-G	77	75
New breed	59	47
HF grades	80	53

Does not consider the purebred herd necessary to produce the F1.Continuous production of F1 heifers would not be practical on a regional scale, but it might be a good commercial proposition for individual farms in specific cases (Madalena, 1981).

Crisscrossing repeating the HF sire showed the second highest performance at both management levels (Table 1). Although the practical rule to apply this scheme is very simple, it requires the mating of females with a grade higher than 3/4 HF to the G bull and the other females to the HF bull, most farms would lack the organization required to keep track of which females should be mated to each sire breed. The scheme requires keeping at least one bull of each breed, which would not be economical for small herds, so it is better suited for artificial insemination in this case.

Dairy farmers unable to organize rotational crossing would still have two ways of maintaining the herd at intermediate grades:

1. Periodic switching of the sire breed (Roger, 1973). This is the prevailing practice at dairy farms in southeast Brazil (Madalena, 1981). it has the disadvantage of producing a high proportion of extreme genotypes, with too much or too little zebu breeding.
2. Use of crossbred bulls. Poor performance should be expected from inter se matings of unselected crossbred bulls and cows, as those used in our experiment. Negative effects of heterosis breakdown should be counteracted by selection for milk yield. Conventional progeny testing (using elite herds) would be quite possible in many Latin American countries, so that bulls for natural service could be produced by artificial insemination of the better cows with semen of proven bulls. In my opinion, difficulties for the implementation of a scheme of this sort lie more in poor organization of public institutions than on other factors.

Purebred European cattle may be the preferred option for the more intensive systems, particularly when climatic stress is attenuated by high altitude. Based on the results mentioned above, it would appear that purebred HF may be recommended for systems capable of sustaining lactation milk yields of at least 4000 kg, 10 kg per day of calving interval and calf mortality of 15 percent or less up to one year of age.

The elements for deciding on breeding strategy for beef cattle are quite different from those considered for dairy cattle. Practical problems to implement rotational crossing should not be very important as separate breeding herds may be kept for each sire breed (Madalena, 1977). On the other hand, reproductive efficiency of non-adapted European bulls may be seriously impaired in natural service under extensive conditions (Table 2), so

the introduction of genes from these breeds would require the use of crossbred bulls (or artificial insemination when possible). However, heterosis breakdown seems to be less important for reproductive and growth traits than for milk yield and lactation length. Plasse (1983) indicated that zebu-Criollo rotational crossing or composite populations including also other European breeds are promising alternatives, although not enough information is available yet for a final comparison of breeding strategies.

Table 2 REPRODUCTIVE EFFICIENCY OF BULLS OF SEVERAL BREEDS IN NATURAL SERVICE TO NELORE FEMALES IN BRAZIL (from Razook et al., 1985)

Breed of bull	Number of females exposed	Calving percentage
Nelore	177	79.7
Canchim	171	83.0
Sta. Gertrudis	168	48.8
Holstein-Friesian 1/	206	47.1
Brown Swiss 1/	204	52.5
Caracú	170	73.5

1/ Includes some artificial insemination.

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CRIOLLO CATTLE OF LATIN AMERICA

Jorge de Alba

1. INTRODUCTION

The term "Criollo" has been used since early colonial times in Latin America in reference to both people and animals born in the newly-discovered land from imported parents. The word is thought to be French origin, from the equivalent "créole". In Portuguese the term is "crioulo".

As applied to cattle it specifically refers to types and "breeds" of "bos taurus" that evolved and differentiated from the parent stock through the joint action of natural selection and the husbandry to which they were subjected by early settlers. Very distinct ecotypes were created specifically adapted to harsh environments. For this development to take place, early isolation, as well as sufficient time was required for the initial variability to change frequencies and shape the gene pool into something very different from that of the original importations. In this context the Longhorns of the North American western plains are true Criollos. They developed from some lost herds of the earlier Spanish conquerors with minimal intervention of man, after the 16th century, in the vast expanses of Texas, New Mexico and Oklahoma. They acquired great adaptability to very dry conditions and ability to reproduce very effectively where forage was sparse. Their capacity to walk swiftly was well appreciated by drovers when the famous trails to the first railheads were utilized to give a market outlet to the accumulated numbers; this walking ability paradoxically, practically drove them to extinction. The creation of ecotypes is repeated in various regions and environmental niches from the Rio Grande to Patagonia, not excluding the islands of the Caribbean, though man's farming practices were more evident in the evolution of some types. No Criollos developed in the American colonies of the present US because the early bovine populations were constantly influenced by new importations, particularly at the time when specialized breeds were being perfected in Great Britain, the Channel islands and the European continent. On the other hand the "Canadienne" developed in Quebec is really a Criollo breed developed for extreme winter hardiness and ability to thrive on poor roughages by farm owners who appreciated milk for the household.

This paper deals in more detail with the Criollos of Spanish and Portuguese America, with particular emphasis on tropically adapted Criollos. This attitude is based on the conviction, supported by experimental evidence, that tropical adaptability constitutes their most valuable economic asset. This, the author believes, is valuable for the development of human welfare in those regions. Temperate zone Criollos have a lower claim for preservation or survival since more productive types, easily obtained from developed countries, also in the temperate zone, can, and do, manage to live very well and produce effectively in Latin American regions further north or south of the tropical band, or within tropical latitudes in areas where altitude makes for a temperate climate; all this is true provided feed resources are created by man to meet their higher needs. The present status of the types discussed and their relation to the preservation efforts and organization of breed or performance records is summarized in six tables presented in this article.

2. ORIGIN AND GENERAL PATTERN OF EXPANSION

Christopher Columbus brought the first livestock to the American continent on his second voyage. The provisioning of his seventeen ships took place in Cadiz, sailing on 25 September 1493. No record has been revealed yet of how many animals he procured from the Spanish mainland. But he made a second attempt to provision his ships at La Gomera, in the Canary Islands, where he recorded taking in cattle, sheep, goats, chickens and pigeons. His fleet arrived at Hispaniola on 22 November, after discovering Dominica, Guadalupe, the Virgin Islands and Puerto Rico. Columbus was a very sick man on this voyage and his diary is incomplete,

but it can be surmized that no animals were landed on these islands where no Spanish settlement had yet been attempted. Indeed the animals could not have been landed in the first settlement at Hispaniola that he had founded on his first voyage (Nativity) because he found it destroyed and chose a second site for his second attempt at colonization; this time near the first on the northern coast, at a spot he called Isabella. This little seaside port still exists. Some of the Criollo cows recruited for a conservation and study herd founded in 1973 at Santiago, some 50 miles inland in the Dominican Republic, came from that very spot. Indeed one of the cows with superior conformation that convinced this writer to strongly recommend that a herd be founded was sited a couple of kilometres from Isabella.

The northern coast of Hispaniola is very humid east of Isabella, and very dry to the west, hot all the year round. In 1493 it was heavily forested and that environment yields very little forage for bovines. They soon found their way to the interior, where more open country and fertile river beds afforded ample forage. The herd multiplied and became somewhat feral in a land of no fences and no European settlements. A tropical Criollo had started to evolve from the Andalucian and Canary Islands foundation.

The multiplication of cattle, horses and pigs in the interior of Hispaniola was in full acceleration by 1510, some four generations after their arrival. It was from Hispaniola that cattle were sent on all the voyages of intended settlement, immediately after conquest, first to the immediate islands of Jamaica and Cuba and then to the continent. It is known that a man named villalobos arrived with cattle near Tampico, Veracruz in 1521. Similar conquests followed by colonization occurred on all continental lands from Florida to many spots on all coasts of the Caribbean. In most cases, ships that brought cattle obtained their stock from Hispaniola or Cuba, some from Jamaica and few direct from the Canary Islands. The introductions to Brazil and southern South America were not from Caribbean origin but direct from Portugal, Spain or the Canary Islands. The multiplication of cattle in America after 1521 was phenomenal. It suffices to say that the first cattle to enter the present day United States territory occurred in 1540 with the expedition of Coronado which started in central Mexico and ended in southwestern US. He gathered without much trouble 500 head of cattle. This story is flamboyantly told in such books as Dobie's "The Longhorns" (1941). The increase in numbers is documented in other historical anecdotes. For instance in the province of Jalisco in Mexico, where natural grasslands existed for the benefit of the early cattle, it is reported that one ranch by the end of the 16th century, only 79 years after Bos taurus had arrived in Mexico, branded 30 thousand calves, not counting many strays lost to other regions since there were no fences (Rangel, 1924). From the same source we learn that in Mexico city by 1614 one hundred bulls could be spared from breeding and used for a mammoth celebration upon the arrival of a new Viceroy with the staging of multiple bullfights.

Incidentally, the fighting bulls of today in Mexico, Colombia, Venezuela and Peru are not a true Criollo type since they are the result of multiple and recent importations from Spain; no doubt it shows particular genetic drift in each location but it is not the product of the forces of natural selection acting upon a transplanted population. Other instances of the multiplication of all Criollos in the Americas have been told and documented by Rouse (1977) in a book dedicated in its entirety to the subject.

The seedstock arriving at the Caribbean islands was of varied origin and genetic constitution. Spain at the time of the conquest had no recognized breeds of cattle, except some strains of fighting bulls. The Canary Islands had different stock with some probable admixtures from Africa and again the cattle of Portugal were somewhat different. This diversity meant also genetic variability so that the limited number of imported stock subjected to expansion, could rearrange and change the gene frequencies of its pool. Even within one country like Colombia which received all its European seedstock of cattle through the river Magdalena produced divergent types adapted to tropical and non-tropical environments, essentially short-haired cattle for the former and long-haired cattle for the latter, or more remarkably a third type for the intermediate mountains, the Blanco Orejinegro. This ecotype has white hair on most of its coat except the ears and extremities, and besides its distinct coloration

(that has absolutely no connexion whatsoever with the White Park cattle of UK which it superficially resembles, and proves that coat colour genes are older than breeds) developed the toughest and thickest skin and possibly internal immunity defences against the tropical Ox Warble (Dermatobia hominis) and could prosper on the steep middle mountains of Colombia where the parasite prospers on all other kinds of cattle.

3. CROSSBREEDING AND THE DECLINE OF CRIOLLOS AS DOMINANT ECOTYPES

Four centuries elapsed between introduction early in the 16th century and the decline and substitution of the Criollos by introductions of other cattle in the second part of the 19th century with great acceleration early in the present century.

The distinct populations that developed can best be described as ecotypes to emphasize their adaptability to particular regions. Some of the groups have been described as "breeds" and preserved in experiment stations run by governments. The result more often than not has been deleterious to the ecotype. Small populations moved to. management situations that were not identical to those practised by practical farmers and, committed to the perfection of pure lines as judged by minor exterior "points", soon became zoological curiosities, inbred and very "pure" by criteria of breed definitions defined by station technicians, not breeders, and with little attention to improving their productive performance. Some became extinct precisely in the hands of government run stations, In some cases the breeders went a separate way and saved the "ecotype" by making a living from more productive lines. In most cases though identity of the ecotype was destroyed by indiscriminate crossbreeding. In both beef and milk production the introduction of European modern breeds (unadapted to the tropics) or zebus (highly adapted, but not necessarily more productive) resulted, in particular in the first cross, in populations that were obviously more productive through the phenomenon of hybrid vigour.

Experimentation followed breeders' observations and the value of heterosis is well documented; in the case of crosses for beef production, when Criollos were used as the mother breed, superior beef calves are produced in the F1 (steers) and the corresponding crossbred cows are also superior (in fertility and producing ability) than the average of either parent. But the average of the recently introduced breed in the form of bulls was unknown to the rancher or farmer: he could judge only the miracle of the hybrid. Experimental data confirmed these observations but warned at an early stage that F2s or backcrosses were not as good. (Data for Bolivia, Plasse et al., 1975; for Venezuela, Linares et al 1974; for Costa Rica, Muñoz and Martin, 1969 and Perozo et al., 1971) However few or no experimental evidence has been gathered on F3 or later inter se crossbreds.

Besides the benefits of hybrid vigour in two generations, research points out the high fertility of the Criollo as a mother cow. This was a quality not so easily observed by the breeder. In milk production the number of published papers with sufficient data and good designs is more limited. Crossbreeding of milking-type tropical Criollos with European dairy breeds is well documented in the case of the Jersey (de Alba and Kennedy, 1985) though growth rate is nowhere as responsive as occurs in crossbreeding with zebus; the longevity of the F1 Criollo x Jersey or its reciprocal in one generation renders stability in the milk line 90 percent greater than the average of the parent breeds in the same environment (de Alba and Kennedy, unpublished).

The experimental observations came after the experience of the overall results by practical farmers, the flourishing hybrid enamoured the breeder to the newly introduced breed and attributed all benefits to the new bulls. The experimental data arrived a bit late and was not complete in many cases since backcrosses or F2s were so slow in coming and so expensive to maintain in well balanced trials. The most common consequence has been, particularly since 1920, that the Criollo has been substituted by a series of less adapted mongrel populations. In Brazil the substitution has been most complete in favour of zebus. It should be said in all fairness that the zeal and new interest in cattle breeding that the zebu generated has been a step forward in organization, something that the early Criollos never benefitted from. A similar case happened in Argentina

where Criollo types were substituted by absorption to Shorthorn first and then these substituted and absorbed by Angus and Herefords, a process not very different from that of the elimination of the Longhorns in the US by the same English breeds and now they are being threatened by the continental breeds. Colombia and Central America which were strongholds of Criollo ecotypes have also travelled the same road.

In the case of tropical milk production the loss is more lamentable because zebus in their own right are respectable meat producers but very poor milkers. Many primitive milk producing and cheese manufacturing areas of the Latin American tropics have turned to beef and abandoned milk production.

The stage was set, after 1960, for more refined studies and for an assessment of which ecotypes, in what circumstances, should be preserved under the knowledge that it was recurrent crossbreeding that would create the demand and justification for improved Criollos. In all this work it has become more urgent that official government effort adopt an intelligent dialogue with breeders and conviction should be mutual that the preservation effort needs both performance data and interchanges of ideas and germplasm with breeders. The interchange of ideas with the practical man who makes a living from cattle raising has not always been deemed indispensable by the preservation efforts of the past. We shall see that in the individual ecotypes, listed in the rest of the paper, whenever breeding efforts have involved both experiment stations and farmers the usefulness of the Criollo types has made steady progress. On the other hand when the preservation efforts in closed herds have become subjected to the whims of shortsighted technicians, bureaucrats or politicians, an expensively set up station has become a practical failure.

4. DESCRIPTION AND PRESENT STATUS OF EXISTING CRIOLLO ECOTYPES

In this section we will attempt to make a brief description of Criollo breeding groups including some true breeds which can claim some breeder organization behind them and we will make an effort to state their preservation status. The groups will be classified by broad geographical and climatic zones where they evolved and for which they are adapted. Repetition will be avoided by grouping related types with beef and dairy Criollo populations treated separately, with a shorter description of non-specialized groups. Some selected key references are included for each type, though some of the descriptions and statements may stem from first-hand knowledge as observed by the author.

4.1 Criollo Beef Types in the Lowland Tropics

Table 1 LOWLAND TROPICAL BEEF CRIOLLOS
Location, Population Trend and Knowledge

Name	Country of of orgin	Present numbers (approx.)	Population trend	Descriptive and research literature
Romosinuano	Colombia	9 000	+	+
Senepol	U.S. Virgin			
	Islands	3 000	+	0
San Martinero	Colombia	4 000	+	+
Cuban Criollo	Cuba	4 000	0	0
Mocho Nacional	Brazil	?	-	+
Yacumeño	Bolivia	30 000	-	+
Chaqueño 1/	Bolivia Argentina	10 000	0	0
Casanareño	Colombia	17 000	-	0
Llanero	Venezuela	20 000	0	+
Curraleiro or Peduro	Brazil	500	-	+

1/ There is an effort to select Chaqueño Criollos for milk in Sauzalito, Argentina.

0	=	static	0 = scanty or nil			
+	=	increasing	+	=	fragmentary	
-	=	decreasing	++	=	ample	

Table 2 LOWLAND TROPICAL BEEF CRIOLLOS Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Romosinuano	2 1/	3 2/	2 3/
Senepol	0	3	3
San Martinero	1	1	0
Cuban Criollo	2	2	0
Mocho Nacional	1	0	1
Yacumeño	0	2	0
Chaqueño	1	0	0
Casanareño	0	0	0
Llanero	0	1	0
Curraleiro	1	0	0

1/ 0 = none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

4.1.1 Romosinuano

Origin, location and adapt ability - The Romosinuano derives its name from the plains of the river Sinú where it evolved, in the northern humid tropical coastal plains of Colombia, as well as the fact that it is polled (Romo). It is a breed capable of producing early maturing beef on an all-pasture regime, is tick resistant and heat tolerant. When first recognized, it was thought to be exclusively adapted to the humid and sometimes swampy coastal plains of northern Colombia with over 1 700 mm of fairly well distributed yearly rainfall. But it has extended its foothold recently to less fertile regions with poorly distributed rainfall, or a prolonged dry season, though the same total or even more water may fall in the rainy season.

Distinguishing characteristics and performance - Very short legged, pale red hair predominating though some individuals are dark red, a uniform unbroken coat colour with pigmented skin that may be either red or black. A definite beef type with wide loin and long wide rump in the best individuals. Two of its most valuable characteristics are tameness and high fertility. Data from Colombia (Hernandez et al., 1971) demonstrate attainment of calving intervals of 373 days in 1835 observations with 54.3 percent of them being below 365 days. In crosses with other breeds and breeding groups it has repeatedly produced higher calving and rearing percentages than Brahmans or zebu-derived beef breeds (though often but not always surpassed by hybrid cows of these breeds). Low milk yield of the purebred cows is probably related to their high fertility, weaning weights are therefore relatively low individually but weaning tonnage from the whole herd is high. Weaning weights of calves at 210 days rarely surpass 190 kg for males with averages of 170 and females reaching 170 and averaging 156. Weaned at 240 days, males have averaged 220 and females 190. At 18 months males have been equal to Brahman herdmates with 285 kg, while F1 hybrids at the same age have reached 310. Very acceptable carcasses are obtained from liveweights of 350 kg at 24 months on all-grass green-year-round pastures. Average mature weights of cows are at 470 kg and bulls 700 kg. Evidence for heterosis for beef production in crosses between Romosinuano and zebus is well documented with increases of 22 percent in post weaning weight gain over parental average (Hernandez, 1978b).

Related and similar types - Fairly identical to the Senepol of the US Virgin Islands of St. Croix. Also similar to the Mocho Nacional of Brazil.

Conservation status - The breed was threatened through absorption by zebus due to the success of the hybrids. A preservation herd was maintained by the Colombian Government at Monteria, Sinú, but was not very successful in improving performance or expanding numbers. Since 1958 a policy of lending groups of 25 cows and two bulls to interested farmers, though slow to take hold, has been very successful. A breed association was formed in 1976 with interested breeders increasing every year, and herds established outside the original home of the breed.

The "Associación Colombiana de Criadores de Ganado Romosinuano" has its address in Bogotá, Apartado aéreo 4255, Colombia and keeps track of about 9000 animals in its books as live breeders in 1985.

The experiment station of the OAS at Turrialba maintains a herd of 150 cows and is promoting the formation of several satellite herds of private breeders and the Costa Rican Ministry of Agriculture. A herd is under formation from that stock in Mexico.

Source of breeding stock and germplasm - CATIE at Turrialba, Costa Rica has a programme of selection on total performance of cows and on weight gains of pasture fed young bulls. Frozen semen is available locally and for export. The Costa Rican Ministry of Agriculture has maintained a registry and freezes semen from its best bulls.

Ideas about its future - The breed no longer has a threatened status and has moved into development wholly supported by breeders in Colombia and the same is expected to occur in Costa Rica, with valuable assistance from experiment stations. It has affirmed its worth mainly due to its demonstrated high fertility under tropical grassland conditions. However it requires more use of gain tested bulls particularly in Colombia where too much emphasis on shows has prevailed. The relatively small original numbers, before expansion, guarantee uniformity but there is danger of excessive breeding. The great similarity that it has with the Senepol of St. Croix would speak for the advantage to both breeds to break away from inbreeding danger with an exchange of germplasm. This would be beneficial to both populations.

Key references - The popular literature of Colombia abounds with articles and photographs but factual data on performance is limited (Pinzon, 1984; de Alba, 1984).

4.1.2 Senepol

Origin, location and adaptability - Derives its name from the belief that some cattle from Senegal were incorporated into its breeding, and the fact that it is polled. It is claimed that N'Dama blood came from Senegal, yet the only existing photograph of that importation shows animals with zebu characteristics, which are not evident in the present day Senepol. It is also known that in the heyday of the sugarcane plantations during the Danish rule in St. Croix, many cattle were brought as draught animals from the small island of Viquez, between St. Croix and Puerto Rico. These cattle were Criollos and it is from them that the Senepol inherited various traits that make it similar to the Romosinuano: wrinkles around the eyes, or on the forehead in some animals, scanty tail switch and long rumps with abundant muscling. Pastures have been improved recently in St. Croix and great uniformity has been attained in the island herd. Well adapted for beef production under lowland tropical conditions.

Distinguishing characteristics and performance - Darker red than Romosinuano, short legged, prominent vertabrae in tailhead associated with ample birth canal. Red or black pigmented skin, short haired, tail switch very short, as in all tropical Criollos, either black or red, ears very small but pointed in some individuals denoting some zebu genes. Abundant data will be available since the local experiment station is interested in bull testing and semen has been exported for crossbreeding studies at the USDA station in Brooksville, Florida. Interest has spread to southern US breeders.

Conservation status - A breed association has been formed in St. Croix and interested breeders have sprung up in southern US and some semen has been exported to Mexico. It is well on the road to rapid expansion.

Source of breeding stock and germplasm - Frozen semen is available from the experiment station in St. Croix, 00850, US Virgin Islands, and the breed association has exported breeding animals.

Ideas about its future - The breed dominates all breeding on the island of St. Croix. It has nevertheless a narrow genetic base, exchange of semen with Romosinuano would benefit it as well as keeping intact its tropical adaptability, which maybe is lost in the more temperate mainland US. Tests for the presence of the zebu "Y" chromosome should precede its use on the Romosinuano.

4.1.3 Romana Red

This a beef breed derived from crossbreeding of Criollo cattle of the Dominican Republic with old importations of zebus other than Brahman. It was relegated to second place by the originators, the Romana Sugar Company when the popularity of the Brahman made its mark. But the early Romanas which were developed for draught were kept separated. Renewed interest on the part of the Company has sprung up. They are generally red with black markings, rather long legged. Some data reveal that they are more fertile than the rest of the cattle on the large farms. Very few breeders exist outside the Sugar Company.

4.1.4 San Martinero

Origin, location and adaptability - This is an improved breed of the Llanos of Colombia. ft owes its name to the town of San Martin where Jesuit fathers gathered some Llanero cattle and made some attempts to improve ranching practices with the available stock. Some Durham bulls were imported into the area about 100 years ago. Tradition holds that they perished very quickly but left a few offspring from which the San Martinero evolved. They have a good record on poor soils and long drought periods reaching higher weight for age than zebus or common Llanero cattle under harsh tropical conditions.

Distinguishing characteristics and performance - Hair is longer than in the Romosinuano and not exclusively red, but dun and black-marked cattle are common. The bone frame is taller and more sturdy than in other cattle of the Llanos, though horns and small ears are very similar, but it has a more abundant and longer tail switch. Bulls when well fed reach 700 kg and cows, though extremely variable, range from 380 to 450 under grassland conditions at the end of the rainy season. When fed in dry lot, steers were surpassed in liveweight gains by zebus but hybrids of the two breeds were superior to the parental average at 32 to 34 months of age (Fajardo et al., 1976a and b; Arango, 1976b) with 12.7 percent for liveweight and 13.3 percent in heterosis for warm carcass weight when pure San Martineros weighed 425 kg, zebus 472 and the hybrids 509 kg. Yield of boneless beef was 136, 160 and 180 kg respectively.

Conservation status - As with the Romosinuano a preserved herd has been maintained by the Colombian Government at Iracá in the Llanos, near San Martin. Not much progress has been attained but breeders are now interested and a breed association has been organized, with some 4000 individuals initially counted prior to formal registration.

Sources of breeding stock and germplasm - The breed lacks sufficient records to guarantee selection of superior animals. All stock has been confined to the distant Llanos though some individuals are kept on and off at the highland station of Tibaitatá, where semen is sometimes frozen.

4.1.5 Cuban Criollo

The Cuban Criollo was originally selected as a dual purpose animal with some breeders emphasizing beef and others milk. Recently all breeding has been in the hands of the government with emphasis on beef since little or no milk records have ever been published. It shows some recent admixture of zebu blood in most individuals, though it is predominantly of Spanish origin. Bulls can reach an impressive tonnage in liveweight. They are predominantly dun coloured with red and black skin, short haired, but not as short as in the Romosinuano or Dominican Milking Criollo, its close neighbour. A well documented description is not available, though there are abundant short references in popular literature. Few technical writers have visited the herds kept under government auspices where it is said that selection is being carried out for rate of gain; dry lot feeding is common.

4.1.6 Mocho Nacional

A Criollo breed of Brazil, red, hornless, somewhat smaller than Romosinuanos. The name is mentioned for the sake of completeness and its similarity already mentioned to the Romos. It suffered from lack of foresight and nil contact with famers of a preserved herd gathered at Nova Odessa, Sao Paulo in 1911 (Jordao, 1956). Too much attention was given to the finer points of a presumed pure type, and the small group soon became inbred. Presumably it had been important in the 19th century. It seems that it can be considered almost extinct by now. A new effort to establish a government herd has been undertaken in 1985 by EMBRAPA, Brasilia.

4.1.7 Criollo Yacumeño

Origin, location and adaptability - This ecotype evolved in the Beni region of Bolivia, on tropical lowlands little known or visited by the Bolivian technicians or visitors from outside the country. It has gained recognition largely through the observations made on a large beef producing establishment (Estancias Eisner) and the association between a dedicated manager and a sound geneticist adviser. Some of the work has been published (Plasse et al. , 1975; Bauer et al., 1976, among others). The most striking find has been the hybrid vigour measured for growth and weight gained in crosses with zebus (Bauer, 1973). Also, the purebred Yacumeño has gained a name for itself as an efficient producer under harsh conditions through early results on a selected elite herd. The name comes from the river Yacumá which has its source in swampy lands partly drained by the river Beni, west of the Yacumá, which passes by, coming from the higher Andes, with both rivers following different courses towards the Amazon. The average altitude is 200 m, and temperature 27 C with rainfall accumulating 1800 mm between October and March and practically nothing between April and September.

The breed is thus adapted to extensive ranching, poor soils and alternating periods of excess rainfall and extreme drought.

Distinguishing characteristics - The breed comes in a variety of solid colours with dun and red predominating; is horned, black-hoofed with short hair; tail and head markings may be black or red, skin is pigmented. More has been published about its performance than its appearance or external variability, a rare case for Criollos.

The selected herd has been created with fertility and breeding performance as its goals. Bulls are produced from this herd as well as from a Nellore herd of Brazilian origin for a criss-crossing programme that involves some 30 000 cows. The selected group of Criollos is made up of a herd of 500 cows obtained by carefully examining records and palpating for pregnancy in an original lot of 6000. This work was started in 1961. By 1974 the selected group showed decided advantage in the number of pregnant cows palpated after a restricted breeding period, with a remarkable 95 percent, followed by the halfbreds (F1s with Nellore) that reached 86 percent. The non-selected Criollos were inferior to these two groups, though more fertile than many other populations, with 75 percent, and were ahead of a group of 1474 purebred Nellores that showed 71.5 percent. In a study involving 15 838 steers coming from commercial crossbreeding and excluding products from the purebred herds the carcass weight averaged 248 kg from F1S when the average was 230 and the non-selected Criollos yielded lighter carcasses. The tropical world looks forward to more advanced results and the use of these improved Criollos by other regions.

Conservation - The ecotype would have been threatened with extinction were it not for the work of Bauer and Plasse. At the moment it constitutes one of the most promising sources of improved tropical beef cattle germplasm. The selected herd of 500 cows will produce all the bulls needed for criss-crossing within the corporate farms; larger numbers will be needed for sale and establishment of other nuclei.

Source of breeding stock and germplasm - At the moment the only source is with the home herd. It is logical to expect, if the work is adhered to for another 10 years, that the improved Yacumeño will consitute a logical source of improved germplasm for all lowland beef production in the tropics. The Colombian and Venezuelan Llanos, the Chaco and headwaters of other Amazon rivers may well look upon the Yacumeño as a source of improved beef Criollos.

Key references - Besides those cited, Bauer has produced a mimeographed description of the Yacumeño, available through Bernardo Bauer, K. Estancies Eisner, Casilla 2, La Paz, Bolivia.

4.1.8 Minor groups of tropical Criollos utilized for beef

Under this heading are grouped poorly characterized ecotypes that are found in several regions of South America. Descriptions are brief since they have not appeared in technical publications. Indiscriminate

crossbreeding and poor contact or identity of owners as interested breeders make the knowledge very fragmentary; some are still numerous and others threatened with extinction.

Chaqueño - Is a group that has survived the rigours of the Chaco region of Bolivia and Paraguay. In what respect they differ from neighbouring types is not known. The Bolivian Government has shown recent interest in establishing a preserved herd.

Casanareño - Derives its name from the Casanare river in the Colombian Llanos; it is logical to think that it is a close relative of the Llanero Venezolano since there are no natural barriers between their respective areas of origin. They come in all colours, always solid with pigmented skin, a few "barrosos" or blue-gray and very few blacks. In colonial times and early 19th and 20th centuries they were milked during the rainy season and were the source of a Llanero cheese that was marketed in the 19th century and has now disappeared with the emphasis on beef production. Their value lies in the fact that they are still abundant (a recent estimate places them above 17 000) and in their ability to produce hybrid vigour with zebus. Its whole area of occupation is under very poor management. Its value and worthiness of preservation seems to be much in doubt particularly if the San Martinero of the same region continues to make progress at the level of breeder organization.

Criollo Llanero - Very similar to the Casanareño, again not much known about it. They are very much present in Venezuelan literature and folklore. A whole system of land use in the Llanero society developed with them. They were milked seasonally in the past. They appear briefly in the scientific literature through the work of Plasse and his colleagues through work carried out at Calabozo, Venezuela (see A.L.P.A. Mem. 1974, 3: 46, 47, 48, 61, 90, 91). Weight at birth was 25 kg for both sexes combined, growth under irrigated savannah pastures was 603 g when Brahmans reached 660 g; weight at 18 months for both sexes again was 420 kg when Brahmans reached 465 (out of purebred cows, but representing crosses with different bull breeds). The F1 heifers out of Criollo cows surpasses averages of the parents with a daily gain of 703 g and weight at 18 months of 497 kg. in this small sample of data, the story repeats itself of the superior hybrid obtained from a very unimproved Criollo when mated with zebus, Brahmans in this case. The data is more surprising with age at puberty, seldom mentioned in this review of known performance, as determined by palpation, of the first corpus luteum. It appeared at 681 days in the Llanero, 730 in, the Brahmans, and 672 (22 months) in the F1 heifers.

The measurement of heterosis was possible in some of these studies and given by Plasse et al. (1974) as 20 percent for birth weight; 6.74 for daily gain before weaning and 8.97 percent for weight at 205 days and 17 percent for weight per day of age up to 18 months. Ordonez and Plasse (1971) took 26 measurements on 43 Llanero cows and give an average adult weight of 371 kg, with corresponding linear measurements confirming that it is a small breed, but fertile and capable of raising superior F1S in outcrosses. There seem to be no interested breeders or government scheme to preserve them or improve their qualities and like the Casanareño is threatened with extinction. If interest is found it should merge efforts with the Casanareño and Yacumeño.

Curraleiro or Pé-Duro of Brazil - This was a very abundant ecotype in Brazil prior to the arrival of zebus (Alves Santiago, 1960). The zebu expansion in Brazil is well documented: few samples came early, starting in 1813 from India, Africa and even Madagascar. In 1890, 200 animals arrived from Mysore, 150 in 1906, 200 in 1908 and 5000 between 1910 and 1955. The multipliction of these massive importations and a policy of grading-up to zebus wiped out the Curraleiro, and everybody forgot that the early fame of the imports owned half its merit to the mother cow. A few attempts have been made to establish preserved herds, but with little support over the years. The most recent has involved the Research Organization of EMBRAPA at a station in Teresina, Piaui, Brazil. It is hard to find animals of any merit in a few scattered remnants. It could benefit from the introduction of semen or bulls of better organized breeding seeking the same aim: a sturdier beef type Criollo destined to be used commercially for crossbreeding with zebus. Certainly the Yacumeño and San Martinero should be

considered, as it should specialize in fertility and growth. A brief reference by de Carvalho (1985) from Piaui serves to identify the recently formed herd.

4.2 Mountain Ecotypes - Lessons in Poorly Understood Preservation and Improvement

There are numerous Criollo nuclei that inhabit mountain slopes up to 4000 metres in altitude in the high Andes of Ecuador, Peru and Bolivia, parts of Argentina and Chile, and at lower altitudes, down to 3500 in Colombia or lower in Venezuela, Guatemala and Mexico. They are generally long-haired and much smaller than some of the improved Criollos of lower altitudes in the same countries. Their claim for survival is the fact that they contribute an important component of the limited welfare of the poverty stricken local populations. In the higher altitudes their immunity to chronic mountain sickness speaks also in their favour against "exotic" improvement schemes. Their productivity is low and scarcity of forage resources makes their substitution by larger, quicker growing or more demanding types virtually impossible or unadvisable. They are called Chusco or Serrano cattle in the high Andes, unspecified Criollos in southern Mexico. Some are even found in the high altitudes of Pico Duarte in the Dominican Republic and, as in the case of the Mexican or Guatemalan cattle, no local name is given to them.

Their improvement or preservation is enigmatic and challenging. Some areas of Peru have utilized Brown Swiss in organized ranches, but the usefulness of a larger framed animal for the poor peasants is very much in doubt. In Mexico much capital was spent on an ill-advised programme of preservation of Criollos of Chiapas. Some of the mountain types were confounded with lowland types and were managed with supplemental feed at great cost. Some were crossed haphazardly with bulls of no known qualities and even with imported semen (of all things with the Salers breed from France on the argument that they were also red). The demise of this programme is not missed, but the money spent will never be recuperated.

Three distinct Criollo groups are included under this heading: the Longhorns, the Frijolillo of Lower California and the Argentine Criollo. As a group they differ radically from the tropical types in having longer hair and a long and abundant tail switch whereas most of the Criollos of the tropical lowlands have very short hair and a very scanty and in extreme cases non-existent tail switch.

4.3 Temperate Climate or Subtropical Criollo Ecotypes

Table 3 MOUNTAIN AND TEMPERATE CLIMATE CRIOLLOS
Location, Population Trend and Knowledge

Name	Country of of orgin	Present numbers (approx.)	Population trend	Descriptive and research literature
Chuscos,	Ecuador			
Serranos,	Peru			
Criollo de las	Bolivia			
Sierras and	Mexico			
Highlands	Guatemala			
	Venezuela	2 000 000	-	0
Longhorn	U.S.A.	3 000	+	+
Frijolillos	Lower			
	California	5 000	-	0
Argentine				
Criollos	Argentina	2 000	+	+
Blanco				
Orejinegro	Colombia	4 000	-	+

0	=	static	0	=	scanty or nil
+	=	increasing	+	=	fragmentary
-	=	decreasing	++	=	ample

Table 4 MOUNTAIN AND TEMPERATE CLIMATE CRIOLLOS
Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Chuscos, Serranos			
Criollo de las Sierras			
and Highlands	1 1/	0 2/	0 3/
Longhorn	1	1	3
Frijolillos	0	0	0
Argentine Criollos	2	2	3
Blanco Orejinegro	1	1	1

1/ 0= none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

4.3.1 Longhorns

This ecotype is of great historical interest, though it has a potentially secondary role as a modern producing breed (Dobie, 1941). Only recently it has been recognized as a satisfactory meat producer. The natural grasslands of Texas, New Mexico and Oklahoma provided ideal conditions for the livestock brought by Coronado in 1540. Between 1866 and 1890 the railheads of the expanding eastern US railways provided markets and originated the famous cattle drives that added up to ten million head driven overland. When the railways were extended to the home of the Longhorn, the cattle drives were no longer necessary. On the return from markets the cattle cars brought Hereford, Shorthorn and later Aberdeen Angus bulls ready to displace the Longhorns with the backing of eastern finances and breed organizations to promote them. By 1925 the Longhorn had almost disappeared.

When the wildlife refuge was founded in the Wichita Mountains of Oklahoma, on 59 000 acres, only two head were found within (Williams, 1957). Funds were appropriated to stock the park and only 30 head were approved as phenotypically "Longhorn" among 30 000 head inspected in remote ranches of Texas and Oklahoma as well as Louisiana. They were taken to the refuge and numbered 300 within 30 years. A few breeders, among them the King Ranch, also took up the idea of preservation for sentimental reasons, as no productive qualities were recognized in the Longhorn. Mounting of horns or heads of steers with very widely spread horns became a fashionable decor for ranches, restaurant or hotels of the West. The Longhorn has returned, through that route, to some degree of popularity and, as is often the case, some important productive qualities are beginning to be recognized: their fertility, mothering ability and their ability to make a good living totally unaided by husbandry in desert grasslands. It is emerging also that their hybrids can be more productive than some of the purebreds of British origin that displaced them. Results of experiments now underway are anxiously awaited. Longhorn numbers are on the increase in the hands of fanciers more than producers though. A breed association has been formed and frozen semen is available from large distributors.

4.3.2 The Frijolillos of Lower California

Related to the Longhorns, they have been isolated in a harsher environment than that of the US western plains. Lower California is a very dry peninsula with many areas receiving less than 100 mm of rainfall per year, but it is full of thorny shrubs, saguaros and some small trees and sources of water are few and far between. Ranching has never been prosperous and always poorly organized. These cattle do not have particularly large horns like their US relatives. They are called Frijolillos more in Sonora than in their native peninsula, because of the high frequency of peculiar coat colours sprinkled with very small irregular spots that resemble a native pinto bean. Steers and bulls coming out of this desert are appreciated by fattening pens since they can show compensatory growth and attain over 400 kg on short sojourns in confinement. They have been subjected to a few studies and much has been said in Sonora and Lower California about conservation, but not much done.

4.3.3 The Criollos of Argentina

Origin, location and adaptability - The story of the Argentine Criollos Is the southern counterpart of that of the Longhorns in the north. They multiplied and provided the basis for a huge export industry of beef, first dried and then chilled or canned. They were totally dominant over the Pampas and north to the Chaco where this commerce flourished and produced money so that Shorthorns, Herefords and more recently Aberdeen Angus could be imported in large numbers. A few were early preserved in a small pasture commemorating the work of a writer who is dear to Argentine literature, Ricardo Güiraldes, at Pagos de Areco in Buenos Aires province. They are adapted to fend for themselves and were never completely replaced by British breeds in the drier part of Tucuman.

Distinguishing characteristics - These cattle are strongly built, big framed with fat steers attaining 500 kg. They come in many colours and have a particularly long tail switch, with cows in the habit of resting their coiled tails on their own loins. Some detailed studies have been published under the authorship of Dr. Sol Rabasa of the Institute of Medical Research in Rosario, Argentina. Most of the recent studies are confined to one herd at the experiment station in Leales, Tucuman.

It is encouraging for the practical application of the breed in the future that research results obtained under well managed artificial pastures in the station at Balcarce, south of Buenos Aires (Molinuevo and Miquel, 1979) that F1 calves obtained from Argentine Criollo sires on Aberdeen Angus females were quicker growing than contemporary purebred Aberdeen Angus: birth weights of 72 Aberdeen Angus were 27.6 kg when F1s weighed 30.1 kg, for males the corresponding averages for females were 27.6 and 28.1 kg. At weaning hybrids outweighed purebreds (A.A.) by 6 kg in males and 8.4 kg in females. In adults sexual dimorphism is shown by large bulls outweighing cows by more than 300 kg (Rabasa).

Conservation status - The Argentine Criollo has emerged out of a threatened status to a period of expansion and potential utilization in modern beef production. A breed association has been formed with a very enthusiastic following, and has its headquarters at Rosario.

4.4 Blanco Orejinegro - Unique Case of a Breed Founded on External Parasite Resistance

It is difficult to classify this breed under the group of beef producers or milk producer, or separated from temperate climate adapted Criollos. It is a mountain breed, but not of high altitudes. Its producing ability is lower than many of the better types of Criollos yet it deserves very serious consideration for its resistance and in some individuals total immunity to attacks of external parasites.

Origin, location and adaptability - The breed originated on the slopes of the Colombian Andes that have a mild climate and are heavily populated by an external parasite that produces suppurative sores where more vector flies are attracted to deposit more larvae and the sore may increase on susceptible animals to harbour 400 parasites in one huge lump. This is the Tropical Ox Warble, also known as Nuche, Tórsalo, Berne etc. (Dermatobia hominis). The slopes of its home grounds are very steep, perennially overgrazed and covered by short Paspalum grasses and some important tiny legumes. Pastures are green almost all the year round, one factor very much to the liking of the skin parasite, since there are two distinct rainy periods per year. This is where the northern winds that originate in Canada die out as they sweep south across the Gulf of Mexico and the Caribbean to dissipate their moisture against the first solid obstacle of mountains, the north face of the Colombian Andes.

These intricately woven mountains were taken over by the very fast expansion of coffee growing in the early 19th century. This brought wealth and purchasing power to a scattered population in the Departments of Antioquia and Caldas. Commerce developed before the coming of the railways (which have never been too successful in Colombia). Mules were scarce, so the Blanco Orejinegro was trained as a beast of burden and its appreciation rose in the eyes of the whole population since other cattle could not carry any loads if their backs, or sides at the rib cage were covered with Nuche sores Even the red Criollos from the North Coast, partially resistant, could not be used. The surefootedness of the Blanco Orejinegro, and docility made them ideal for the purpose. Furthermore the small coffee grower could keep a few cows fed on nothing but an enlarged corral and gleanings from the coffee rows or pruning from the shade trees. His deficient diet of expensive rice was well supplemented by the little milk he could obtain from white black-eared cows.

Distinguishing characteristics and performance - The Blanco orejinegros possess the strongest, tightest, toughest and thickest hide known to the author in any bovine. The hide is totally pigmented jet black and the hair is medium to short and white, except for the ears and extremities. This is the product of the dominant white gene

on a black self-base, often not homozygous, giving origin to whites with red ears (foolishly referred to by semi-techncial writers as the red mutation of the breed). It is the same combination of genetics of coat colour that give rise to the White Park Cattle of Great Britain as well as some individuals of the Fjallrasse of Norway. This only proves that gene versatility for coat colour of bovines is very old; it provided good material for Mendelian segregation and changes in gene frequency that were beneficial to the adaptability of this naturally evolved breed for the circumstances of the middle mountains of Colombia. The gene can as easily be found in the genome of a unique Criollo adapted to a parasite infested country as in the shaggy cold tolerant breeds that have an otherwise totally different genome. It should be stated that the partially dominant white is rare in other populations of Criollos, but not unknown. The author has seen and photographed individuals in Yucatán, Mexico, and Mr. John Cypher, professional animal photographer for the King Ranch, was kind enough to donate to me a picture of a white bull with black ears he saw near Managua, precisely in the regions in which I had told him all Criollos were either red or dun only.

The dominant white is incompletely dominant and never affects the ears which are jet black. It is also incompletely dominant because in crosses with solid coloured breeds the white is less extended in the extremities. There is a variety called "Azul Pintado" much favoured by some Colombian breeders which has abundant "flea bitten" small black spots giving the bluish appearance. But the black and white hairs mingle little so that the meaning is not synonymous with that of the Belgian Blue which has different genes in operation.

Only one work has been located by the author that proves that the immunity to Dermatobia is real. Colmenares (1961) classified the cattle found at the Nus experiment station (that included some crossbreds) at the time, by the number of parasites they carried in one season. It is well known of course that parasites are more abundant in some months. He found no difference between the black-eared and blonde-eared animals. These are referred to as Blanco Orejimonos, from the Colombian meaning of "mono", which besides monkey, means blonde human beings. In 873 individuals examined 575 or 66 percent were totally free of Dermatobia and for the whole population an average of 4.8 parasites were counted per individual. Of 21 Jerseys none were totally free and they averaged 27 parasite counts per head. In 194 halfbreds of the two breeds the average count was 22 larvae per individual. It is not stated whether all animals came from the same pasture.

Crossbreeding studies for beef production - In one trial at El Nus 225 BON cows were divided so as to produce comparable numbers of offspring from the service of three bulls each of the BON, zebu or Charolais breeds. The results are presented in table form for birth weight and weaning weights at 270 days (Rodriguez et al., 1971).

	Birth weight kg		Weaning weight per day of age, in grammes	
	Males	Females	Males	Females
Pure BON	28	26	780	560
F1 with zebu	36	32	830	800
F1 with Charolais	33	31	850	770

It is interesting to note that there was no significant difference for the two types of F1S for weaning weight but birth weight was greater for the zebu crossbreds, an unexpected result. The coat colour of the F1s is also of interest. With zebus the extension of the dominant white was reduced and with Charolais the dilution gene gave rise to "barroso ears" and equally black diluted small spots on legs and neck.

Fattened F1 steers and bulls (in dry lot) marketed at 30 months of age gave the following results in liveweight, kg (Arango, 1976a).

	Bulls	Steers
Charolais x BON	542	526
Zebu x BON	558	504

Studies on milk production improvement of the BON have been done in crossbreeding with Jerseys. These studies have been greatly hampered by poor planning in relation to milk let-down without the calf. The BON is particularly difficult to milk without the calf by its own inheritance as well as by cows having been used that had not been trained before or selected for easier let-down. The milk improvement brought by the Jersey was not utilized to produce a better milking strain within the BON, one trait that the coffee peasant is sure to have appreciated.

Conservation status - There is a breed association of BON breeders and with the proven local adaptability, experimental results and popularity of the breed with small producers its future should be assured. Such is not the case. The experiment station has wavered too much in its goals and sporadic trials on beef or milk as the specialized future of the breed. It is not very valid also from the lack of contact and interchange of genetic material with the small producers who need the breed for their own household needs. The association, with headquarters in Bogotá, is made up of larger producers. How to improve the BON for the future is still an enigma..

Sources of stock and germplasm - About 3080 head are presently recognized by the association, but large numbers in the hands of the small coffee planters may be still in existence. Frozen semen could be obtained from the Ministry of Agriculture from bulls at El Nus with no particular performance known.

4.5 Tropical Milking Criollos

A single heading is chosen for a group of similar ecotypes, though each evolved in a different country or region. Most of them have been pursuing similar goals and the existence of a few performance records has made interchange of bulls and semen across countries a reality, though it has not reached large-scale programmes for farmer-breeders. In all cases the environment in which the ecotypes developed was a similar lowland tropical environment, with varying length and severity of dry season and total annual rainfall ranging from 1500 to 2500 mm. Summer temperatures reach a maximum of 38 C and external parasites are always ever present, particularly ticks of the geni Amblyomma or Microplus. Some areas have mild numbers of Dearmatobia, but certainly not as severe as in the areas of prevalence of the Blanco Orejinegro. All have a history of empirical selection for milk production under tropical grassland conditions and seasonal production of cheese, which has been dwindling in the past decades. The similarity is greater among the ecotypes derived directly from Dominican or Caribbean Criollos; in that respect the Caracú of Brazil is a bit apart; though similar in appearance it evolved from Portuguese imports. For the sake of brevity some headings will treat several of the ecotypes together. The Criollo group has the most abundant literature.

Table 5 TROPICAL MILKING CRIOLLOS
LOCATION, POPULATION TREND AND KNOWLEDGE

Name	Country of of orgin	Present numbers (approx.)1/	Population trend	Descriptive and research literature
Central American	Nicaragua			
	Honduras	1500 2/	0	++

Dominican	Dominican Rep	2000	0	+
Limonero	Venezuela	3000	0	++
Barroso	Guatemala	1000	0	+
Costeño con				
Cuernos	Colombia	500	-	+
Chino Santanderano	Colombia	1700	0	0
Harton del Valle	Colombia	5500	-	0
Lucerna	Colombia	2000	0	+
Santa Cruz	Bolivia	1000	+	+
Caracú	Brazil	6 000	+	+

1/ Breeding cows.

2/ Includes herds in Costa Rica and Mexico.

0	=	static	0	=	scanty or nil
+	=	increasing	+	=	fragmentary
-	=	decreasing	++	=	ample

Table 6 TROPICAL MILKING CRIOLLOS
Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Central American	3 1/	3 2/	0 3/
Dominican	3	3	0
Limonero	3	2	3
Barroso	0	0	0
Costeño con Cuernos	1	0	0
Chino Santandereano	1	0	0
Harton del Valle	1	0	0
Lucerna	0	2	0
Santa Cruz	3	2	0
Caracú	1	1	0

1/ 0 = none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

4.5.1 Milking Criollos of Central America and Venezuela

Most of the data and observations presented come from either the Turrialba herd or the one started at Maracay and now near Carrasquero in the department of Zulia in Venezuela. The latter is in close contact with farmer-breeders in the area. Turrialba is in a climate which is more humid and with more rainfall than the area where most farmer-breeders were who supplied the foundation stock. Germplasm has gone from Turrialba to Venezuela, but unfortunately no way has been found for the opposite to take place on account of foot-and-mouth disease in South America and not in Central America or the Caribbean islands.

Origin, location and adaptability - Two strongholds of the ecotype are recognized, one in Rivas, Nicaragua and another in the area of Rio Limón in the Goajira of Venezuela. It was from Rivas that the first outstanding animals originated that were sent to Turrialba. The beginning of that story is described in a publication by de Alba and Carrera (1958). Rivas was the home of the most outstanding breeder of Milking Criollos, D.N. Joaquin Reyna. This herd survives to this day in the hands of his widow. Important references and research results related to the Turrialba herd are given in a more recent bulletin (de Alba, 1985).

Rivas is in the strip of land that separates Lake Nicaragua from the Pacific Ocean. It rises from sea level to the average altitude of lake Nicaragua which is 40 m. It has a rainy season that adds up to 1500 mm and a dry season of almost zero precipitation from January to April. Mean monthly temperatures above 25 prevail for 8 months of the year. The climate is not very different from that which prevails in other areas of the Pacific side of Central America where similar ecotypes are found in Choluteca, Honduras and in Guatemala where the Barroso breed is found. The climate is also similar in the Goajira of Venezuela. However irrigation is common in most ranches of the Rio Limón.

The herd at Turrialba is located in a more humid climate, with total rainfall averaging 2800 mm and a very short dry season, but high relative humidity, reaching 100 percent for many days, acid soils and heavy infestation of Dermatobia as well as ticks and internal parasites.

The experimental herd was founded in Turrialba in 1950 with animals imported from Rivas (before the discovery of the Reyna herd) which supplied most of the later imports as well as 33 cows that came from Choluteca in the Honduras (de Alba, 1985). The Venezuela herd was founded following the recommendation made in a study of the Venezuelan Livestock Industry (Morrison et al., 1954) and housed initially at Maracay. The foundation animals came "From Rio Limón and Goajira peninsula on the Colombian border; in 1956 the herd was enriched with the purchase of 11 cows and one bull from D.N. Joaquin Reyna and 1968 saw nine Turrialba bulls sent to the herd that was located by then in the Rio Limón area. The story of the Venezuelan Milking Criollos and data from the experiment stations are well documented and summarized in two publications (Abreu et al., 1977 and Rios et al., 1959) ,

A herd in Tampico, Mexico, that is beginning to yield results was founded in 1965 with 18 cows of the then deceased D.N. Joaquin Reyna and two bulls from Turrialba. Semen from Turrialba was utilized to produce the first generation of selected Milking Criollos in Santiago, Dominican Republic and important work has been carried out in Santa Cruz, Bolivia, based on locally selected cows, that includes comparisons and crossbreeding with Brown Swiss (Wilkins et al., 1984).

Distinguishing characteristics and performance - Solid colour with or without markings, very short hair, pigmented skin, wrinkles in the hide around the eyes, neck and in extreme cases very unique wrinkles in the forehead and poll. Very short tail, scanty switch.

Birth weights of males and females respectively at Turrialba were 29 and 26 kg in one sample and 26 and 25 in another. In Venezuela these were 28.3 and 26.1 kg. Weights of cows at Turrialba: of Rivas origin 430, of

Honduras 356. In Venezuela, first calvers weighed 366 kg, and for second, third and fourth 406, 442 and 462 kg.

Superior fertility. In Turrialba 834 calving intervals averaged 383 days; in Venezuela the interval was 413 days in one sample, when contemporary Brown Swiss in the same environment averaged 448. In Turrialba, 1.58 services per conception when contemporary crosses of Swiss x Zebu averaged 1.63; in Venezuela 1.45 when contemporary Brown Swiss averaged 1.94. In Venezuela 169 purebred Criollos in private farms averaged 367 days for calving interval when on the same farms those with apparent recent admixture of European dairy breeds averaged 381 days. In Caroa, again in Venezuela, where a new breed has been proposed based on Milking Criollo x Brown Swiss, cows predominantly Criollo averaged 439 days when those predominantly Brown Swiss averaged 453.

Age at first calving. In Turrialba 35 months, when contemporary jerseys in the same environment and management calved at 34 months of age. In Mexico purebred Criollos calved at 38.9 months when groups of Jersey and crosses with Brown Swiss averaged respectively 29 and 43 months.

Milk production . In Turrialba in a final assessment of performance including 2 300 lactations accumulated from 1954 to 1981, 305-days 4 percent fat corrected milk yield was 1627 kg when comparable Jerseys produced 2035 kg per lactation and F1s (2 reciprocals) averaged 2240 kg. In Venezuela, on breeders' farms Milking Criollos averaged 1670 kg, when comparable cows with evidence of recent European dairy breed crossing averaged 1849 kg, and mixed undefined crosses produced 1685 kg. Butterfat percentage at Turrialba was 4.57 when Jerseys produced 4.53 and hybrids 4.6. In Venezuela the average percent butterfat for first lactation was 4.62 in Milking Criollos when comparable Brown Swiss gave 3.91. Percent protein in the foundation herd at Turrialba was 3.56 while contemporary Jerseys gave 3.39.

Calf mortality . Studies have been limited, and little data has been gathered on private farms. In tropical lands calf mortality is generally very high, particularly when artificial rearing is practised, reaching easily 40 percent. This is one reason for milking with the calf being still favoured even when milk pricing is favourable in respect to beef prices. In Venezuela, under artificial rearing and an initial period of confinement comparable data between Milking Criollos and Brown Swiss shows: a total loss in relation to number born of 16.7 percent for Milking Criollos and 32.3 for Brown Swiss. In relation to the total lost in both breeds, neonatal losses accounted for 31.8 percent in Brown Swiss and 12.5 in Criollos, respective percentages in confinement to 7 months were 25 and 25.5 and at 18 to 12 months (when calves were exposed to ticks) 43.2 and 31.2 (Bodisco and Carnevalli, 1960).

Resistance to ticks and Dermatobia . In Turrialba, foundation cows from the Reyna herd had 10.9 ticks and 2.3 Dermatobia per monthly count on a 10 x 10 cm area in the scutcheon and ribside, and 4.0 and 1.5 for cows of Honduran origin, when Jerseys showed 21.8 and 10 (respectively for ticks and Dermatobia).

Heat tolerance . Climatic chamber studies at 40.5°C after exposure for 6 hours showed rectal temperatures for Criollos as 39.7 C when Jerseys were 40.3 and Ayrshires 40.9; in the same trial Holsteins averaged 40.2 while halfbred Brown Swiss x zebu were showing 39.7 C. In Venezuela no difference could be found in loss in milk production, following a very hot day, in Criollos compared with Brown Swiss, but cows were receiving concentrate feeding in relation to initial production. On dry cows observed on pasture, Criollo cows (sample of only 4) showed 29.6 bites per minute when Brown Swiss averaged 24.6 in March; and in September comparable figures were 19.4 and 16.6. From observations made on respirations per minute (5 cows each breed), Criollos in March were breathing at 44.6, while Brown Swiss were at 56.8 and respective figures for September were 43 and 61 respirations per minute (Castillo and Bodisco, 1964).

Crossbreeding results . At Turrialba (de Alba and Kennedy, 1985) halfbreds (with Jersey) outproduced both parental breeds exhibiting 22 percent heterosis for one lactation. The difference in favour of F1s increased with accumulated lifetime production reaching 93 percent heterosis. Production was lower in the back crosses than in F1, though the 3/4 Jersey was superior to the 3/4 Criollo. Results with crosses with other breeds show the same tendency, though comprehensive studies with valid purebred controls are few. The results from Bolivia with Brown Swiss constitute the best planned work now in progress.

4.5.2 Additional notes on related types

Though most of the experimental data quoted comes from Venezuela and Costa Rica, and mention has already been made of the herd in Mexico, note should be made of other distinct Milking Criollos that although short on experimental results may become more important in the future if they manage to stimulate interchange with local farmers.

Dominican Milking Criollos

These are ancestrally the parent stock from which all Caribbean cattle on the islands or mainland descended. Yet very little has ever been recorded about their history or performance. They suffered the invasion of zebus and specialized dairy breeds early in the 20th century and were on the verge of extinction. A survey made under the auspices of FAO prior to writing a UNDP project (Petersen et al. , 1972) included in its recommendations that something should be done about gathering some very outstanding dairy type Criollos that had been seen in the central and northern regions visited. The idea was taken up by a Civil Development Society in Santiago and largely through the efforts of the farm manager, Emilio Olivo, a herd of 100 purebreds and 65 grades was assembled. By 1981 there were enough lactation records to select dams from which to produce bulls. The herd is being perfected through a registry scheme in joint effort with the Ministry of Agriculture and Criollo breeding on private farms is now in progress.

Costeño Con Cuernos

This is a group of northern Colombia that has suffered the consequences of conservation schemes followed with few input ideas and burdened with bureaucracy, and is almost extinct. The existence of some superior lines of Milking Criollos in the lower Magdalena valley and the Goajira has historical evidence with the existence of a local cheese industry of a primitive nature, particularly on the island and near the town of Mompos. A preserved herd was assembled by the Ministry of Agricuture in about 1950 in Valledupar, close to the area where cows for the Venezuelan project were bought. The herd moved to Tolú Viejo which the author visited in 1954. Some excellent individuals were seen. The herd was later moved to Monteria where more qualified personnel could take charge, yet records were very fragmentary and the appearance of the herd had deteriorated by 1970. No systematic use of records has ever been made for the purposes of selection for milk production. It is estimated that in all Colombia only about 571 individuals remain, and the area surrounding the experiment station is wholly interested in beef and no interested breeders have been contacted to look for a brighter future.

Chino Santandereano

An ecotype of the Department of Santander in Colombia, with more mountainous topography than the area of the Costeño. It is similar to other Milking Criollos, the word Chino being applied to its characteristic of having very short hair. A preserved population nucleus is now being formed and breeder interest seems to be awakened and some 1700 individual animals have been located.

Harton del Valle

This is a Criollo ecotype of the middle Cauca valley which lies at a 1000 metre altitude. It was much appreciated by early milking enterprises and some breeders maintained that it was a more economical producer

under all-grass feeding than imported dairy breeds. The Breeder Organization known as Fondo Ganadero del Valle has recently decided to push more energetically an old preservation project and carry out selection, as there are no reliable local records by which bulls can be selected. Results are not available. Some 5500 individuals are estimated as remaining.

Lucerna Cattle

The Harton went into the formation of the emerging breed which under the name of Lucerna has been developed by members of one family. It may be important in the future if more nuclei are created.

Barroso

This ecotype is particular to the western coast of Guatemala. It has been improved on one farm near Chiquimulillas by the Melgar family, and some scanty data published. For the last few years it has benefitted from irrigated pastures. It is a larger framed variety of the Nicaraguan Milking Criollo and of a different coat colour, diluted black, very much like the one seen in the first cross between Charolais and Angus. The dilution gene is fairly common in red populations giving rise to duns, or yellows. Occasional Barosos are encountered in other countries, and the double dilution which gives rise to white of a very different genetic nature than the one found in Blanco Orejinegro, is seldom seen. Lack of continuous milk recording halts progress of this fine herd.

Milking Criollos of Bolivia

This ecotype was discovered by John Wilkins who conceived the idea of gathering outstanding cows in a breeding project initially sponsored by the British Council in about 1970. The project has been making steady progress since its foundation. Since no records could be found on the purchased cows or the first generation offspring, the purebred herd has been developed from inseminations with semen from Turrialba and from the Reyna herd in Rivas (processsed at Turrialba). Contact with farmers gives a bright outlook to this project.

Milking Criollos of Honduras

The Honduras Milking Criollo went into the formation of the Turrialba herd with purchases from Choluteca, and many outstanding cows located in other areas, but impossible to transport with the money available at the time. The breeders in Choluteca have disappeared. But the ecotype is mentioned because of a recent attempt to gather a herd at La Ceiba, by a local branch of the National University.

Source of breeding stock and germplasm . The Reyna herd has been regarded as the most reliable source of superior milking stock since 1950. It still deserves that distinction. But in the days of A.I. it is more logical to obtain semen from Turrialba, from sons of cows with a long milking record history. The Venezuelan project has been slow in supplying semen from superior bulls and also in the incorporation of superior bulls from its milk recorded farms. Semen is now available from CATIE in Turrialba, CAMPA in Tampico and from CIMPA in Santiago, Dominican Republic.

4.5.3 Caracú

This is the most noteworthy Criollo breed of Brazil. It was known to early writers on the Brazilian animal production scene. A description appeared in the first issue of the Brazilian "Revista do Dpto Nl de Produção Animal (Lopez, 1934). A preserved herd at Nova Odessa in Sao Paulo was the subject of a review by Pacheco Jordão (1956) with some fine animals found there in 1958 by the author. But this preserved herd suffered the consequences of extreme preoccupation on the part of technicians with the pure line and no emphasis on performance. Furthermore the preserved herd lost contact completely with the few remaining private breeders and ended up as an extremely inbred, zoological curiosity. Fortunately for the breed a large estate at Pocos de Caldas kept and improved the breed for milk production and as draught animals for coffee plantations. Though the selection has been rather empirical it is obvious that some progress has been attained and recently has been

the subject of genetic studies under the pen of Dr. Jonas Pereira and a complete set of articles is in preparation. A new breed association has been organized and the breed seems now on the road to recovery.

The Caracú is generally dun coloured with bulls exhibiting darker brown on head and shoulders, some individuals being totally red. Fine legs and ability to cover much ground in grazing hilly country are among its qualities. Milk production for some of the dams of bulls has been above 3200 kg under grassland conditions, though the herd averages so far known are quite variable and below 1200 kg. Liveweight in bulls ranges from 500 to 680 kg and females from 380 to 500.

Source of breeding stock and germplasm . Though a breed association was founded at Nova Odessa in 1949, and aregister undertaken, starting with the preserved herd which had been started as early as 1908 (Jordão, 1949), it was obvious by 1960 that the private herd of the Carvalho Dias family at Pocos de Caldas had made more progress in developing a productive type. Breeding stock can be obtained from that source. Other breeders have now been recognized and hopefully performance records will officially appear in the future.

5. SUMMARY AND CONCLUSIONS

Brief descriptions of the origin, location, characteristics and conservation status of 31 Criollo ecotypes, of which some eight can claim to be true breeds (with a breed association or close contact between several breeders) are presented separately for each ecotype. Of these, 12 are classed as beef producers and another 12 as milk producers, 3 as mountain types and the Blanco Orejinegro standing alone for its unique resistance to external parasites; all these ecotypes are within the tropical zone, and the list is completed by three that are north or south of it and thus in the temperate zone. Preservation schemes have played a major role in the understanding of these breed types in some cases but have been very detrimental to improvement in several cases. The experiment station approach with goals of proving qualities and defects by research methodology has been more fruitful. Where the data justify the effort for productive purposes the next necessary step is of course to stimulte farmer-breeders to take the initiative beyond the confines of the experimental herds. Crossbreeding has proved to be both a blessing and curse of the Criollos. Unfailing and very high heterosis has been proven in all crosses between Criollos and zebus for beef or Criollos and specialized European dairy breeds for dairying. But haphazard crossbreeding beyond the F1 has proven much inferior; so it is proven that the original Criollo stock must be on hand to repeat crossings with pure and better bulls obtained through performance testing which has been the weakest point in all ecotypes,

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