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TABLE RONDE
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ADAPTABILITY OF FARM ANIMALS TO TROPICAL CONDITIONS • ADAPTABILITE DES ANIMAUX DOMESTIQUES AUX CONDITIONS TROPICALES

ADAPTABILIDAD DE LOS ANIMALES DOMESTICOS A LAS CONDICIONES TROPICALES • ANSPASSUNSFAHIGKEIT DER HAUSTIERE AN TROPIKALISCHE BEDINGUNGEN

INTRODUCTION PRESENTATION
PRESENTACION VORSTELLUNG

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Nearly half the world's 1 200 million cattle live in the tropics proper, i.e. between the tropics of Cancer and Capricorn, while sheep and goats are largely concentrated in the semi-arid zones just south and north of the two tropics. Pigs are more common in the temperate zones, but still some 15-20 percent of the world total of about 600 million pigs are kept in the tropics. The adaptability and reproductivity of the livestock in the tropical areas is therefore of great importance to overall world availability of livestock products. Animal productivity in these areas is low. The average lactation yields of cows used for milk production in Africa and the Indian subcontinent are generally of the order of 300-500 Kg only. In 1970 the beef output per head of cattle was only 14 Kg in Africa as compared with 60 Kg in Europe (including USSR) and 88 Kg in North America. The production of mutton and goat meat per animal was in the same year only 2.7 Kg in Latin America while Europe and North America had 6.6 and 11.1 Kg respectively. There are many reasons for the low animal productivity in the tropics and they relate to general management and feeding as well as to breeding and animal health. In this Round Table, we will discuss some issues regarding the possibilities for and limitations to increasing productivity through breeding. As the topic is very large, the discussions will be limited to cattle. Contributions have been made by specialists working in Australia, Botswana, India, Israel, Kenya, South Africa and Latin America. They have been chosen with a view to covering different approaches to improvement with regard to both dairy and beef production.

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Measures of adaptability

The ability of animals to produce and survive in tropical climates obviously depends on the degree of climatic stress and the type of management, and on a number of animal characteristics such as heat tolerance, resistance to parasites and diseases, the ability to utilize coarse roughages, etc. It is, therefore, very difficult to measure the overall degree of adaptability. However a number of tests to measure the animals, reactions and ability to stand up to high ambient temperatures have been developed. The most common ones are based on the changes in rectal temperature, respiration rate and feed intake as a result of heat exposure. Zebu cattle and European × zebu cattle crosses have in general better heat tolerance scores than pure European-type dairy cattle. High-yielding European-type dairy cows usually show high stress symptoms when exposed to high temperatures. However, there is an individual variation in this respect among cows of the same level of production. Excessive heat has a negative influence on productivity, mediated primarily by reducing appetite. In warm climates, heat is only one of several factors giving rise to stress. Parasites, periodic malnutrition, shortage of water and disease are often more important stress factors than heat. Cattle of Indian or African origin have shown themselves to be considerably more resistant than European-type cattle also to these types of stress factor. They appear to have a superior water economy and can walk long distances to watering points; their skin and hair coat reflect solar radiation better and they have a high degree of resistance or tolerance to parasites and infectious diseases. Turner and Seebeck (5) in their contribution describe how various tests for climatic adaptability have been utilized to improve productivity in large-scale crossbreeding and selection experiments in Queensland, Australia. Their work on the resistance to ticks and internal parasites and the relation to averall productivity of various European and zebu breeds and crosses is most interesting and encouraging for future developments.

Most studies of cattle with a tropical origin have been based on *Bos indicus* but the superiority over European-type cattle seems to apply also to some *Bos taurus* breeds with a long history of adaptation to the tropics, e. g. Criollo cattle in Latin America, the West African Shorthorn and the N'Dama cattle. The latter types are particularly well known for their tolerance towards trypanosome infestation.

Accurate tests for measuring specific traits which influence overall adaptability and productivity and which are practical enough to be used for selection have only been developed rather recently. The systematic approach being used both for dairy and beef cattle at CSIRO Animal Genetics Division, Australia (for reference see Turner, 1973; Seifert, 1973; J. M. Rendel, 1972), whereby various measures of adaptability are incorporated in the selection procedure, warrants follow-up and application also in other countries.

Dairy cattle

Although well adapted to hot climates, cattle strains originating from the tropics generally have poor milk yields. In addition, they lack the ability to let down the milk without the presence of a suckling calf, which limits their useful-

ness in modern dairy operations. On the other hand, European-type cattle with good potential for milk production are deficient with regard to climatic adaptation. However, climatic stress can be largely alleviated through proper management and feeding regimes. Dairy production in the tropics is therefore usually tackled from two angles, viz. easing of the climatic stress through management and the introduction of improved genotypes. Numerous results (for a review see RENDEL, 1973) indicate that where the climatic stress is moderate and the managerial skill is at a high level, European-type dairy cattle do well. The best example is provided by Israel. VOLCANI (6), in his paper, elaborates on this point and describes how the climatic stress can be minimized through suitable buildings, the use of rations with a low fibre content, feeding at the right times of the day, and other measures. Additional examples of this point based on experiences in South Africa are given in the contribution by OSTERHOFF (7). However, it is equally clear that where the climatic stress is severe or where there is a lack of skill, crossbreds between native cattle and European-type dairy breeds are equal or superior to European purebreds in the overall productivity including such traits as fertility and calf viability. The contributions by BHAT (1) and PEARSON DE VACCARO (3) elaborate further on this point and exemplify with experience from India and Latin America respectively.

Very little systematic and well-planned work has been done to improve existing strains of tropical cattle for milk production. There are at least three notable exceptions to this general neglect, namely the improvement programmes for the Jamaica Hope breed (for ref. WELLINGTON *et al.*, 1970), the Sahiwal stud at Naivasha, Kenya and the work at CSIRO, Australia (HAYMAN, 1974) to produce an Australian Milking Zebu by Sahiwal and Jersey crossbreeding. The contribution by MEYN (2) describes the organization of the selection and the progress obtained with the Kenya Sahiwal.

As most native tropical strains have not been subject to systematic selection for milk yield, crossing with European dairy breeds is usually necessary in order to improve their genetic potential in a reasonable time. For this purpose, artificial insemination services and nucleus elite herds for the production of bulls need to be organized so as to avoid expensive mass importations of breeding stock.

Experience in many countries shows that the first generation of crosses between native tropical strains and European-type dairy breeds do very well and this seems to apply also to the first backcross to the European breed. However, where to go from there? If the right management is available and climatic stress is not too severe, continued upgrading seems to be the answer but in many areas this appears to be a rather risky approach. Some form of continued crossbreeding may be necessary either by making use of crossbred bulls or utilizing bulls of an improved native breed (if such stock is available). The continued use of crossbred bulls will demand the organization of schemes for pedigree and production recording so that good bull mothers can be identified and progeny testing be performed. Should bulls or semen be available of well-adapted and improved native dairy breeds, a criss-cross programme with alternate use of European-type and native bulls would seen to have considerable merit. The work to develop the Jamaica Hope breed, the improved Kenyan Sahiwal or the Australian Milking Zebu is of particular interest as they would seem to be very useful in such crossbreeding programmes. Unfortunately very few other native

tropical breeds have at present enough dairy potential to be used in crossing without decreasing milk production in the crossbred excessively. In countries in which well-adapted native dairy breeds exist, e. g. India and Pakistan with Sahiwal, Red Sindhi, Tharparkar and other breeds or the Sudan with the Butana and Kenana breeds, it is essential that concerted programmes be initiated for their improvement and conservation as purebreds, as otherwise a valuable source of breeding material may soon be lost for ever.

Beef cattle

The problems with regard to breeding for beef in the tropics are quite different from those relating to milk production. In the latter case it is usually economically feasible to make considerable improvements in the environment, and the breeding policy takes this into account. Beef production, on the other hand, will continue to be based on the utilization of the extensive grazing lands. The finishing phase may be carried out under intensive or semi-intensive conditions but for the breeding herd environment can be improved only marginally. The animals will have to cope also in the future with harsh conditions including exposure to external and internal parasites and other diseases, intensive heat and solar radiation as well as seasonal variations in the quality and availability of fodder. *Survival, fertility* and *growth rate* are accordingly the three most important production characteristics for extensive beef production in the tropics.

As already pointed out, cattle native to the tropics are superior to temperate beef breeds in viability and resistance to climatic stress. The paper by Turner and Seebeck (5) gives additional information on this point. As for fertility, very little is known about its heritability, particularly under tropical conditions. However, there appear to be breed differences in this respect. The Brahman is often said to be less fertile than other breeds. Fertility is generally improved considerably in crosses between breeds or strains. Heritability for growth rate is moderately high (0.2-0.5) but the actual level seems to depend on the magnitude of the environmental stress. Therefore experiments in tropical countries have often given fairly low heritabilities, e. g. Trail *et al.*, 1971.

There is considerable *heterosis* for growth rate and mothering ability in beef cattle. Literature on the subject was summarized by Mason (1966). The full benefit of crossing is not reached till the F_1 cow is used for breeding. Available results indicate that the F_1 cow from a European breed $\times$ zebu cross is superior to a purebred cow by 10-30 percent in weaning rate and 10-15 percent in weaning weight of the calf, making a total advantage of 25-35 percent in weight of calf weaned per cow mated. The published data on experiments in the tropics are not numerous. Trail and co-workers (1971) have carried out large-scale crossbreeding experiments using in Uganda, Ankole, Boran and local zebu as dam breeds and Angus, Boran and Red Poll as sire breeds. These and other studies indicate that the heterosis effect in crossing zebu and European breeds is very large.

Any breeding programme for beef production in hot climates will have to consider not only factors related to the physical environment but also the social and economic levels of development in the countries concerned. As most countries in the tropics are poor and lacking well-developed infrastructures, breeding

programmes for beef cannot usually be based on production recording and selection within private herds. Governmental organizations or parastatal bodies will have to take the lead. These breeding programmes should make use of (*a*) the superior adaptability of zebu-type cattle and other breeds indigenous to the tropics and (*b*) the marked effect of hybrid vigour on growth rate, fertility and viability. A suitable programme would normally be based on selection for growth within well-adapted strains, e. g. Boran, or the Australian zebu strains developed through crossbreeding between zebu and British cattle. Bulls from two or more improved strains should thereafter be used in alternation in the beef-producing herds. Such a crossbreeding scheme may well include European beef breeds in addition to the zebu strains.

Problems for the future

A better utilization of available livestock resources in tropical and sub-tropical countries is essential both for improving the living standards in individual countries and for satisfying the rising world demand for livestock products, particularly beef. Breeding measures will have an important role to play in this regard. Sufficient knowledge is available to initiate concerted improvement programmes through breeding, but more research and studies are required as development goes on. So far, little is known about the production potential under various conditions of the very many local strains of livestock in the tropical areas. Quite naturally FAO has taken a great interest in this subject. This Organisation has, over the last eight years, organized a number of meetings to discuss and advise on the *evaluation, conservation and utilization of animal genetic resources* (FAO, 1966, 1968, 1971 and 1973); special consideration has been given to problems in the developing countries. The conservation aspects are dealt with by another Round Table at this meeting.

Evaluation of the available genetic resources is a necessary prerequisite to any sound conservation or utilization programmes. Studies are now under way in several tropical countries to evaluate local and imported cattle breeds and their crosses. The report by Trail (4) gives an account of the interesting work going on in Botswana to evaluate local cattle breeds. It also describes a national improvement programme based on selection in governmental stations and the dissemination of high quality stock to the farmers. Another interesting example of breed evaluation in Africa is the Kenya feedlot project which is a joint undertaking by FAO, the United Nations Development Programme and the Kenyan Government. The growth of steers of various local strains and of European crosses has been measured under intensive and semi-intensive feeding regimes. The improved Boran breed of Kenya has been shown to have excellent growth potential, being superior to Friesian and Hereford crossbreds under semi-intensive feeding and slightly inferior to these on high energy diets (Creek, 1972).

Further research will be needed on the nature of the specific adaptability shown by animals and strains to various stress factors, e. g. the tolerance to trypanosomiasis shown by N'Dama and some other non-humped cattle strains in West Africa; the high degree of resistance of many zebu strains to tick infestations as well as their superior ability to repel or tolerate certain internal parasites. Another subject which requires considerable research is the magnitude of *geno-*

type-environment interaction, when similar genotypes are subjected to greatly different environments. Very rarely only have tropical and temperate breeds been compared simultaneously in two different environments (e.g. Boran vs. Red Poll in both the tropics and the temperate zone) so accurate information on this point is lacking. However, there are some studies which indicate that such interactions may play an important role. For example, SACKER *et al.* (1971), found that, under extensive ranch conditions in Uganda, Red Poll cattle were inferior to well-adapted African breeds such as Boran, while the Boran × European crosses clearly outgrew pure breeds of both parental breeds. However, is genotype-environment interaction a factor to reckon with when the environmental differences are more moderate, for instance if intensive dairy production is carried out in a temperate or a tropical environment? This question is not entirely academic as the presence of sizeable genotype-environment interaction could mean that bulls which in progeny testing in the temperate zones have received excellent proofs might turn out to be less useful in the tropics. This problem is now subject to studies in several countries with the use of frozen bull semen and making progeny tests both under tropical and temperate conditions. If genotype-environment interactions were very important it would mean that rather than import breeding stock and semen from temperate areas, tropical countries should pay more attention to building up facilities for production recording and progeny testing so that selection might be based on records obtained under local conditions. It will probably take quite some time before sufficient knowledge is gathered on this rather complex set of problems. In the meantime, a pragmatic approach to development is necessary. For example, it should be quite obvious that for producing F_1 heifers from local cows for milk production in ordinary herds, there is no need to use progeny-tested top bulls from temperate countries. Any bull of practically any recognized dairy breed, which has passed the rigour of selection for entering into reputable A.I. centres in the major milk producing countries in Europe or North America would increase the dairy potential of the F_1 heifers most considerably above that of the local cattle population. Semen from dairy bulls of average quality can be obtained at low cost or for developing countries free of charge through the FAO bull semen donation scheme. Large-scale insemination programmes of local dairy cows with such semen have considerable merit in order to obtain a quick improvement of the average dairy potential. At the same time, facilities should be built up for nucleus herds of desired breeds and strains which would be subject to production recording and selection so that gradually locally-produced and tested bulls would become available (for further discussion see RENDEL, 1973).

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