

# Livestock Improvement in Tropical America

By

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Only limited effort has been made to develop breeds of livestock or hybrids especially adapted to tropical conditions. Most of the highly productive breeds have originated in the temperate zones. Experience, along with evident genetic-environmental interactions, has demonstrated dramatically the need for harmonizing the genetic adaptability of animals and their environment if economical production of meat and animal products is to be achieved in the tropics.

If this coadaptation can be effected, the tropics could well replace the temperate zone as the principal source of animal products to supply the needs of the world's rapidly expanding human population. Thus, it becomes increasingly imperative to expand scientific investigations in animal breeding, nutrition, climatology, feed production and coadaptation of these disciplines into production of livestock products in the tropics.

## BASIC CONSIDERATIONS

*Conditions under which improved animals will be used  
should be anticipated*

Genetic improvement of animals is a slow process. Rapid changes seldom can be made to correct mistakes made in forecasting the characteristics needed in genetic stocks or the conditions under which they will be utilized. Since, to obtain maximum efficiency it is necessary for animals to be adapted to their destined use and to their environment, it is of paramount importance that an intelligent prognosis of these factors be made in planning breeding experiments. This is especially true of developing lines and in selecting for adaptability. For example, valuable time can be lost in selecting for heat tolerance in excess of that need in reasonably managed dairy herds where shade will be provided. There is no point in selecting beef cattle for efficiency in converting concentrates when they will be finished on pasture.

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Unwarranted and ill-founded assumption about environment and adaptative mechanisms should be avoided. For example, great emphasis has been placed on skin folds in cattle as being indicative of heat tolerance. Recent experimental results indicate that this is a misguided belief. From the literature, one gains the impression that lack of tolerance to high temperatures and humidity is a primary inadequacy of European and certain American breeds of livestock to *all* of the tropics. Granting that said breeds can not tolerate the temperatures and humidity of *lower* tropics, they are being used successfully in other areas where temperatures and humidity are higher than those recorded for much of the higher tropics. Breeding experiments should be based more on a scientifically documented approach and less on unfounded assumptions of which there are altogether too many displayed in animal breeding and animal climatology literature.

*Adequate nutrition and partial climatic control by artificial means are to be anticipated for many livestock operations in the tropics*

The low productivity of native livestock and lack of adaptability to the tropics of improved breeds from the temperate zone has resulted from the direct effects and interactions of a complex group of factors; included in this group are: (1) Generally poor nutritional status of animals resulting from the low content of essential nutrients in animal feed in general along with the fibrous nature of tropical forages and wide seasonal fluctuations in quantity and quality of feed. (2) The ravages of tropical diseases, especially among animals introduced into the tropics. (3) Seasonal interrelationships of length of day, light intensity, and temperature that are different from those of these temperate zones. (4) The effects of greater solar radiation in the tropics. (5) Generally high temperatures frequently associated with high humidity, especially in the lower tropics. Temperature and humidity vary widely in the tropics, however, and generalizations are hazardous. In the opinion of the writer, the direct effects of ambient temperatures and humidity on animals in the higher tropics is of less importance than has been generally assumed.

The present outlook for development of scientific information on the nutritional requirements of livestock in the tropics, along with the virtual certainty of rapid expansion of the feed industry and improved pastures, would suggest that poor nutritional status will not long remain a problem for poultry, swine or dairy cattle. Further, because of economy and health regulations, enterprises with these species will be well managed, making use of shade and the latest developments in artificial control of unfavorable climatic factors.

Beef cattle present a different problem since beef production will most likely continue under pasture conditions where it is more difficult to remove nutritional or climatic stress.

*Unique genetic characteristics required in the tropics and deficiencies of existing stocks*

It is well known that with the modern knowledge of nutrition and disease control man can with the aid of partial climatic control through housing, clothing, heat, and air conditioning, move freely from the tropics to the frigid zones with no serious impairment of growth, ability to work or reproduction. Thus, in view of the outlook presented in the preceding section, the existing improved breeds of dairy cattle, swine, and poultry will likely give much more satisfactory performance in much of the tropics than has been generally predicted. This view is supported by the rather widespread use already in the tropics of breeds originating in the temperate zone in preference to native stocks.

Probably the greatest deficiency of existing breeds of the above species to the higher tropics is lack of tolerance for the microbiological and disease organisms prevalent in the tropics. Undoubtedly selection under tropical environment would improve adaptation. The objective is to embark on the best method for developing both adaptation and productivity in the same stocks, a subject which is discussed in the next section. Genetic tolerance to unfavorable organisms is a much better means of control than therapeutic measures. Thus, from a long range point of view, the tropics probably should breed its own livestock although it should be born in mind that in the case of dairy cattle and poultry especially, it may require many years of development before production will exceed that of existing breeds given a little help in the form of disease and climate control.

Improved tolerance for solar radiation, heat and high humidity would of course be highly desirable in breeds of dairy cattle, swine and poultry to be used in the tropics. Efforts in this direction should be encouraged and in the case of poultry the outlook for success is not discouraging. With dairy cattle, however, it appears at present that heat tolerance and productivity are negatively associated. Swine have a wide range of adaptability already. In view of these considerations along with the outlook for most operations with these species being located in the higher tropics where temperatures and humidity are in the range of tolerance of existing stocks it would appear other traits are of greater importance. It appears possible that increased tolerance to solar radiation could be developed in dairy cattle without interference with productive capacity. This would be an important feature where grazing is to be practiced but not essential for animals that are fed in shade.

The requirements of beef cattle for the tropics, however, are distinctly foreign to the European beef breed. The more essential requirements for tropical beef cattle are:

1. Adaptation to the microbiological organisms and insects of the tropics.
2. Tolerance for high solar radiation.
3. Ability to utilize fibrous roughage.

4. Tolerance to high ambient temperatures and humidity in many regions.

The European breeds are deficient in each of these traits and their only apparent potential for the tropics is for crossbreeding of combination with Criollo or Zebu type cattle to form crossbred foundations for new selections.

Zebu type cattle possess the desired adaptive traits but are in general of slow growth and late maturity. The use of Zebu and derivative breeds in straightbreeding and crossbreeding operations appears to offer the greatest opportunity for beef production in the tropics.

#### BREEDING PLANS FOR ANIMAL IMPROVEMENT IN THE TROPICS

*Swine.* Because of the wide range of adaptability of existing breeds and there being no tropical stocks with promise of contributing valuable genes, it would appear that modern improved stocks must form the foundation for swine in the tropics. As pointed out previously, various breeds as they presently exist perform reasonably well in the higher tropics provided they are given adequate nutrition, protected from solar radiation and have access to some means of cooling by water. Undoubtedly, however, the microbiological and parasitic environment of the tropics is different from those under which present breeds were developed. Selection within improved stocks in the tropics should improve performance.

In selecting within straightbred populations for improved adaptation, it probably would be wise to challenge breeding animals with a health environment comparable to that which will be encountered in reasonably managed commercial enterprises. Other than selection for adaptability to the area, swine improvement appears to offer no special problem. In selecting for adaptability, performance of the animal and not some phenotypic characteristic assumed to be indicative of adaptability should be the criteria used.

Various breed and strain crosses should be tested for production in commercial enterprises. Systematic crossing has proven to be more productive than straightbreeding operations elsewhere and in all probability will prove likewise in the tropics. Maintenance of suitable strains and breeds for crossbreeding, however, is essential.

*Beef cattle.* In beef cattle, as in the case of swine, the best outlook for commercial production is for exploitation of hybrid vigor through systematic crossbreeding. There will be a need, however, for straightbred stocks for commercial production on small operations where crossing is not practical and as sources of breeding stock for crossbreeding operations.

Improvement has been made in certain groups of Zebu cattle and their use in the tropics has been increasing. Notable among such cattle are the Gir and Indu-Brazil in Brazil, the Africander in Africa and the American Brahman which has been topcrossed widely on native and Zebu type cattle in Latin American countries. Zebu derivative selections such as the Santa Gertrudis and more recently the Brangus

and Charbray have received some attention but are still limited in number and have not been tested adequately to assess their value in the tropics.

The outlook for continued improvement and utilization of Zebu type cattle is good. It is known that dramatic hybrid vigor results from crossing such cattle with cattle of European origin. None of the improved European breeds, however, possess enough adaptability that the outlook is good for using bulls of the improved European breeds for crossbreeding in the tropics. Herein lies one of the principal problems facing beef cattle breeding in the tropics, namely that of developing animals to use in crossbreeding with the Zebu.

Possibly the most promising method for obtaining such animals is to select from the better specimens of the native cattle of Latin America that do not have Zebu blood. These descendants of Spanish introductions have acquired good adaptability to tropical conditions and are known to have good combining ability with the Zebu. Indeed such animals may have great potential when put under selection pressure. By all means this potentially valuable genetic material should be preserved at least until its value can be determined.

Another possibility for crossbreeding would be improved European x native or European x Zebu hybrids used as sires in systematic crossbreeding with the Zebu.

In summary, the most promising means for developing beef cattle especially adapted for the tropics are:

1. Selection within Zebu or Zebu derivative populations.
2. Selections from a foundation of the better specimens of non-Zebu native cattle.
3. Development of Systematic crossbreeding programs using the Zebu and:
  - (a) Improved native or Criollo stocks.
  - (b) Native x European hybrid bulls.
  - (c) European x Zebu hybrid bulls.

The importance of simultaneous improvement of management and nutrition along with genetic potential is emphasized. The processes of natural selection have largely fixed in native cattle the genotypes best suited for the conditions under which they have existed. Only limited genetic improvement of factors such as growth can be realized unless nutrition and management are changed to keep pace.

*Dairy cattle.* The challenge of breeding dairy cattle for the tropics is that of combining heat tolerance and productivity in the same animal. Because of the tremendous metabolic heat load released by producing cows, the heat eliminating mechanisms are taxed even in the temperate zone. Recent experimental results suggest that good heat tolerance and productivity in dairy cattle simply are not compatible.

Apparently the unusual heat tolerance of the Zebu is explained more by the ability to lower metabolic heat production during periods of high temperature or humidity than by an unusual ability to eliminate

heat. Crossing of such cattle with high producing breeds in an attempt to combine both heat tolerance and productivity in the same animal have proved disappointing. This was to be expected since any lowering of metabolic activity to reduce heat load would automatically lower milk production. The prospects for achieving animals with high productivity that also have good tolerance for high ambient temperatures or humidity do not appear bright. It appears that the best that can be done would be a compromise for fair heat tolerance and fair production. While such cattle have little utility in the temperate zone, they possibly could be of great importance in the tropics.

With the possible exception of the Brown Swiss and to a lesser extent the Jersey, all of the modern breed of dairy cattle have poor tolerance for solar radiation. There would appear to be opportunity for selection in the improved breeds for this factor, thus extending the area of usefulness of such breeds in the tropics. Also, a few generations of selection will undoubtedly improve the tolerance of the animals to the biological and disease environment of the tropics.

The more promising methods for improving dairy cattle for the tropics would appear to be:

1. Selection of the improved breeds for improved adaptability to the tropics. Selection should be made with adequate nutrition and access to shade. The criteria by which adaptability is judged should be production and reproduction rather than phenotypic traits assumed to be associated with adaptability. Selection programs should be initiated with numbers adequate to avoid intensive inbreeding. Programs of this nature should develop dairy cattle that will perform satisfactorily in the higher tropics under conditions of well managed herds. Such cattle should be valuable also for crossbreeding with Criollo dairy stocks for production under less favorable conditions.
2. Selection from crossbred foundations formed by crossing stocks adapted to tropical conditions with improved dairy breeds. Selection criteria and methods should be the same as those mentioned above. The proper proportions of dairy and adapted stocks introduced into the foundation would vary depending on the area and conditions where the cattle are to be used. In general, the proportion of dairy breeding probably should be kept as high as conditions will permit. This method possibly could lead to the development of reasonably productive cattle with tolerance for higher temperatures and humidity than cattle selected from modern dairy breeds.
3. Selection from a Criollo foundation, beginning with the most productive specimens obtainable. A program of this nature has already been initiated in Venezuela. The importance of selection being made on the basis of performance rather than on phenotypic traits assumed to be associated with adaptability can not be over emphasized. In addition, the temptation to fix breed type or color should be avoided until production per-

formance is at a satisfactory level. Attention to numerous superficial traits such as color, breed type and items assumed to be associated with adaptability dissipates the selection pressure that can be applied on performance, which after all is the best criteria available of adaptability and of proper type from the standpoint of utility.

4. Systematic crossbreeding for dairy production in the tropics. Crossbreeding for dairy production has not received the attention that hybridization has received in other classes of livestock. Such programs might well give significant response in the tropics, however, and merit investigations. Of the improved breeds, it is suggested that Brown Swiss-Holstein or Brown Swiss - Jersey crosses may offer possibilities. Improved strains of Criollo crossed with the dairy breeds might have utility in areas unsuited for dairy breeds.

*Poultry.* The writer is not a poultry specialist. His interest in poultry breeding is limited to that of animal genetics in general, and the fact that he has friends among poultry breeders and poultry geneticists. Consequently comments will be confined to a few general impressions gained from limited observations.

Experience has shown that the birds being sold to commercial producers in the United States perform reasonably well at least in the higher tropics when given adequate housing and ventilation. It would thus appear that the foundation for any breeding stocks established in the tropics should be improved strains.

The comparative performance of improved strains in the United States and in the tropics is not known to the writer. If such information is not known, it should be obtained. If production in the two areas is comparable, it would appear that the logical approach would be for the tropics to depend on existing breeding establishments for breeding stock, at least for the time being. On the other hand, if production is lower in the tropics, selection for improved adaptability should be attempted. Commercial breeding establishments have become extremely large, highly skilled operations capitalizing on hybrid vigor. It will be difficult for small scale straightbreeding operations to compete with their product unless there is a genetic-environment interaction of large magnitude. Further, it is possible that with a large-potential market, the larger North American breeders may develop birds especially for the tropics.

## R E S U M E N (1)

A trabajos sencillos y limitados se ha reducido el esfuerzo de criar razas o híbridos de ganado adaptables al trópico. La mayoría de las razas existentes se han originado en zonas templadas. La experiencia juntamente con el conocimiento de la interacción

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genético-ambiental, nos ha demostrado la necesidad imperiosa de armonizar el genotipo con el ambiente a fin de producir, en forma económica, la carne y demás productos de origen animal en el trópico.

El mejoramiento genético es lento. Es de vital importancia planear concienzudamente todos los programas de mejoramiento y en especial los de selección por una mejor adaptabilidad. Deben evitarse hipótesis infundadas acerca del medio ambiente y el mecanismo de adaptabilidad. Por ejemplo, se le ha dado una gran importancia a los pliegues de la piel del ganado como indicativos de resistencia o tolerancia al calor. Algunos resultados experimentales de fecha reciente demuestran la falidez de estas creencias.

La baja productividad del ganado nativo y la falta de adaptabilidad del ganado mejorado al trópico es el resultado directo de un grupo complejo de factores y sus interacciones. Se incluyen en este grupo los siguientes: (1) la condición nutricional pobre de los animales como un resultado directo del bajo contenido nutricional de los forrajes. Estos forrajes, además de su alto nivel en fibra, fluctúan grandemente de estación a estación en cantidad y calidad; (2) los efectos devastadores de las enfermedades tropicales; (3) la interrelación en la duración del día, la intensidad de la luz y la temperatura en relación a las zonas templadas; (4) los efectos de una mayor radiación solar en el trópico; y (5) a las temperaturas más elevadas, que generalmente se acompañan a humedades relativas altas, principalmente en el trópico bajo.

A excepción del ganado de carne, se considera que las razas existentes de ganado lechero, de cerdos y de gallinas producen satisfactoriamente en el trópico, a un nivel mayor que el generalmente concedido, con el solo hecho de mejorar su ambiente de explotación. Quizás el factor limitante en la explotación de las especies mencionadas sea la no resistencia a los microbios y enfermedades del trópico.

## PROGRAMAS DE REPRODUCCIÓN Y MEJORAMIENTO PARA EL TRÓPICO

**Cerdos:** Debido al amplio espectro de adaptabilidad de las razas existentes y a falta de una raza tropical digna de una contribución valiosa, se considera que las razas modernas mejoradas deben servir de base al mejoramiento del cerdo en el trópico.

Bajo ambientes mejorados, algunas de las razas de cerdos existentes producen ya satisfactoriamente en el trópico. La selección para su mejoramiento subsiguiente se deberá basar en factores económicos de producción y no en factores fenotípicos que se consideran indicativos de adaptabilidad. El cruce sistemático ha demostrado ser más productivo que la producción con una sola raza en otras regiones y probablemente sea igual en los trópicos. Sin embargo, es esencial el mantenimiento de líneas y razas para realizar el entrecruce.

**Ganado de Carne:** En el ganado de carne, al igual que en el cerdo, la mejor perspectiva para una producción comercial radica en la cruce con el fin de explotar el vigor híbrido.

Algunos grupos de ganado Zebú se han mejorado grandemente y su uso en el trópico va en aumento. Hasta hoy su actuación ha sido buena y su futuro es halagador. Quizás un plan de mejoramiento deba incluir lo siguiente:

- 1) Selección dentro de la población Zebú.
- 2) Selección dentro de la población Criolla o Nativa.
- 3) Desarrollo de un programa de cruce sistemática utilizando el Zebú y
  - a) Animal criollo mejorado
  - b) Criollo por toro híbrido Europeo
  - c) Europeo por toro híbrido Zebú.

A la misma vez que se pretenda la mejora genética deberán mejorarse todos los factores de manejo y nutrición. Sólo mejoras insignificantes de orden genético se obtienen bajo sistemas inadecuados de administración y nutrición.



Figure 1. (Above) VERA CRUZ JALAP X 2/3.

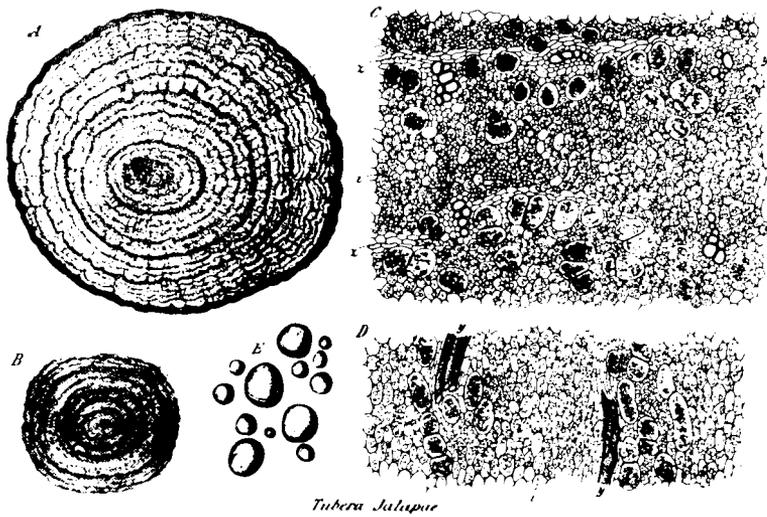


Figure 2. (Below) **JALAP TUBER.**

(from Anatomischer Atlas, (1865) Berg.)

- A. Transverse surface.
- B. Transverse surface.
- C. Transverse section.
- D. Longitudinal section.
- E. Starch.

z. cambium; y. xylem elements; l. latex cell; i. parenchyma.

**Ganado Lechero:** En la cría de ganado lechero para el trópico deben combinarse la tolerancia al calor y la productividad del animal. Debido al tremendo calor metabólico liberado por la vaca, el mecanismo termo-regulador se presiona aún en zonas templadas. Algunos resultados experimentales de fecha reciente indican que la tolerancia al calor y la productividad en el ganado lechero son incompatibles.

A una posible excepción del Pardo-Suizo y a un grado menor en el jersey, las demás razas modernas de ganado lechero carecen de tolerancia a la radiación solar. A este respecto existe una buena posibilidad de seleccionar aumentando así la utilidad de estas razas en el trópico.

Los métodos más prometedores para un mejoramiento del ganado lechero para el trópico son los siguientes:

1) Selección dentro de las razas mejoradas para una mejor adaptabilidad al trópico. La selección se deberá hacer siguiendo un régimen adecuado de nutrición y proporcionando a la vez sombra a los animales. La selección deberá basarse en factores de producción y reproducción en lugar de caracteres fenotípicos que se consideran asociados a la adaptabilidad. La selección deberá practicarse en una población grande a fin de evitar consanguinidad intensiva.

2) Selección dentro de una población cruzada de ganado adaptado a los trópicos con razas lecheras mejoradas. Los factores de selección deberán ser idénticos a los descritos en el párrafo anterior.

3) Selección dentro de una población de ganado criollo. De nuevo se hace hincapié al hecho de que la selección deberá basarse en caracteres económicos de producción y no en factores fenotípicos generalmente considerados como asociados a una adaptabilidad.

4) Cruza sistemática. Se sugieren las siguientes cruzas:

- a) Pardo-Suizo con Holstein.
- b) Pardo-Suizo con Jersey.
- c) Criollo mejorado con alguna raza standard mejorada.

**Aves:** La experiencia nos ha demostrado que las aves de tipo comercial producidas en los Estados Unidos de Norte América actúan en forma aceptable en el trópico si se les proporciona un buen manejo y ventilación. En consecuencia, se considera que la base para reproductoras en el trópico debe obtenerse de líneas mejoradas.

Si la actuación comparativa de estas líneas mejoradas en los Estados Unidos y en el trópico es similar, sería lógico utilizar por ahora aves criadoras producidas en los Estados Unidos. Si la producción es inferior, se deberá seleccionar por una mejor adaptabilidad y producción en el trópico.