Animal Production in the Tropics

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In October 1972, twenty animal scientists from twelve countries, participated in a meeting in Djakarta sponsored by the Joint FAO/IAEA Divsion of Atomic Energy in Food and Agriculture, to discuss the rôle that isotopes and other nuclear techniques have in alleviating some specific problems in poultry, pig and ruminant production associated with tropical countries.

Participants were from Indonesia, Malaysia, Thailand, the Philippines, Kenya, India, Egypt, Sudan, U.S.A., U.K., Australia, and the Federal Republic of Germany. All had first-hand experience of nuclear applications in studying factors that limit the production of animal protein, some of which are particularly relevant to tropical and sub-tropical areas.

Animal production is the result of an interaction between the genetic make-up of the animal and environmental and economic factors. These factors include:

(i) the quantity and quality of available feed and water,

(ii) climatic factors, such as air temperature, humidity, and solar radiation

(iii) In addition, parasites, disease, managerial marketing, socio-economic and political factors must also be taken into account.

The Djakarta meeting was concerned only with the first two of these factors. The use of nuclear techniques in the study and control of parasites and disease has been the topic of separate specialized meetings organized by the Division. However, the participants were acutely aware of the major limitation on production imposed by parasites and disease in tropical countries and the fact that the application of radiation attenuated vaccines, particularly to control coccidiosis in poultry and some forms of helminthiasis, shows considerable promise. The other environmental and economic factors listed were, of course, outside the terms of reference of this meeting.

In addition to their applications in the study of environmental factors, nuclear techniques are relevant to the genetic improvement of the livestock populations. They can be used to measure physiological and biochemical functions associated with higher productivity and also to provide indices for the selection of superior individuals for use in breeding programmes, especially where the incorporation of a particular physiological attribute into a particular breed-type is desired.

The improvement of the genetic composition is a relatively long-term process and relatively inexpensive, whereas some modification or alteration of the environment can be achieved in a relatively short time but is likely to be relatively costly.

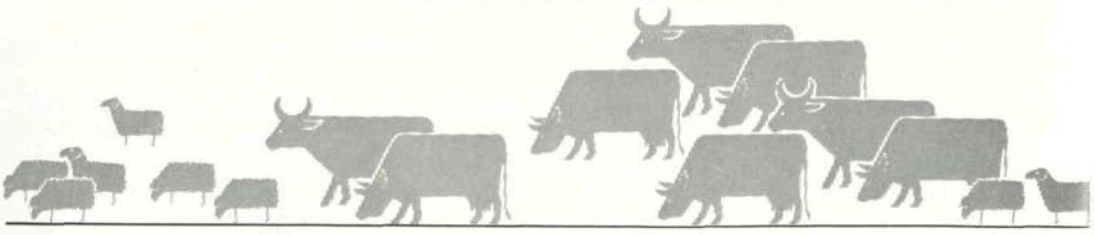
Nuclear techniques in alleviating nutritional limitations are applied in the study of the utilization of energy, nitrogen and minerals in available feedstuffs. There is a lack of information in tropical countries on the nutritional requirements of indigenous animal species to perform productive functions, and also on the ability of locally produced feedstuffs and by-products to supply these requirements. In the case of minerals, information is lacking for poultry, pig and ruminant production, and in the case of energy and nitrogen, more information is necessary particularly for ruminants. Ruminants

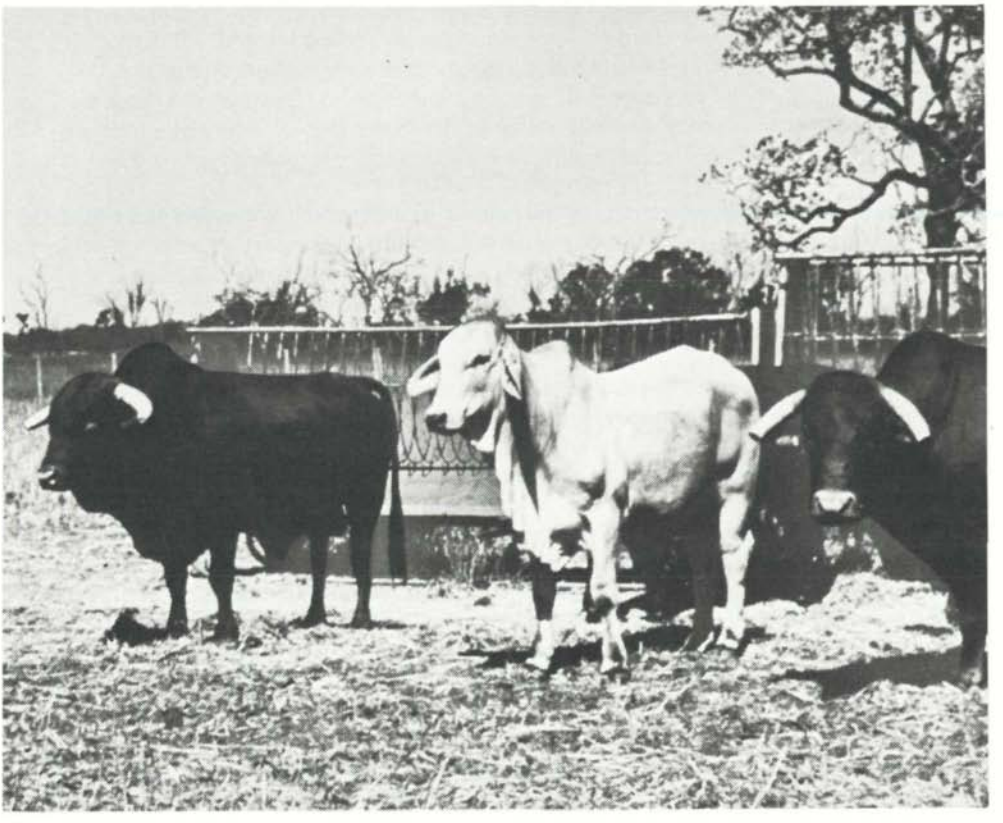
Priangan cross sheep in the New Guinea coastal area. These sheep have good growth, body solids content and fertility under wet conditions . . . . Macfarlane

(cattle, buffaloes, goats and sheep) are capable of utilizing both concentrate and roughage feeds and converting non-protein nitrogen (such as urea) into protein of high biological value for their own needs. This means that there is a greater variety of feedstuffs and agro-industrial by-products which can be potentially converted into animal protein (milk or meat) by these species.

The nutritive value of feedstuffs is determined primarily by the amount eaten, the digestibility, and the efficiency of utilization of the absorbed nutrients. It is in assessing two latter parameters that radioisotopes have specific roles.

In studies of gastro-intestinal absorption, secretion, flow rate of digesta, retention time of food and digestibility, radioactive non-absorbable inert markers are being used with increasing frequency. They are very easily analysed and they have a decisive advantage over the non-radioactive markers which must be analysed by colorimetric or turbidimetric methods. Radioactive markers have been developed which measure the flow





Brahman and Africander bulls under test conditons in Northern Australia

rate of liquid and solid phases of digesta and quantitative studies of the patterns and sites of digestion of feedstuffs are now more easily and accurately made.

The rate of production of volatile fatty acids, and the relative proportions of each acid formed by rumen microbial activity, can be determined by isotope dilution techniques. This rate is closely related to the amount of rumen microbial protein synthesized which can also be estimated independently using ^{35}S. Nitrogen is often a limiting element for microbial protein synthesis and hence the rate at which cellulose is digested. This in turn affects the amount of food eaten. A nitrogen deficiency can be rectified by supplementing diets with urea or other non-protein nitrogen sources and the efficacy of such procedures can be studied by using ^{14}C-urea or preferably ^{15}N compounds. Other limiting components and minerals can also be studied through their effect on the rate of digestion as measured by the production rate of volatile fatty acids and rumen microbial protein synthesis.

The availability of minerals in feedstuffs and animal requirements for the major and trace minerals are most effectively studied using isotopically labelled minerals. Much of our detailed knowledge on mineral metabolism, particularly iron, calcium and iodine, is from the results of the application of isotope techniques. This knowledge must be extended to cover the variety of available feedstuffs in the tropics, many of which are unique to those areas, and should include studies on poultry, pigs and ruminants.

In addition to their value in nutritional evaluation studies, which is possibly the major limitation to production, nuclear techniques will also provide important information in the physiological responses of animals to climatic factors which depress production. The regulation of body temperature in hot climates is important to the physiological integrity and the productive capabilities of animals.

Two of the more important things which happen when body temperature regulatory mechanisms fail, and body temperature increases, are a decline in food intake, and an increase in urinary nitrogen and creatinine excretion, which is indicative of an increased catabolism of muscle protein. In addition, there is evidence that this may be related to an increased susceptibility to certain parasites and diseases. The evaporation of water, via cutaneous and respiratory pathways, is the major method of controlling body temperature and so the estimation of water turnover is an important criterion associated with temperature regulation and energy metabolism, particularly under field conditions. Under dry tropical conditions, water may be limited and the efficient use of water is important for survival and sustaining an optimum level of production. This of course may be less than the maximum that can be realized under conditions of plentiful water. Under these circumstances productive individuals may be those that partition water usage efficiently between cooling and other processes, **Tritiated water is ideally suited to these important studies, because not only does it enable estimates of water turnover to be made but also it enables indirect estimates of body composition.**

The turnover rate of plasma proteins may be another criterion on which heat tolerant animals could be selected. It is possible that in some species, an increase in body temperature is not associated with an increased catabolism of body protein and these species need to be identified. Whole body counting to measure the loss of ^{40}K resulting from a standard heat exposure has also been suggested as a method of assessing heat tolerance so that desirable individuals can be selected for use in breeding programmes.

The deleterious effects of increased body temperature are mediated through the effect of temperature **per se** on the rates of the biochemical reactions taking place and also by interference with the production of hormones and hormonal balance which regulate energy and nitrogen metabolism. Competitive protein binding and radioimmunoassay techniques are used in assessing the magnitude of these effects with the ultimate aim in view of using a "hormone profile" and the changes in it that result from a standard heat exposure, as an index for selecting superior productive individuals for breeding purposes.

In summary, while it is obvious that the innovation of some of these techniques is more urgent than others, it is clear that nuclear techniques have an important and an increasing role to play in contributing to an increase in animal production in tropical countries. Appropriate techniques are available, equipment is available and local people trained in the necessary skills are no longer a bar to the initiation of studies in these countries. But coordination of these studies is important to prevent unnecessary duplication, to progress effectively and efficiently, and to exchange ideas and information between interested groups. It is in this way that the Joint FAO/IAEA Division will foster and encourage the start that was made at the Djakarta meeting.