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AID MINERAL RESEARCH PROJECT
Contract number AID/ta-c-1153

RESEARCH IN MINERAL DEFICIENCIES FOR GRAZING RUMINANTS

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences
Center for Tropical Agriculture
Department of Animal Science

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Contract Number AID/ta-c-1153

DEVELOPMENT OF EFFICIENT MINERAL SUPPLEMENTATION REGIMES FOR GRAZING RUMINANTS IN THE TROPICS

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences
Center for Tropical Agriculture
Department of Animal Science

ANNUAL REPORT

March 1, 1978 to June 1, 1979

Prepared by: Joe H. Conrad and Lee R. McDowell

REPORT SUMMARY

A. Statistical Information

1. Project Title and Contract Number:

Development of Efficient Mineral Supplementation Regimes for Grazing Ruminants in the Tropics.

AID/ta-c-1153

2. Principal Investigator, Contractor and Mailing Address:

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Cooperating Graduate Students at University of Florida: Mangeye Kiatoko, Zaire; Soekanto Lebdosoekojo, Indonesia; Marcelo Mendes and Julio Cesar de Sousa, Brazil; David Morillo, Venezuela and Edmundo Espinoza, Bolivia.

Cooperating Animal Nutritionists from Latin American Countries: Listed in Appendix.

3. Contract Period (as amended): From November 1, 1977 to November 1, 1980.

4. Period covered by report: from March 1, 1978 to June 1, 1979.

5. Total AID funding of contract to date: $748,972.00.

6. Total expenditures and obligations through previous contract years: $636,485.69.

7. Total expenditures and obligations for current year: 112,486.31.

8. Estimated expenditures for next contract year: 150,000.00.

B. Narrative Summary of Accomplishments and Utilization

1. Reconnaissance and Recruitment Phase

a. Literature related to mineral analyses of soils-plants-animals in Latin America has been extensively reviewed. A summary of this information is found in a number of published articles. Three major reviews have been published which summarize the incidence of mineral deficiencies and toxicities in tropical regions, emphasizing Latin America. The three reviews list 176, 269 and 451 references. The majority of the Latin American papers established sporadic mineral deficiencies or toxicities on the basis of mineral response, levels of minerals in animal tissues, or forage mineral concentration. A brief review is as follows: Numerous mineral deficiencies, imbalances and toxicities are severely inhibiting the ruminant livestock industry in Latin American and other developing countries. All minerals for grazing ruminants have been infrequently and sporadically studied. In cattle, the most prevalent mineral element deficiency throughout the world is lack of phosphorus. The most devastating economic result of phosphorus deficiency is reproductive failure, with phosphorus supplementation dramatically increasing fertility levels in grazing cattle from many parts of the world. This is illustrated in the majority of the individual country summaries presented in this report. Other studies also illustrate the growth response from phosphorus supplementation. Next to phosphorus the most widely deficient minerals are cobalt and copper, but the extent of these deficiencies has not been defined because of inadequate research. Calcium deficiencies, except for dairy cattle, during peak lactation periods, appear to be rare. Inadequacies of magnesium,

sodium, iodine, selenium, and zinc and toxicities of molybdenum, selenium, and fluorine have been encountered in widely diverse areas of Latin America, but all have been infrequently studied.

b. Personal contacts have been made through visits and correspondence with interested personnel in eleven Latin American countries. Active research is in progress in the Bahamas, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Peru, Uruguay and Venezuela. Visits to cooperating institutions from 1 to 3 times annually are necessary for stimulating mineral research. In late 1977 visits were made to interested researchers in Indonesia, Malaysia and the Philippines. Research programs are now being conducted in these countries. Thailand was visited in November of 1978, with mineral research programs now in the planning stages. Attempts to locate appropriate countries for mineral research in Africa are being carried out. Since late 1978 contacts have been established in Malawi and a trip was made in April of this year. Prospects for mineral research in this country are good. Depending on the termination date of the contract, several additional African countries (i.e., Zaire and Sudan) could be included in this program.

c. A list of research personnel, country by country contacts, and research institutions are presented in the appendix. Linkages and collaborations with other AID contacts, and national and international institutions include: in the Bahamas, BARTAD; in Bolivia, IBTA, CIAT-British Mission and Facultad Veterinaria y Zootecnia; in Brazil, EMBRAPA, EPAMIG, institutions in the states of Ceará, Minas Gerais, Mato Grosso, São Paulo, Rio Grande do Sul, and the Amazon Cattlemen's

Association; in Colombia, ICA, Caja de Crédito Agrario and CIAT; in Costa Rica, the University of Costa Rica and CONICIT; in Ecuador, INIAP; in El Salvador, Ministry of Agriculture (Ganadería) and the Universidad de El Salvador; in Guatemala, INCAP; in Haiti, Ministry of Agriculture; in Indonesia, Gadjah Mada University, CSIRO, Universitas Ubayana (Bali) and Bogor Agriculture University; in Malaysia, Universiti Pertanian Malaysia and MARDI; in Malawi, University of Malawi, Bunda College, Ministry of Agriculture, Department of Research; in Peru, IVITA, Universidad Nacional Agraria and Universidad Nacional Pedro Ruiz Gallo; in the Philippines, University of the Philippines and PCARR; in Thailand, Kasetsart University and Chiangmai University; in Uruguay, National Veterinary Research Center, Agronomy Faculty, University of the Republic; in Venezuela, Centro de Investigaciones Agronómicas, Universidad Central, Universidad de Oriente, and Universidad del Zulia.

d. Specific contributions of Latin American institutions compared to AID/Florida inputs are estimated to 15-20:1. The project is conducting difficult analyses and is contributing professional expertise for design, implementation, and conduct of research, as well as interpretation of research data and also securing difficult to obtain chemicals, laboratory supplies, and expendable supplies for collection, preservation, and analysis of samples (details are given in the appendix).

2. Experimentation Phase

Experiments designed to pinpoint mineral deficiencies and toxicities for specific farms and regions are in progress in all participating countries. Research data from participating countries is further

confirming the incidence of phosphorus deficiencies. As an example twelve recent theses have been completed in Costa Rica by the Department of Animal Science at the University of Costa Rica. In one thesis 100% of all farms had deficient forage phosphorus concentrations while 50% of the blood contained less than 4 mg% phosphorus. Similar conclusions were found in all of the other theses. During the past years mineral research data from Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Malaysia, the Philippines and Venezuela have indicated borderline to severe copper deficiencies in grazing cattle. Extensive analyses from vast areas of Colombia have indicated widespread copper deficiencies in this country. Incidence of sodium, cobalt, zinc, manganese, magnesium and other mineral deficiencies are highly variable and are noted in individual country discussions. New research data are being generated through experiments in all cooperating countries which are designed to determine the mineral deficiencies and toxicities and the mineral relationships between levels in soils, plants and grazing ruminants..

In previous research, phosphorus supplementation has been shown to dramatically improve the low reproductive performance (i.e., Bolivia, Brazil, Colombia, Panama, Peru and Uruguay). A study in Brazil resulted in a 77% calf crop when bonemeal was fed compared to 55% for the controls. Recent trials in the Colombian llanos demonstrated that the pregnancy rate was increased from 50% for the controls up to 84% when complete minerals were fed. Benefit to cost ratios have been at least 2:1 when phosphorus has been supplied to deficient cattle with low reproductive rates. During the past two

years attempts have been made to encourage mineral supplementation trials in Latin American countries to verify the effect of phosphorus on reproduction under conditions existing in these countries. Mineral supplementation trials are now underway in Bolivia, Brazil, El Salvador, Colombia, Ecuador, Peru, Uruguay, Malaysia, the Philippines, Indonesia and Venezuela.

The largest mineral supplementation trial involves 1870 cattle in the Beni region of Bolivia. For the year end results, phosphorus supplemented weaned animals gained 97 kg versus 77 kg for controls. From Goiás, Brazil, cattle receiving common salt gained only 53 grams/animal/day versus 90, 137 and 112 grams for animals receiving Phosphorus, phosphorus + cobalt + copper + iodine and phosphorus + cobalt + copper + iodine + zinc + iron + manganese, respectively.

3. Distribution and Application of Results Phase

The "Latin American Symposium on Mineral Research with Grazing Ruminants" was held in Belo Horizonte, Brazil on March 22-26, 1976. This symposium was jointly sponsored by Brazilian universities, research organizations, and the Florida/AID project and each of the 250 participants from 10 countries received a copy of the proceedings in Portuguese at the beginning of the meeting. Brazilians presented 11 papers, University of Florida personnel 12 papers, and invited speakers, 4 papers. This symposium was a major effort to stimulate research and update the available information on mineral deficiencies and toxicities in Latin America. The proceedings were published in Portuguese and distributed at the meetings. A major effort was made to translate these proceedings into both English and Spanish. In addition to translating, an extensive photographic

section was included in both the English and Spanish editions. A total of 3500 copies of the proceedings were printed in either Spanish or English. The English and Spanish editions were available for distribution in March and May, 1979, respectively.

Earlier in the program nearly 1500 copies of a manual on "Methods of Mineral Analysis for Plant and Animal Tissues" had been widely distributed in English, Spanish and Portuguese. This publication was revised and a second edition published in May, 1979 in English and a Spanish edition should be available in June or July of this year.

A large quantity of literature related to mineral research is sent to collaborating institutions and other interested groups. This includes thesis of mineral research carried out in Latin America. Copies of 3 Ph.D. theses, of which 2 were from Brazil and 1 from Colombia, were widely distributed.

Many seminars have been presented in the visited individual countries and articles on mineral deficiencies and toxicities have been presented at national and international scientific meetings. During the past year mineral research data has been presented by University of Florida staff at conferences at the following locations: New Orleans, East Lansing, Gainesville, Madrid, Buenos Aires, Belem and Rio de Janeiro.

Research results are being published, with the majority of research still in progress. Recent published results are located in the appendix.

4. Extension Phase

During the past 4 1/2 years the mineral status of some of the major ruminant livestock producing regions of Latin America have been

established. With slightly over a year remaining there is insufficient time to accomplish the desired goals in Latin America and to effectively expand the program into selected areas of Asia and Africa.

Strategy for a new 5 year program would include a lowered commitment to certain Latin American countries and less frequent trips there. One trip per year would be sufficient for Latin American countries such as Costa Rica, Guatemala, Peru, Ecuador, Brazil and Venezuela. These areas have developed a higher technological level and 1 trip per year would be sufficient to assist with experimental design and data interpretation. Trips in Latin America would be concentrated more in countries which need a higher level of technological support and in areas where new experiments are being designed. Also emphasis in Latin America could be directed to regions where specific production problems exist (i. e., Bolivia, Venezuela, Colombia) that appear to be the result of nutritional inadequacies.

In the last comprehensive review of the mineral research program in November, 1976 a major recommendation was to expand this program into Asia and Africa. However, increased budgets required for developing comprehensive mineral research programs in Africa and Asia were not provided. Only two trips have been made to Asia and one to Africa to develop contacts and stimulate plans for research. It is proposed that the annual budget be increased from 150 to 230 thousand dollars to allow for more extensive programs in Asia and Africa. The increase would allow for hiring additional staff or consultants, program implementation and increased travel to these areas. A proposed budget is included.

Following are some of the reasons why extension of the mineral

research program for five more years is desirable:

a) To continue to determine the location of mineral deficiencies, adequacies and toxicities in selected areas of Latin America where grazing ruminants predominate. The mineral status of numerous regions of Latin America, where grazing livestock are extremely important, is still unkown.

b) To provide more emphasis to mineral research for several key countries of both Africa and Southeast Asia, such as Indonesia, Malaysia, the Philippines and Thailand. African countries could include Malawi, Botswana, Sudan and Zaire. More reconnaissance is needed to further identify appropriate locations in African and Asian countries, making use of those principles which have proven to be effective in Latin America.

c) To define deficiencies of energy, protein and vitamin A in addition to minerals which may be limiting animal production. The research can be broadened to evaluate these nutrients through both chemical analysis and supplementation trials.

d) To emphasize the solving of small holder animal production problems that appear to be caused by nutritional deficiencies or toxicities. For example, there are requests for involvement in finding the etiology of "falling disease" in Venezuela and "wasting away disease" in Colombia. Both syndromes appear to have mineral complications.

e) To continue research on soil-plant-animal mineral relationships for diagnosis of mineral status of grazing ruminants.

f) To set up additional experiments to determine the cost/benefit ratio from the effect of supplemental phosphorus and other minerals on reproduction and weight gains of ruminant animals.

g) To broaden mineral research to include small ruminants as defined under the title XII Small Ruminant Program. This would include sheep and goats in a number of countries, cameloids (llamas and alpacas) in Bolivia and Peru and water Buffalo in Asia and perhaps Bolivia.

h) To continue research to determine validity of different methodologies for establishing mineral status of grazing ruminant animals.

i) To continue to improve developing institutions' capacities to carry out mineral research.

j) To continue to locate regions for well controlled mineral supplementation studies.

k) To determine the effect of phosphorus supplementation during the rainy season and the carryover effect from periodic mineral supplementation especially phosphorus.

l) To investigate the possibilities of using more economical phosphorus supplements (i.e., basic slag and triple superphosphate).

m) To attempt to establish more graduate student programs where degree candidates would conduct research in their home country. When the researchers returned to their own country, after receiving a degree, they would be more prepared to work on local livestock production problems.

n) To continue to generate accurate data which can be used to design adequate mineral supplements for different regions where grazing ruminants are important.

o) To continue to improve a systematic approach for standardizing sample collections, analyses, and methods of reporting data.

p) To continue to publish and distribute research information in order to stimulate the use of mineral supplements wherever deficiencies exist.

q) To continue to evaluate mineral supplements and to encourage mineral supplement companies, researchers, and ranchers to formulate, produce, and use high quality and nutritionally adequate mineral supplements.

r) To publish producer oriented extension leaflets and bulletins on mineral deficiencies and toxicities for grazing ruminants (in Spanish, Portuguese and English).

s) To investigate the possibility of holding an International Conference on Nutritional Limitations to Grazing Livestock.

5. Research Methodology

Research methodology is being studied which will permit rapid determination of the mineral status of ruminant livestock populations. An accurate review of the mineral status in a specific region will permit prescribing mineral supplements for correcting deficiencies and toxicities. Mineral status varies with soil type, forage species, age, and physiological function of animal. The following research techniques are being studied as integral parts of the research methodology.

a. Tissue collection and analyses. Kinds of material: soil, plant, and animal tissues. Physiological state of plants and animals. Kinds of animal tissue: blood, liver, bone, milk, saliva, feces. Sampling technique: liver biopsy of live animal or slaughter animal for liver sample. Locations: farms and centralized commercial slaughterhouses. Season of Year: wet, dry.

b. Mineral supplementation. The duration of the majority of mineral supplementation experiments is at least 2 years. Phosphorus supplementation to increase low reproductive rates is being emphasized. Some isolated experiments have shown that a 50 to 55% calf crop can be increased to 75 to 80% by correcting the phosphorus deficiency. Supplementation studies are the most important for the livestock producer, but they are also the most difficult to control and conduct. A few well controlled experiments on experiment stations along with a number of trials on cooperating ranches are being conducted.

6. Contribution to Institution Building

This project has made and is continuing to make excellent progress toward increasing cooperating laboratories' capability to do mineral

analyses. A manual on "Methods of Mineral Analysis for Plant and Animal Tissues" has been distributed to all cooperating laboratories in one of three languages - English, Spanish or Portuguese. This publication standardizes procedures for sample collection, identification and analysis. A total of 8 visiting scientists or laboratory technicians have spent anywhere from 2 weeks to 6 months at the University of Florida studying mineral laboratory techniques. Project personnel have visited all cooperating laboratories for periods of from one day to one week to discuss and demonstrate laboratory techniques. One or more laboratories in each country are currently conducting the majority of mineral analyses, except cobalt, molybdenum and selenium, and some of these laboratories are serving as training centers for laboratory technicians throughout the country. Several different experimental designs have been prepared and discussed with cooperating country personnel. From these, a satisfactory experimental design has been developed for each of their experimental situations. All phases of this project have been conducted in complete cooperation with indigenous and international research organizations. These organizations and cooperating personnel can be found in the appendix.

7. Utilization Plans

The ultimate objective is to have livestock producers use nutritionally formulated mineral supplements to correct mineral deficiencies. Results of the research to date have been presented at ALPA (Latin American Society of Animal Production), American Society of Animal Science, Latin American Livestock and Poultry Conference, Symposium on Mineral Research in Latin America, Pfizer

Central American Conference, International Congress of Nutrition, World Conference on Animal Production, Symposium on Feed Composition, Animal Nutrient Requirements, World Conference on Animal Feeding and Brazilian Society of Animal Production and numerous national livestock meetings. Popular articles are being written regarding the value of using mineral supplements.

Mineral supplements are being evaluated and we are finding that few, if any, contain proper amounts of all of the required minerals. The 3 mineral elements most likely deficient for grazing livestock are phosphorus, cobalt and copper. Phosphorus is the most deficient and also the most expensive. Therefore, many mineral manufacturers formulate phosphorus deficient supplements. For many mineral supplements evaluated, cobalt, in the majority of cases is supplied in adequate concentrations. However, copper and usually zinc are generally provided in very suboptimal amounts. Livestock producers are being informed concerning nutritionally adequate mineral supplements and how they should be used.

ANNUAL RESEARCH REPORT

A. General Background

Mineral deficiencies have been identified as one of the major factors limiting ruminant livestock production throughout Latin America. Although Latin America has 21% of the world's cattle, the annual slaughter rate is about 12% compared to 38% in the United States.

Many of the reasons for the low levels of cattle production are nutritionally related.

1. Reproductive performance of cattle is low and average calving rates are usually between 35 and 50% compared to 85% average in the U. S. Table 1 presents research data from 10 mineral supplementation trials carried out in 6 Latin American countries. In each instance mineral supplementation has dramatically increased average calf crop.

2. Most evidence indicates that the mortality rate for beef cattle in Latin America is at least 12 to 15% compared to 5 to 6% in the U. S. These high mortality rates occur primarily during the first 3 months of life and during the first dry period post weaning. Mineral and other nutritional deficiencies are directly and indirectly a major cause of mortality.

3. Slow development of cattle to market weight is illustrated by the fact that they reach 400-500 kg in approximately five years. Numerous studies have shown increased gains, from mineral supplementation in Latin America. A study in the high altitude grasslands of Ecuador showed daily gains of 80 kg prior to mineral supplementation as compared to 212 g per day after. From Bolivia, phosphorus supplemented animals gained 20 kg per animal over controls. Cattle receiving common salt in Goiás, Brazil gained only 53 grams/animal/day versus 90,

Table 1. Latin American studies on effects of mineral supplementation on increased calving percentages.*

Country	Control	Control + mineral supplement	Reference
Bolivia	67.5	80.8[b]	Bauer (1976, unpublished data)
Brazil	55.0	77.0[b]	Conrad and Mendes (1965)
Brazil	49.0	72.0[b]	Guimarães and Nascimento (1971)
Brazil	25.6	47.3[b]	Grunert and Santiago (1969)
Colombia	50.0	84.0[c]	Stonaker (1975)
Panama	62.2	68.8[d]	Ríos Araúz (1972)
Panama	42.0	80.0[b]	Poultney (1972, personal communication)
Peru	25.0	75.0[e]	Echevarría *et al.* (1974)
Uruguay	48.0	64.0[b]	De León Lora (1963)
Uruguay	86.9	96.4[b]	Schiersmann (1965)

[a]Control animals received only common salt (NaCl).

[b]Bonemeal.

[c]Complete mineral mixture.

[d]Dicalcium phosphate + triple superphosphate.

[e]Dicalcium phosphate + copper sulfate.

*References noted in McDowell and Conrad (1978).

137 and 112 grams for animals receiving phosphorus, phosphorus + cobalt + copper + iodine and phosphorus + cobalt + copper + iodine + zinc + manganese, respectively.

Often grazing livestock do not receive mineral supplementation and must depend largely upon forages to supply their requirements. Only rarely, however, can forages completely satisfy all of the mineral requirements. Borderline or deficient levels of certain elements were noted for many forages in the 1974 Latin American Tables of Feed Composition (AID-csd-2498): cobalt, 43%; copper, 47%; magnesium, 35%; phosphorus, 73%; sodium, 60% and zinc, 75%. Chemical analyses of feedstuffs gathered under the University of Florida Latin American Feed Composition Project (AID/csd-2498) have also revealed that an extremely small number of laboratories are actively engaged in performing trace mineral determinations.

B. Statement of Project Objectives as Stated in the Contract

The objective of this research contract is to determine the essential mineral supplements for grazing animal diets to increase the efficiency of Lesser Developed Countries' (LDC) meat and milk production systems with a resultant increase in quality and quantity of LDC diets and a subsequent increase in employment and income levels.

The Contractor shall establish collaborative research activities in Latin American countries that have institutional and scientific capability to carry out this research project. These countries shall include Brazil (Empresa Brasileira de Pesquisa Agropecuaria, Brasília and Belo Horizonte), Ecuador (Instituto Nacional de Investigaciones Agropecuarias, Santa Catalina), Colombia (Centro Internacional de Agricultura Tropical, Cali and Instituto Colombiano Agropecuario, Bogotá)

and Costa Rica.

Selection of additional countries shall be made in consultation with the AID/W Project Officer and not limited to those countries specified in the foregoing.

This research will be carried out 1) to experimentally determine the locations of mineral deficiencies, adequacies and toxicities in selected areas of Latin America where grazing livestock predominate; 2) to establish by experimentation the biological response and economic benefit of mineral supplementation to grazing animals; 3) to experimentally evaluate methods of mineral supplement administration for grazing cattle; and 4) to publish and distribute research information in order to stimulate the widespread use of mineral supplements. The work to be undertaken has been separated into the following phases: 1) Reconnaissance and Recruitment Phase, 2) Experimentation Phase and 3) Distribution and Application of Results Phase as follows:

1. Reconnaissance and Recruitment Phase

To carry out the Reconnaissance and Recruitment Phase, the literature on grazing cattle must be evaluated and, also, contacts in participating countries must be established by both correspondence and personal visits. In each country under consideration, previous research on mineral concentrations of soils, forages and animal tissues, in addition to reports of clinical signs of plant and animal mineral deficiencies at specific locations, will be evaluated to determine the highest priority for cooperative mineral research project.

Research institutions and personnel shall be located that have the ability and desire to carry out the proposed mineral research. Laboratory equipment and the methods of analysis for each mineral shall be

determined by the contractor. The specific contributions of both the Latin American institutions and the University of Florida to the mineral research program shall be clearly established. This phase shall be completed and AID advised within 4 months from initiation.

2. Experimentation Phase

The experimental field work shall be initiated and carried out during this phase. The experimentation phase shall consist of two separate phases; the Tissue Collection Phase and the Mineral Supplement Phase. During the Tissue Collection Phase, tissue samples (liver, blood and bone) shall be collected from cattle ranches and slaughterhouses. Analyses of these tissues shall pinpoint mineral deficiencies and toxicities for specific farms and regions within the participating countries. Soil and forage analyses on farms and ranches from which the animals originate shall permit development of soil-plant-animal relationships with respect to minerals and other nutrients as well as toxic elements. Following the Tissue Collection Phase, a Mineral Supplement Phase shall clearly demonstrate production and economic benefits from mineral supplementation. In addition to establishing appropriate mineral supplement mixtures, methods of mineral administration in specific cattle producing regions shall be investigated. Both the Tissue Collection Phase and the Mineral Supplement Phase shall be initiated in Brazil, followed by Ecuador and Colombia. The exact sites for experimentation within each country shall be decided in cooperation with the Ministry of Agriculture of Brazil, INIAP (Instituto Nacional de Investigaciones Agropecuarias) of Ecuador, and ICA (Instituto Colombiano Agropecuario), and CIAT (Centro Internacional de Agricultura Tropical) of Colombia, based on criteria established in the Reconnaissance and Recruitment Phase. It is

anticipated that a large percentage of the analyses required herein will be carried out at the University of Florida.

3. Distribution and Application of Results Phase

Experimental results shall be distributed to farmers, government officials and scientists. Results shall be published in both scientific journals and in one- to two-page summaries suitable for distribution to farmers through local livestock organizations where available in each country and through other means considered appropriate by the Contractor and/or the AID Research Specialist. Publications reporting this research shall be based on maps that establish mineral status of cattle producing regions within participating countries. In addition, publications shall recommend mineral mixtures suitable for specific areas.

Results of the experimental findings shall be presented at local Latin American short courses in conjunction with annual and semi-annual livestock meetings in each country in addition to national and international scientific meetings.

C. Continued Relevance of Objectives

The project objectives as stated in the contract are still relevant. Many individuals and institutions recognize the importance of mineral research. However, a large number of organizations lack equipment, methods, or techniques of analysis and technicians that can carry out mineral research programs. In order to improve the institution capacity to carry out mineral research, the AID-Florida contract is providing various types of assistance. Publication of the manual entitled "Methods of Mineral Analysis for Plant and Animal Tissues" has provided a systematic approach for standardizing sample collections, analyses and methods of reporting data.

An overall objective of the mineral research program is to encourage the use of mineral supplements. It is increasingly clear, however, that it is not enough to stimulate the widespread use of mineral supplements, but to insure that these supplements are adequate to meet the requirements of grazing animals. Often farmers believe that they are providing adequate mineral supplements for their livestock, but in reality the mineral supplements used are extremely inadequate.

In addition to many inferior mineral supplements sold in the market place, many farmers have a poor understanding of animal requirements and methods of administration. For example, even though phosphorus supplements are administered to some cattle in Latin America frequently the quantities are insufficient, the incorrect class of animal is emphasized (animals growing or in maintenance versus breeding females) and minerals are supplied the wrong time of year (dry versus the wet season). Surveys from Colombia and Ecuador indicate that many farmers dilute mineral mixtures anywhere from 10:1 to 100:1 with additional salt.

More emphasis needs to be given to training people to do mineral research. People are frequently available who have nutritional and laboratory experience. However, these people often need short-term training in mineral research techniques. More of this kind of training is needed.

D. Accomplishments to Date

1. Findings: The activities under this research project were separated into three phases and the findings will be discussed as follows:

a. Reconnaissance and Recruitment Phase:

In the early phases of the program the project included 3 full-time animal nutritionists and 8 part-time animal nutritionists. The project has reduced the staff to 1 full-time animal nutritionist plus the 5 part-time animal nutritionists. A larger staff was needed during the beginning of the program to review literature, establish research procedures and initiate research programs in the respective countries.

1) A complete search of the literature on mineral research in Latin America was conducted at the Hume Library, University of Florida, and Inter-American Center for Agricultural Documentation and Information (CIDIA) located at CATIE, Turrialba, Costa Rica. Visits were made to a number of research organizations throughout Latin America. A total of 269 articles from journals or other publications were reviewed.

Mineral research information has been summarized in three major publications. Mineral Deficiencies and Toxicities and their Effect on Beef Production in Developing Countries was presented at a conference in Edinburgh, Scotland, and published in the proceedings, Beef Cattle Production in Developing Countries, edited by A. J. Smith. This publication contained 176 references concerning the incidence of mineral deficiencies or toxicities in the tropical countries. A second publication "Current Status of Mineral Research in Latin America" was presented at the "Latin American Symposium on Nutrition Mineral Research with Grazing Ruminants". This paper contained 269 references and summarized all the published mineral research pertinent to grazing ruminants in Latin America. The proceedings were published in Portuguese in 1976. During the last half of 1976 and 1977 the Brazilian Proceedings were prepared for English and Spanish editions. This involved editing, translating, rewriting and adding a large photographic section of mineral deficiencies and toxicities.

In 1979 an extensive review will appear as a chapter in the book entitled "CRC Handbook of Nutrition and Food". The chapter is titled "Geographic Distribution of Nutritional Diseases in Animals" and contains 94 pages and 451 references. The majority of these references deal with the location of mineral deficiencies and toxicities in developing countries.

Brief summary of review of literature: Table 2 illustrates both confirmed as well as suspected Latin American locations of mineral deficiencies and toxicities in ruminants. The most widespread mineral deficiency for grazing livestock is that of phosphorus. Calcium deficiencies are rare under grazing conditions. This fact is especially important since many old texts used in Latin America have given greater importance to calcium than experimental evidence indicates.

Of 1129 forage entries in the 1974 Latin American Tables of Feed Composition (Table 1), 72.8% of the phosphorus values were borderline to deficient containing less than 0.30%. From 154 forage samples analyzed in Rio Grande do Sul, Brazil, 67.8 and 95.1% contained 0.15% phosphorus or less during the wet and dry seasons, respectively (Gavillon and Quadros, 1970). Forage analyses from the state of Goiás, Brazil indicated that about 50% of the forage samples have less than 0.18% phosphorus (Lopes, E., 1978, unpublished data). In a study of six ranches in northern Mato Grosso, Brazil, Sousa et al., 1978 reports deficient forage phosphorus concentrations ranging from 0.07 to 0.18% and borderline to deficient phosphorus rib bone ash levels, ranging from 15.1 to 15.5%. From the llanos of eastern Venezuela virtually all analyzed forage samples were deficient in phosphorus. Only 7 out of 1000 contained more than .20% phosphorus, with the majority less than .1% phosphorus (Velásquez, J.,

Table 2. Geographical locations of mineral deficiencies or toxicities of ruminants in Latin America[a]

Required elements	
Calcium	Argentina, Brazil, Colombia, Costa Rica, Guatemala, Guyana, Mexico Panama, Peru, Surinam, Venezuela.
Magnesium	Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Guyana, Haiti, Honduras, Jamaica, Peru, Surinam, Trinidad, Uruguay.
Phosphorus	Antigua, Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba Ecuador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Surinam, Uruguay, Venezuela.
Potassium	Brazil, Haiti, Panama, Venezuela.
Sodium	Brazil, Colombia, Guatemala, Panama, Surinam, Venezuela.
Sulfur	Brazil, Ecuador.
Cobalt	Argentina, Brazil, Colombia, Costa Rica, Cuba, El Salvador, Guyana, Haiti, Mexico, Nicaragua, Peru, Surinam, Uruguay.
Copper (or molybdenum toxicity)	Argentina, Brazil, Colombia, Costa Rica, Cuba, Guyana, Haiti, Mexico, Panama, Peru, Surinam, Uruguay.
Iodine	Antigua, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Haiti, Nicaragua, Paraguay, Peru, Uruguay.
Iron	Brazil, Costa Rica, Panama.
Manganese	Argentina, Brazil, Costa Rica, Panama.
Selenium	Bahamas, Brazil, Costa Rica, Ecuador, Guyana, Honduras, Mexico, Paraguay, Peru, Uruguay.
Zinc	Argentina, Brazil, Costa Rica, Guyana, Panama, Peru, Puerto Rico.
Toxic elements	
Fluorine	Argentina, Guyana, Mexico.
Manganese	Brazil, Costa Rica, Peru, Surinam.
Selenium	Argentina, Brazil, Chile, Colombia, Ecuador, Honduras, Mexico, Peru, Puerto Rico, Venezuela.

[a]McDowell (1976); Fick *et al*. (1976).

1978, unpublished data). Phosphorus deficiency as a serious limitation to cattle production in Costa Rica is illustrated in Table 3 with research findings demonstrating the severity of phosphorus deficiency from various regions of this country.

Copper and cobalt deficient areas are likely to extend over wide areas of Latin America, but their limits are impossible to define because of inadequate research. During the past years' mineral research data from Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras and Venezuela have indicated borderline to severe copper deficiencies in grazing cattle. Extensive analyses from vast areas of Colombia have indicated widespread copper deficiencies in this country. Inadequacies of magnesium, sodium, iodine, selenium and zinc and toxicities of molybdenum, selenium and fluorine have been encountered in widely diverse areas of Latin America but all have been infrequently studied.

Forages rarely provide all the mineral requirements of grazing cattle. Therefore, it is a highly recommended practice to provide adequate mineral mixtures to assure the necessary intake of the elements needed.

2) Project personnel made frequent trips to visit interested research people in several Latin American countries. Currently active research is in progress in Bahamas, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Peru, Uruguay and Venezuela.

Late in 1977, a visit was made to the Asian countries of Indonesia, Malaysia and the Philippines. Institutions in these countries have initiated mineral research programs. Thailand was visited in late 1978 for the purpose of determining if mineral research was desired. In April, 1979 the African country of Malawi was visited to determine the possibilities of cooperative mineral research. Project personnel have

TABLE 3. PHOSPHORUS DEFICIENCY IN CATTLE OF COSTA RICA[a]

Location	Description	Reference
Throughout country	Twelve of forty forage samples were deficient in phosphorus (< .20%).	Kidder and Davis (1960).
4 cattle regions	57% of all forage species were deficient in phosphorus (< .20%) with 100% of Jaragua (*Hyparrhenia rufa*) samples deficient during the dry season.	Molina (1961).
Unspecified	Phosphorus concentration in Jaragua (*Hyparrhenia rufa*) declined from approximately 0.20% at the onset of the dry season to severely deficient levels of 0.07% 80 days later.	Blue and Tergas (1969).
Guanacaste	Phosphorus concentrations in Jaragua (*Hyparrhenia rufa*) were deficient in both wet and dry seasons.	Wills (1971).
Guanacaste Province	49% of beef cattle from 15 ranches had deficient plasma phosphorus concentrations (< 4.5 mg%).	Lang (1975).
Cañas, Guanacaste	From 19 beef cattle ranches, plasma phosphorus was deficient (< 4.0 mg%) in 50% of animals and 89% of 90 forage samples were deficient, containing less than 0.18% phosphorus.	Murillo Bravo (1977).
Cartago Province	51.5% of dairy cattle from 34 farms had deficient plasma phosphorus (< 4.0 mg%) and 92% of 64 forage samples contained deficient concentrations of less than 0.30% phosphorus, averaging 0.15%.	Palmer Francis (1977).
La Cruz, Cañas Dulces and Filadelfia, Guanacaste	27% of beef cattle from 12 ranches were deficient in plasma phosphorus (< 4 mg%) and 71% of 60 forage samples were deficient, containing less than 0.18% phosphorus.	Guzmán (1977).
San Carlos	98% of 12 beef cattle and 9 dairy farms had deficient plasma phosphorus concentrations (< 4.5 mg%).	Kiatoko *et al.* (1978).
Nicoya, Guanacaste	28% of beef cattle from 10 ranches were deficient in plasma phosphorus (< 4 mg%) and 91% of 68 forage samples were deficient containing less than 0.18% phosphorus.	Reyes (1978).

[a]References: (McDowell *et al.*, 1978).

been discouraged from stimulating mineral research in Paraguay because of AID project priorities. Request for assisting mineral research programs in Chile, Mexico and Trinidad have also been made.

During most of the time covered by this report, project personnel were as follows:

1 full-time Animal Nutritionist

5 part-time Animal Nutritionists

1 full-time laboratory technician

1.5 bilingual secretary equivalents

4 graduate students

b. Experimentation Phase:

A brief discussion of the research program in each country is as follows:

Bahamas

We have cooperated with the Bahamas Agricultural Research Training and Development Project (BARTAD), San Andros P. O., North Andros Island, Bahamas at the request of AID/TAB Washington. Liver samples from slaughtered lambs were collected and sent to Florida in polyethylene bottles containing formaldehyde. Samples were analyzed for copper, iron, selenium and zinc but the results were inconclusive because the samples were badly decomposed on arrival. Attempts are being made to obtain other liver samples. However, the analyses indicate the samples were low in selenium and zinc.

Bolivia

The mineral research program in Bolivia was initiated in late 1976. There are three groups with potential to do mineral research: 1) La Paz and Cochabamba - Instituto Boliviano de Tecnología (IBTA), 2) Santa Cruz - A cooperative program between Centro de Investigación Agrícola Tropical (CIAT) and the Facultad Veterinaria y Zootecnia and 3) Private ranches in the Beni region.

Ing. Bernardo Bauer and Ing. Enrique Galdo are responsible for carrying out an extensive mineral experiment located at Mr. Bauer's ranch, west of Trinidad at San Rafael. This experiment consists of approximately 1,870 steers and heifers 12 to 15 months of age allotted to the following treatments: a) no mineral supplement, b) salt only, c) salt plus $Ca_3(PO_4)_2$. Within each treatment are various combinations of injections of selenium-vitamin E, copper, iodine and cobalt bullets. For the first year there were three weighing dates after initiation of the experiment in June, 1977. Only a few animals have died to date. Several have died from broken legs when becoming entangled in the weighing chutes. For the first weighing period weight gains for the three main treatments had not shown any beneficial effects for either supplemental salt or bonemeal. On the contrary, the group receiving no minerals had the best weight gains. However, in subsequent weighings this trend has reversed.

Average Daily Gain of All Animals (1 Year Results)

	Control	Salt	Salt + Tricalcium phosphate
Males	0.241	0.249	0.294
Females	0.257	0.227	0.285
Both	0.249	0.238	0.289

The control animals are averaging somewhat better than the salt supplemented group, with the Ca and P group being much better than either the control or the salt supplemented group. With this particular trend each animal supplemented with phosphorus would gain an additional 50 kg. Likewise, six months less would be required for these animals to go to market. Enrique Galdo noted that the cost to provide the phosphorus would be one-half of the gain, or approximately 25 kg. Therefore, this gain from phosphorus supplementation would be economically profitable.

The raw data for this experiment has been statistically analyzed. Tables 2, 3 and 4 summarize some results and significant differences. With one exception, all trace minerals resulted in higher gains than control animals. Some of these combinations of mineral treatments were higher at a significant level ($P < .05$). A breed effect with different amounts of Zebu blood produced significant differences ($P < .05$). There was a sex effect with males having significantly higher gains than females.

Mineral consumption for the one year experiment was very low. The salt only group consumed 11.5 g per day while the salt plus $Ca_3(PO_4)_2$ mixture group consumed 16 g on a daily basis.

The design of the experiment for year two will be changed since the heifers will be moved out of the pastures and into new areas. The steers will remain until October, 1979 and then will be sold for slaughter. The breeding season for the heifers was four months from September 1 - December 31, 1978. The control animals receiving no minerals will be eliminated. The format for the second year experiment will be as follows:

Treatment	Number of Animals	Female	Male
Salt only	472	200	272
Salt + Tricalcium phosphate	970	450	520
Total	1442	650	792

Table 2

BAUER (BOLIVIA) EXPERIMENT
ONE YEAR RESULT
EFFECT OF MINOR TREATMENTS

Treatments	No.	Minor	Major Treatments: 0	Salt	$S + Ca_3(PO_4)_2$	Mean Minor Treatment	S. E.
0	1	0000	77.1	75.9	93.6	82.1	0.71
			1.61	1.14	0.84		
I	2	1	81.1	83.7	85.5	83.4	3.41
			5.73	5.98	5.91		
Co	3	10	90.6	83.3	100.2	91.4	3.29
			5.73	5.64	5.62		
Cu	4	100	81.9	73.1	96.5	83.8	3.35
			5.97	5.70	5.63		
Se	5	1000	78.5	80.5	102.3	87.1	3.19
			5.70	5.42	5.35		
Co + I	6	11	82.0	82.9	94.5	86.5	3.30
			5.77	5.67	5.62		
Cu + Co	7	110	81.0	78.6	94.0	84.5	3.37
			6.30	5.40	5.63		
Se + Cu	8	1100	87.8	80.8	103.4	90.7	3.47*
			5.68	5.96	6.29		
Se + I	9	1001	74.7	94.8	97.7	89.1	3.32*
			6.10	5.41	5.62		
Se + Co	10	1010	76.6	78.1	90.5	81.7	3.40
			5.67	5.96	5.91		
I + Cu	11	101	83.8	71.0	94.6	83.2	3.35
			5.72	5.65	5.92		
I+Co+Cu	12	111	84.4	76.1	94.2	84.9	3.28
			5.65	5.67	5.62		
Se+Co+I	13	1011	92.2	76.2	94.6	87.7	3.30
			5.70	5.43	5.91		
Se+Cu+I	14	1101	82.7	77.6	95.0	85.0	3.35
			5.68	5.66	5.94		
Se+Cu+Co	15	1110	80.2	64.5	102.4	82.4	3.29
			5.67	5.66	5.61		
Se+Cu+Co+I	16	1111	88.8	92.7	103.3	94.9	3.42*
			5.73	6.29	5.63		
Mean Major Treatment			82.7	79.4	96.4	86.2	1.04
S. E.			1.75	1.71	1.59		

*P < 0.05 (different than control).

Table 3. Breed Effect Bauer Bolivia Experiment

Breed	Major Treatments			Mean	S.E.	Difference*
	0	Salt	$S+Ca_3(PO_4)_2$			
1 (2204-Calves 3/4 Zebu Blood)	78.3	78.4	92.9	83.2	1.05	-6.0
2 (2508 and 2516-Calves between 1/2 and 3/4 Zebu Blood)	89.0	82.7	100.5	90.7	1.20	+5.9
3 (2208 and 2216-Calves 7/8 Zebu Blood or more)	86.5	88.3	102.7	92.5	1.58	+6.8
4 (5208-less than 1/2 Zebu Blood)	86.5	81.4	92.5	86.8	1.81	+0.3

*Differences between breed versus all other breeds.

Table 4

BAUER (BOLIVIA) EXPERIMENT
ONE YEAR RESULT
COMPARISON OF MINOR TREATMENTS AND SEX AND BREED EFFECT

A Comparison of Minor Treatments

-All combinations of I	86.8
Versus remaining animals	82.7
Difference	+ 4.1
-All combinations of Co	86.7
Versus remaining animals	82.8
Difference	+ 3.9
-All combinations of Cu	86.1
Versus remaining animals	82.8
Difference	+ 3.3
-All combinations of Se	87.3
Versus remaining animals	82.6
Difference	+ 4.7

Treatment Sex Effect

Sex	0	Salt	$S+Ca_3(PO_4)_2$	Mean + S.E.
1 (Male)	82.9	83.6	100.1	88.9
S.E.	2.20	1.87	1.68	1.15
2 (Female)	82.5	75.2	92.7	83.5
S.E.	2.00	1.87	1.71	1.17

From the steers which will be slaughtered in October, 24 animals will be slaughtered at the ranch at which time liver and bone samples will be taken. Bones will be taken from the rib area and also the metacarpal. These animals will be slaughtered over a 3-month period and used for local consumption on the ranch. For the third year, trace mineral combinations will be administered to 80 animals for each of the major 2 treatments.

For the first years' experiment, samples were collected only twice during the year although there were three weighings. For the second year experiment collections will be made at each of the weighing periods. The three weighing periods will be the same as before, the last half of February, May and September. During the third year of the experiment, the most important observation will be the effect of phosphorus on the calving percentage for the second calf heifers.

Some interesting developments at the main ranch of Espiritu, owned by Bernardo Bauer, have been noted. Several years ago they cleared an area of the ranch which had never before had cattle. Animals which stayed there for one year developed what could very well be a copper deficiency. After handling, some of the animals would suddenly drop dead. Also, they had an unusual pacing gait to their walk. Both of these clinical signs would be suggestive of a copper deficiency. They have already started giving copper injections to animals on this part of the ranch.

Research is underway at the Patacamaya experiment station which is a one and one-half hour drive from La Paz. Those responsible for research at the experiment station are Ing. Tito Rodríguez (head of the llama research) and Ing. Juan Rodríguez (sheep research).

The title of one experiment now completed is "Supplementation During Different Periods of Parturition in Order to Improve Fertility". The

objective of this experiment was to determine if supplementation at different stages of gestation is effective in reducing embryonic mortality. The procedure was for llamas to be fed daily supplements composed of wheat bran, alfalfa hay and cottonseed meal. There were four treatments of ten animals each. Treatment five, the control, was composed of the majority of the herd. The treatments were as follows: 1) animals receive supplement for the first 85 days of parturition only, 2) animals receive supplement for the second 85 days of parturition only, 3) animals receive supplement for the third 85 days of parturition only, 4) animals receive supplement for the last 85 days or parturition only and 5) animals receive no supplement during gestation. The results of this experiment were as follows:

Treatment	% Fertility	Birth Weight kg
1	60	10.6
2	10	10
3	40	8.8
4	70	9.5
5	60	9

It was surprising that the groups supplemented at either the second or third 85 days of parturition did so poorly. It might be concluded that the best time for supplementation would be during the last 85 days of parturition.

In another experiment digestion comparisons were made between llamas, alpacas, corridale sheep and criolle sheep consuming silage or alfalfa hay. It was found that the llamas and alpacas have a higher digestibility of roughages than do sheep. The study noted a 60% digestibility of silage and alfalfa hay versus 40% for sheep. It has been observed that apparently llamas can utilize forages with higher lignin contents than can cheep. Regular observations would conclude that sheep would lose condition when

fed very poor quality forages while llamas would maintain or gain weight. The cameloids are ruminants, however, with three stomachs instead of four. The digestive physiology of the cameloid is not well understood. However, apparently, in the main stomach there are glands which do provide secretions. These secretions could be enzymes which assist in the digestion process. Even though the cameloids have a higher digestibility of roughages their consumption of roughages per unit of body weight is less than sheep (2 versus 4%).

One experiment which had been recommended during our last visit was initiated in August, 1978. The title of the experiment is "The Mineral Status of Growing Llamas". The object is to determine the mineral status of llamas and establish baseline mineral tissue concentrations for this species.

The procedure was to allot 15 weanling (6 months) male llamas to the following 3 treatments: 1) salt (NaCl) only free choice, 2) complete mineral supplement free choice, 3) complete mineral supplement fed free choice plus supplement feeding of wheat bran, cottonseed meal and alfalfa hay. The concentrate mixture contains 16% protein. The duration of this experiment would be one and one-half years (the normal slaughter age or before if the treatment group reaches slaughter weight earlier). In this experiment all animals will receive the same pasture for 6 hours. For the remainder of the day they will be separated into their supplementation group. We observed the animals on this experiment and noted that the pasture was extremely poor. However, there were some green shoots that the animals were consuming. The pastures will continue to be poor and will be at their lowest nutritive value in September and October. In November the rains will begin and the pastures will improve. The observations to date have noted

that the consumption of the two mineral treatments is very poor while the consumption of the concentrate mixture is approximately 15 g per animal per day (also low). It is felt that these mixtures will require some time in becoming accustomed to. The mineral mixture for treatment two is Rumophos. This is mixed with 20% salt. In this experiment pasture samples will be taken every six months for the major pasture species. These will be analyzed for all of the minerals. At slaughter, liver, blood and bone samples will be taken from all animals for analysis.

The weight gains in February for this experiment were as follows:

Treatment	Number of Animals	Average Weight (kg)	Average Daily Gain (g/day)
Common salt	5	57	89
Complete mineral mixture	5	65	98
Concentrate mixture + mineral mixture	5	70	117

Three additional experiments were suggested during the last visit and the titles of these proposed experiments were as follows: 1) Performance of Llamas Fed Optimally, 2) Economics of Early Weaning for Llamas and 3) Nutrient Digestibility of Specific Altiplano Forages. One of these additional experiments will probably be initiated in November or December with the other two initiated later next year. Unfortunately it may not be possible to put too much further emphasis on nutrition research with llamas due to budget limitations. The Patacamaya research budget was cut by 20% when the new government took power. Some of the experiments which we have suggested would require a considerable amount of purchased feed. A request was made as to whether the Florida-AID mineral project could provide funds so that these experiments could be continued and initiated. It was calculated

that $1700 would be needed per year for four years for purchase of feed.

In March, 1979 an experiment at Patacamaya was initiated entitled "Evaluation of Nutritional Status of Sheep and Llamas, with Emphasis on Minerals, in the Altiplano of Bolivia". This program will be part of an M.S. degree program. The outline of the experiment is presented at the end of the Bolivia section of this report. Twenty sheep (10 castrated males and 10 females) and 20 llamas (10 castrated males and 10 females) of approximately 1 year of age are being used in this study. Animal tissues, blood, liver and bone of both species along with soil and forage samples will be analyzed for mineral concentration. Also, soil and forage samples will be collected to evaluate the status of minerals, protein, energy and vitamin A.

Nutrition research is now also being conducted at the Chapare experiment station in the region of Cochabamba. One of the large markets for beef produced in the Beni region of Bolivia is in Cochabamba. To reach Cochabamba from Trinidad (Beni state) cattle must travel one week by boat to Chapare and then by land to Cochabamba. As a result of the considerable travel from individual ranches to Trinidad and then to Chapare and to Cochabamba, the cattle lose a great deal of weight. Therefore, in the Chapare there is a tremendous potential for fattening cattle on pasture alone and/or with banana, yuca, rice bran or other products. Livestock would be able to take advantage of a compensatory growth once they reach the Chapare region. With compensatory growth mineral nutrition would be extremely important. Therefore, it had been decided over one year ago to investigate the possibility of fattening cattle in the Chapare prior to being marketed in Cochabamba. Ing. Juan Flores is now in charge of an experiment undertaken at the station.

The Chapare experiment involved 36 animals divided into the following

four treatments: 1) common salt supplementation only, 2) free choice bananas, 3) free choice minerals (pecutrin) and 4) a combination of the free choice minerals and bananas. The duration of the experiment is for 6 months. Animals are all together on the same pasture during the day and at night they are separated into their individual treatments. Liver, blood and forage samples are taken at the beginning, middle and end of the experiment. Samples are now being analyzed for mineral content at Florida.

An additional experiment is being considered by the COFADENA Corporation which has a large ranch located 100 miles north of Trinidad in the Beni. The title of this proposed experiment is "The Mineral Status of Beef Cattle in the Region of Trinidad, Bolivia and the Response to Mineral Supplementation". The treatments for the particular experiments are as follows: 1) Control - salt only, 2) a complete mineral supplement administered all year, 3) a complete mineral supplement administered only 6 months during the wet season. The duration of this experiment is for 2-3 years. Every six months animal tissues, forages and soil samples will be collected for mineral analysis. The experimental proposal is at the end of this report.

One of the major mineral research efforts over the last one and one-half years in Santa Cruz is the completion of an Egresado thesis devoted to mineral research. The majority of the analyses for this thesis were completed by Sr. Hugo Pérez who brought samples to Florida for analysis. Samples were collected, analyzed, evaluated and written up in the thesis by Armando Peducassé. The work involved evaluating the mineral status of beef cattle in areas near Santa Cruz, Bolivia. The title of the completed thesis is "Evaluación de Minerales en la Cuenca Lechera de Santa Cruz Central (Provincias Andres, Ibañez, Warnes y Santisteval)." In this

experiment, samples were collected from animals one to two years of age. Some of the conclusions for this experiment are as follows: a) Calcium - Soil extractable calcium was low on two farms with averages of 54.8 and 55.3 ppm while the additional six farms had average to high values fluctuating between 96 and 174 ppm. However, all forage samples were relatively high, ranging between 0.36 and 0.81%. Blood calcium concentrations were normal. Therefore, on the basis of all analyses, it was concluded that the calcium status is adequate. b) Phosphorus - Extractable soil phosphorus ranged between 24 and 56 ppm which would indicate a medium to high level. However, some individual samples were as low as 3.4 ppm. Five of eight farms contained adequate forage phosphorus concentrations, however, three farms had forages containing less than 0.25% phosphorus. Blood inorganic phosphorus levels were high. In general, it would be concluded that these particular regions are not severely deficient in phosphorus. c) Magnesium - Available soil magnesium ranged between 18.8 and 32 ppm while the averages of the forages ranged between 0.19 and 0.20% in four ranches and 0.14 to 0.16% for the remainder. A high percentage of the blood magnesium values were also low containing less than 1.8 mg%. d) Copper - Available soil copper levels were low to marginal ranging between 1.5 and 0.8 ppm. Eighty-eight percent of all forages were borderline to deficient in copper containing less than 10 ppm. Blood copper levels were low but within the normal range. Only three of eight farms contained adequate liver copper concentrations of more than 100 ppm. Four out of 32 samples contained less than 25 ppm with the majority containing less than 75 ppm. The data definitely suggests that copper is a limiting element in the nutrition of cattle on the majority of the farms studied. e) Zinc - Extractable soil zinc ranged from deficient levels of 0.86 ppm to high levels of 0.9 ppm. All forage zinc samples were

deficient in zinc containing less than 50 ppm with 17 out of 23 containing even less than 30 ppm. Blood zinc levels were relatively low with 17 out of 120 samples (14.7%) considered borderline to deficient. However, liver zinc values were normal containing more than 84 ppm. It is felt that zinc is in the borderline category and should be investigated further. It could be a problem in some years while adequate in others. f) Iron - Extractable iron was in the normal range in both soils and forages. Liver iron concentrations were also normal. g) Manganese - In forages, 6 out of 8 farms were considered borderline to deficient, containing less than 40 ppm, with 12 out of 23 of the forages borderline to deficient in manganese, and 21.7% even containing less than 20 ppm. However, these low forage manganese values were not supported by low liver manganese concentrations. Therefore, like zinc, manganese would be another mineral to keep under observation. h) Cobalt - Extractable soil cobalt levels for the eight ranches ranged from 0.55 to 1.06 ppm, the higher level being in the adequate range. The majority of the cobalt forage analyses were adequate with only a few below the animal's requirement. i) Molybdenum - Available soil molybdenum ranged between 0.05 and 0.99 ppm. These are quite low. Likewise, forage molybdenum concentrations were extremely low with most values being less than 2 ppm. Therefore, molybdenum toxicity is not considered to be a problem. Ing. Peducassé has written an abstract on his research for the coming ALPA meetings next September.

Since Ing. Armando Peducassé has now completed his Egresado thesis he is hoping to come to Florida to study for a Master's Degree. During the year Ing. Peducassé has been collecting samples both during the wet and dry season from additional regions in the Santa Cruz area for determination of mineral status. Ing. Peducassé is now going ahead with collections for an additional

season. He will do many of the analyses in Santa Cruz and he hopes to attend the University of Florida in September. However, unfortunately, a complication has arisen. Ing. Peducassé took too long to obtain his Egresado degree and now the scholarship for training in the U. S. is no longer available.

Some of the ranches being sampled by Ing. Peducassé in the more recent experiments include cattle with the disease, "cara inchada". This is the condition where the jaw is swollen and teeth are lost in animals from 2 to 18 months of age. These lesions often result in death of the animal. For the farms with this condition, approximately 30% of the calves are affected. Apparently Santa Gertrudis suffer more from this condition than do other breeds. Apparently the region where "cara inchada" is diagnosed is quite large. During our last visit we discussed some of the characteristics of "cara inchada" in Brazil, noting that often it was on newly cleared forest lands which exhibit the condition. Dr. Parra who is most familiar with the condition, noted that this is a similar occurrence in Bolivia but instead of clearing out trees for new ranches, it is a type of bamboo. Some reports indicate that mineral supplementation diminishes this problem.

MASTER OF SCIENCE RESEARCH PROGRAM FOR EDMUNDO ESPINOZA

Title: Evaluation of nutritional status of sheep and llamas, with emphasis on minerals, in the Altiplano of Bolivia.

Introduction. A recent Bolivian survey indicated that the majority of small farmers own livestock. For the small farmer of the Atiplano sheep and llamas (or alpacas) are important for utilizing pastures and crop residues to provide high quality nutrition (milk and meat) to these families.

Little information is available on nutritional requirements or response from supplemental nutrients to cameloids. However, information is available on nutrient requirements for sheep and methods to evaluate the nutritional status of these animals. Baseline studies for evaluating the nutritional status of cameloids is needed. This proposed research is geared to study the nutritional status of Altiplano sheep and llamas consuming only pastures.

Research Objectives: (1) to establish if specific mineral (or other nutrient) deficiencies or toxicities exist for growing sheep on the Altiplano of Bolivia during the wet and dry seasons of the year, (2) to compare the nutritional status (mainly mineral) of growing llamas compared to sheep and thereby help to establish baseline mineral tissue levels for llamas, and (3) to study the nutritional value of Altiplano forages during both the wet and dry seasons.

Location of Research: Patacamaya Experiment Station, Bolivia.

Procedure: The study will consist of 20 sheep (10 castrated males and 10 females) and 20 llamas (10 castrated males and 10 females) approximately 1 year of age. The 40 sheep and llamas will be located in a 20 Ha pasture with an additional 30 to 40 animals to maintain a typical grazing pressure. The remaining animals (both sheep and llamas) not selected should be of similar age and weight as the experimental animals. These extra animals could serve as substitutes for tissue samples if needed. The only supplementation will be free choice common salt. Animal tissues (blood, liver and bone) of sheep and llamas, along with soil and forage samples will be collected to evaluate the status of minerals, protein, energy and possibly vitamin A.

Samples will be collected three times during the year (early March, late June, and October or November). Only samples collected during the first two collections will be included in the M.S. degree thesis.

SCHEDULE

1) Middle to end of February (as soon as possible). A number of potential animals should be weighed. From these 20 uniform corridale sheep (10 females 10 castrated males) and 20 llamas (10 females, 10 castrated males) at approximately 1 year of age should be selected. All selected animals should be relatively uniform in size and weight. Selected male animals should be castrated as soon as possible.

2) March (during 1st week). All animals should be weighed and the following samples collected:

a) Soil - 5-10 separate composite samples from different areas of the pasture. In sampling at least 10 or more sample sites can be combined for each composit sample. At least 200 g for each composite sample should be available.

b) Forage - Separate samples of each of the major species should be taken. This would likely involve 15-25 species from the assigned pasture. Forages should be identified by scientific and common names. In sampling the aerial parts of the plants in a field, select at random at least 10 or more sample sites for each species. A forage questionnaire should be filled out which includes the % of each species on offer. Pasture samples should be collected only after careful observation of animal grazing patterns. It is necessary to watch the animal graze and hand pluck a sample to represent the animal's diet. From the composite forage samples, 2 samples each of the major forage species should be analyzed. For each sample, a total of 200 g should be available. Samples should be dried and ground (using stainless steel equipment).

c) Blood plasma (or serum)- From each of the 40 animals, approximately 20-40 ml of blood should be collected. One method would be through the use of California bleeding needles. As soon as the blood is collected, the container should be tipped and inverted and thoroughly but gently mixed with the anticoagulant. If lithium citrate (20% solution) is used, add 1/10 ml for each 10 ml of blood to be collected. Centrifuge the samples using a portable centrifuge within 30 minutes of collection. Pipet off 1 ml of plasma and mix thoroughly with 10% trichloracetic acid (1 ml plasma and 9 ml of 10% trichloracetic acid) and centrifuge. Regrigerate or freeze until needed. If serum is used versus plasma, separate from cells as soon as possible and refrigerate or freeze.

3) May (during 1st week). Weigh animals.

4) June (last 1/2 of month). Weigh animals and at this time sacrifice 8 animals for the purpose of obtaining bone samples and larger liver samples. Sacrificed animals could be as follows: a) 2 female sheep, 2 castrated sheep, 2 female llamas, 2 castrated llamas or b) 4 castrated sheep and 4 castrated llamas.

The following samples should be collected:

a) Soil - same
b) Forage - same
c) Blood serum or Plasma - same
d) Liver - From each of the 40 animals (except those sacrificed), liver biopsy samples should be taken. The procedure is outlined beginning on page 201-5 in the manual entitled "Métodos de Análisis de Minerales para Tejidos de Plantas y de Animales." The procedure will be demonstrated by L. R. McDowell and Edmundo Espinoza. Samples should be frozen. Prior to shipment to the U. S. 10% formaldehyde should be added to each biopsy bottle.

Liver samples from slaughtered animals should be removed immediately in order to prevent contamination. Every effort should be made to avoid contamination, therefore, plastic gloves may be used. Approximately 100-200 g of the right lobule (lobus dexter) of the liver is cut out with stainless steel scissors or a stainless steel knife.

The sample is refrigerated or frozen until analyses are made. The sample is stored in 8-16 oz. polyethylene bottles containing 10% formaldehyde and delivered to Florida for analyses.

e) Bone - Metacarpal bones and right ribs should be taken from each of the slaughtered animals. The bone samples should be stripped of all soft tissue. Four cm of the central part of the right ribs are cut and split into halves, and the bone marrow removed using a jet of distilled water. Two cm of the central part of the left metacarpal bone should be cut. Density of all bone samples can be measured by weighing in the air and in the water. Bone samples will be placed in 10% formaldehyde prior to shipping to Florida.

5) July (during 1st week). Weigh animals.

6) September (during 1st week). Weigh animals.

7) October - November - Terminate experiment by taking weights and soil, forage, liver, blood and bone samples as noted in the June collection.

Analyses: The following analyses would be recommended:

a) Soil - Complete soil analyses to include soil classification, soil structure, pH, organic matter and available forms of the following minerals: Al, Fe, Mn, Zn, Co, Cu, P, Ca, Mg, K, Na, N, Se, Mo and I.

b) Forage - Co, Se, S, Fe, Mn, Cu, Zn, Mo, P, Ca, Mg, K, Na, N, I.

c) Blood - Ca, P, Mg, Zn, Cu, Fe and Blood Urea Nitrogen (optional).

d) Liver - Zn, Cu, Se, Co, Mo, Fe, Mn, Mg and vitamin A (possibly).

e) Bone - Bone ash, specific gravity, P, Ca, Mg and Zn.

The majority of analyses will be completed at the University of Florida. However, as time permits, certain analyses can be completed at Patacamaya. These could include soil pH, N, P, ether extract Ca, K and possibly vitamin A.

Records - The following records should be kept:

a) Individual animal and health observations.
b) Forage identification records.
c) Weight gains.

Schedule for Edmundo Espinoza: Ing. Espinoza will plan to be at the Patacamaya Experiment Station from approximately mid June to mid August. In addition to collecting samples, analyzing samples and weighing animals, Ing. Espinoza will be reviewing available literature on the nutrition of llamas. During mid March to mid June Ing. Espinoza will be taking courses as part of his degree program. One course will include laboratory techniques needed while at Patacamaya.

A PROPOSED MINERAL SUPPLEMENTATION EXPERIMENT NEAR TRINIDAD, BOLIVIA

Title: The mineral status of beef cattle in the Trinidad region of Bolivia and the growth and reproductive response to mineral supplementation.

Introduction: The most important limiting factor to cattle production in tropical countries is low reproductive rates characterized by first calving at 4 to 5 years of age and often a calf in alternate years only. In many areas of Latin America, numerous mineral deficiencies, imbalances and toxicities are severely inhibiting the cattle industry. Often grazing livestock do not receive mineral supplementation and most depend largely upon forages to supply their requirements. Only rarely, however, can forages completely satisfy all of the mineral requirements. Borderline or deficient levels of certain elements were noted for many forages in the 1974 Latin American Tables of Feed Composition: Co, 43%; Cu, 47%; Mg, 35%; P, 73%; Na, 60%; and Zn, 75% (McDowell et al., 1974). Phosphorus deficiency has been reported in 38 developing tropical countries, Mg in 17, Na in 14, Co in 21 and Cu in 20 countries (Fick et al., 1976; McDowell, 1976; McDowell, et al., 1976).

Phosphorus supplementation has dramatically increased fertility levels in grazing cattle from many parts of the world. Latin American countries reporting increased fertility rates resulting from phosphorus administration include Bolivia (B. Bauer, unpublished data, 1976), Brazil (Conrad and Mendes, 1965), Colombia (Stonaker et al., 1975), Panama (Ríos Araúz, 1972; R. G. Poultney, personal communication, 1972), Peru (Echevarría et al., 1974), and Uruguay (Schiersmann, 1965; De León Lora, 1963).

In Panama (R. G. Poultney, personal communication, 1972) supplemental phosphorus increased calving percentage from a range of 42 to 80%. A study conducted in Brazil resulted in a 77% calf crop when bonemeal was fed compared to 55% for the controls (Conrad and Mendes, 1965). Pregnancy rate was increased from 50% for the controls to 84% when a complete mineral mixture was fed to cattle in the Colombian llanos (Stonaker, et al., 1975).

Attempts to raise livestock productivity in tropical countries will be unsuccessful unless the nutritional environment, including protein, mineral and vitamin A is adequate. Mineral supplementation is a least cost input to improvement of livestock production. Economical return on mineral investment has been at least two to one in some studies (Conrad, 1976).

Observations and data from the Reyes region of Bolivia indicates that calving percentages are between 40-50%. The time required for animals to reach market weight is usually 5 to 6 years. Soils of the Beni are also known to be of low fertility. Soils of the Beni are particularly low in phosphorus.

Although mineral supplementation is a least cost input to improvement of livestock production, nevertheless, minerals in Latin America are expensive. Limited research suggests that there may be a carryover effect of mineral supplementation and that the major benefits can be obtained by feeding minerals only during the rainy season. This concepts needs investigation to determine if total mineral supplementation cost can be reduced.

Location of Research: 100 Km. North of Trinidad, COFADENA FARM (Main Researcher: Eng. Jorge Quiroga Gómez).

Purpose:

1) To evaluate the biological response (particularly fertility and weight gains of breeding cattle receiving mineral supplementation.

2) To study the carryover effects of mineral supplements administered only during the wet season.

3) To determine the economic benefit of mineral supplementation to grazing cattle (cost/benefit ratio).

4) To establish the mineral and vitamin A status of grazing cattle during both the wet and dry seasons.

5) To study tissue storage patterns of minerals, comparing yearly and wet season mineral administration.

6) To compare daily mineral consumption for cattle receiving year-round vs. wet season administration.

Required Resources and Facilities (1) A minimum of 200 breeding cows or heifers for each treatment (treatments can vary as to number of animals due to carrying capacity of different pastures); (2) Pastures with strong fences sufficiently large enough to accomodate a minimum of 200 animals each: (3) Weighing and handling facilities; (4) 1 or more persons responsible for daily supervision of cattle, management, sample collection, etc.; (5) Analyses of plant and animal tissue in Gainesville, Florida; (6) A supplier of mineral supplements other than salt (there is a possibility mineral supplements can be supplied by the Pfizer Company).

Treatments:

(1) Control - common salt only

(2) Complete mineral supplement (administered all year)

(3) Complete mineral supplement (administered for 6 months during the wet season, October through March).

Duration of Experiment - If the experiment begins with bred heifers then the duration of the experiment can be 2 years. Another option is to start the experiment with young animals 12-16 months. Starting at this age, the duration of the experiment should be 3 years.

Samples to be Collected - Animal and forage tissues could be collected at initiation of the experiment and every 2 months (January and August), thereafter until experimental termination.

(a) Animal Tissues - Sixteen representative samples of both blood and liver (biopsy) will be collected from cows at each collection period. If possible, the same animals should be sampled each collection period.

(b) Forage - Pastures should be sampled at each collection period. Two samples each of the major pasture species should be collected. Each sample should be a composite and will be collected only after careful observation of the cattle grazing patterns.

(c) Soil - A composite sample, in duplicate, should be taken for each pasture.

(d) Mineral Supplements - Minerals used during the experiment should be analyzed.

Detailed information on sample collection methods are stated in the publication entitled "Methods of Mineral Analysis for Plant and Animal Tissues."

Collection Periods. a) Initiation of Experiment: January, 197°. Identify all animals by branding (if not previously done), weigh all animals, after blocking by age or weight groups allot to treatment groups, weigh and record minerals administered and collect samples for analyses.

b) End of 6 month Period - Weigh all animals, weigh and record mineral consumption and collect samples for analysis.

c) End of 1 Year - Same

d) End of 18 Months - Same

e) End of 2 Years - (Termination of experiment) - Weigh all animals, weigh and record mineral consumption and collect samples for analysis.

Blood serum - Ca, P, Mg, Cu, Zn and Se.
Liver biopsy -Co, Cu, Fe, Zn, Mo, Mn, Se and vitamin A
Forage - Protein, NDF, in vitro dry matter, digestibility, Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mo and Se.
Soil - Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mg, Se, Al, N, Organic matter and pH. The available forms of these minerals should be determined.
Mineral Supplements - a complete mineral analysis

Management - Management of the cattle should remain the same in relation to insect and disease control. However, no substance containing a mineral or vitamin should be administered. Calves should be uniformly weaned at the same time for each treatment group. The dates that a bull is kept with cattle should be recorded so that accurate records of mineral consumption will be maintained.

Records - The following should be kept:

a) Individual animal performance including weight and calving dates.
b) Health observations.
c) Mineral supplement consumption.
d) Death losses, etc.

Brazil

The Latin American Symposium on Mineral Research with Grazing Ruminants held at Belo Horizonte on March 22-26, 1976, has had a far reaching and significant effect on ranchers and animal scientists throughout Brazil and Latin America. Copies of the proceedings of this symposium in Portuguese, English and Spanish have been widely distributed throughout Brazil and countries associated with this project. This has become the standard reference manual used by ranchers, teachers, researchers and students which has stimulated a renewed awareness of mineral deficiencies and the importance of mineral supplementation. Researchers use this as a standard reference for preparing research project outlines.

One trip by J. H. Conrad was made to Brazil between March 21 and April 18, 1977, four days of which 3/26 to 3/30 were spent in Montevideo, Uruguay. Another trip by J. H. Conrad was made between November 10 and December 15, 1977, six days of which 11/19 to 11/24 were spent in Uruguay. The itinerary for both trips was São Paulo, Porto Alegre, Santa María, Montevideo, Campo Grande, Rio de Janeiro, Belo Horizonte, Viçosa, Brasília, Fortaleza and Belem. Contact was made with those interested in Mineral Supplementation, those doing mineral research or interested in doing mineral research. During the first trip six seminars were given on "Phosphorus Supplementation for Increasing Reproduction in Cattle." During the second trip seven seminars were given on the material in Dr. Marcelo Mendes' Ph.D. thesis, "Mineral Status of Beef Cattle in the Northern Part of Mato Grosso, Brazil, as Indicated by Age, Season, and Sampling Technique." Both seminars were well received but great interest was shown in the latter which showed results of studies conducted in Brazil.

Another trip was made by J. H. Conrad to Brazil in July and August, 1978. Mineral research information from the material in Dr. Julio Cesar de

Sousa's Ph.D. thesis on "Interrelationships Among Mineral Levels in Soil, Forage and Animal Tissues on Ranches in Northern Mato Brosso, Brazil" was presented at the Sociedade Brasilera de Zootecnia meetings in Belem on July 23-27. At this meeting mineral research was discussed with many of the interested Brazilian animal scientists. Visits and seminars were presented at Fortaleza, Brasilia, Belo Horizonte, Viçosa, São Paulo, Campo Grande, Rio de Janeiro and Porto Alegre.

The AID/Florida Mineral Research Project is cooperating with several different research groups in Brazil and these will be briefly outlined below.

Dr. Waldemar Camargo and Dr. Nelson Fernandes of the Biological Institute of São Paulo have been cooperating with the Amazon Cattlemen's Association. They have been collecting samples, conducting research and analyzing plant and animal tissue samples from 35 ranches in the Amazon region. Phosphorus, copper, cobalt and zinc deficiencies appear to be widespread.

Dr. Enio Prates of the Federal University of Rio Grande do Sul collected samples of native grass pastures from four locations in Rio Grande do Sul, during the months of October, November and December over a period of two years. Twenty-three representative samples have been analyzed at the University of Florida. A cooperative mineral research project is being planned but changes in key personnel who worked for the Secretary of Agriculture have slowed this project. Dra. Olga Gavillon who had conducted some excellent mineral research took early retirement and Dr. Jorge Lopes transferred under contract to the UFRGS (Federal University).

Dr. David Stiles replaced Dr. George Hall at the Federal University of Santa María. Dr. Lauro Muller and Dr. David Stiles are continuing the experiment to study the effects of selenium-vitamin E injections on sheep and

cattle in the Levramento area of Rio Grande do Sul. They are writing a research project to tie together soil-plant-animals with a strong mineral component.

The EMBRAPA sponsored National Beef Cattle Project is located at Campo Grande, Mato Grosso. They are in the process of staffing, building and organizing. Armando Primo, technical director, returned to Florida and completed his research for the Ph.D. and he was replaced by Leonidas Valle who has a Ph.D. in pasture and forages from Florida. Dr. Julio César de Sousa just completed his Ph.D. in mineral research at Florida and went to Campo Grande to head the analytical laboratory. This laboratory is equipped with an Atomic Absorption Spectrophotometer (Perkin-Elmer 306) which was purchased in 1976 and a smaller Perkin-Elmer 103. It is apparent that this laboratory will be well equipped and have capable personnel to do excellent mineral research. Dr. Sousa now has a number of mineral research projects in progress. These include studies on mineral deficiencies in cattle in the territory of Roraima, effect of season of mineral supplementation for slaughter cattle and mineral supplementation of cattle on guinea grass pasture at Miranda, Mato Grosso.

Dr. Jürgen Döbereiner and Dr. Carlos Tokarnia at EMBRAPA/RJ, Km 47 and Universidade Federal Fluminense have been doing mineral research along with the study of toxic plants for many years. Samples of jaw bones in formaldehyde were brought to Dr. Hines and Dr. Stanley at the Dental Faculty, University of Florida. Histological examinations are being made to attempt to identify causative factors associated with a periodontal condition in cattle.

Professor Roberto da Silva is in charge of the analytical laboratory at the Veterinary School, Belo Horizonte. He has a Perkin-Elmer 403 and the laboratory has the capacity for 100 samples daily in which 6 minerals

are determined. Their effort is on identification of mineral deficiencies in Central Brazil primarily the large cattle producing areas of Minas Gerais and assistance with analyses related to Master of Science theses.

The Zootecnia Department, Federal University of Viçosa, Viçosa, Minas Gerais has 75 graduate students in Animal Science. Several of these are working on minerals and their availability in various plants.

Henrique Otávio S. Lopes at the EMBRAPA Cerrado Research Center has been working on mineral research in Goiás. He obtained the following results:

Mean liveweight gains (grams/animal/day) during a wet and dry season from April 11, 1976 to June 10, 1977.

Mean liveweight gain (gram/animal/day)

Treatment	Wet season	Dry season	Wet + dry season
A. Salt	236	-130	53
B. Salt + P	267	- 86	90
C. Salt + P + Co + Cu + I	280	- 5	137
D. Salt + P + Co + Cu + I + Zn + Fe + Mn	274	- 49	112

Forage analyses indicate that about 50% of the forage samples have less than 0.18% phosphorus, 5 ppm copper and 20 ppm zinc. Forage and liver samples are being analyzed for cobalt and molybdenum at the University of Florida.

Dr. José Adalberto Gadêlha at the Federal University of Ceará, Fortaleza, and his group plan to collect and analyze forage and animal tissue samples from five different areas of the state of Ceará in northeast Brazil. Cobalt, copper and phosphorus deficiency are thought to be widespread, but no supplemental trials have been conducted.

Dr. Adilson Serrão and Cristo Nazaré are working primarily with forages and they plan to determine the mineral content of some of the forages common to the Amazon region.

Colombia

A research program between CIAT and the University of Florida has been in progress since March, 1975. Mr. Soekanto Lebdosoekojo had been working on a Ph.D. research program at the Caramagua experiment station entitled "Mineral Supplementation of Breeding Cattle in the Colombian Llanos." Soil, animal tissue and forage samples were collected in herd system programs and were analyzed and written up into a thesis. In 1977 the thesis was completed and an abstract of data from the thesis was presented at the 1977 ALPA meetings in Cuba. There is now no longer a cooperative program between the Florida-AID program and CIAT.

A cooperative mineral research program between ICA and the Florida-AID contract has been in effect since July, 1975. The original leader of this program was Dr. Arturo Gil. In early 1978, Dr. Gil resigned his position at ICA and was replaced by Dr. Max Laredo. Dr. Gil is still active in the program even though his main work is now with industry. An additional contact is Dr. Juan Salazar with the VECOL Company. Dr. Salazar has been very helpful in his supporting of the mineral research program. Likewise, Dr. David Schaer of AID and Dr. Ed Stone of FAO have been helpful in encouraging the mineral research program.

Some of the early research in this program involved pilot projects in 8 ICA experiment stations. Two treatment groups were used with the treatments being with and without mineral supplementation. Every three months liver biopsy, blood and forage samples were collected. Only a small number of animals were used per treatment and therefore statistical evaluation was difficult. However, conclusions were made as to future studies that needed to be undertaken.

The mineral research to date has had both problems and successes. The biggest disappointment was the termination of 4 mineral supplementation

experiments that were in progress in the Medellín and Montería (Caucasia) regions of Colombia. These experiments were in progress for 6 months but were abruptly terminated when the animals were sold. Also there have been failures with supplementation trials with ranches which were part of the Fondo de Ganadería de Meta, Tolima and Antioquia.

Some of the best experimental results have come from the Puerto Boyaca region. In a previous experiment, animals receiving a supplement containing arsenic, sulfate and additional copper had double the weight gains as animals receiving a standard mineral mixture. Further analysis indicated that not only was this area high in selenium but it was also high in molybdenum, thus complicating the copper deficiency. There is currently a big push to determine molybdenum concentration of forages from different parts of Colombia. Ing. José Daniel Gómez who is one of Dr. Gil's associates spent one month in various regions of Colombia collecting forage samples. His primary emphasis was north of Bogotá and along the Atlantic coast area. Forages that are collected are being analyzed for both copper and molybdenum content. Research findings have shown that this, and other areas, contain forages relatively high (20 ppm) in molybdenum. This, coupled with low copper status based on analyses of forages and liver tissue, indicate the need for more copper supplementation.

At this time the researchers at ICA have collected a tremendous amount of samples and have completed numerous mineral analyses. There is currently a rough summarization of the mineral status for 33 distinct regions of Colombia. Based on forage, liver and blood analyses, various areas have been noted to fall in the following category for the specific minerals: toxic, high, normal, low, deficient and severely deficient. With this information a better idea is now becoming apparent as to which minerals are problems in specific regions.

An interesting study in the Puerto Boyaca region was undertaken by a botanist who was working with Dr. Gil. The purpose of this study was to identify the various plants in this selenium toxic region and to determine the selenium concentration. In this way, they could determine if there were selenium indicator plants. This data has been written up as a thesis and there are definitely selenium indicator plants.

An additional interesting study has been undertaken in the Puerto Boyaca region studying the effects of the high molybdenum on copper metabolism. Animals were given radioactive copper (copper-64) and the rate of elimination and retention was studied. After 7 to 8 hours only 10% of the copper-64 was retained for controls while those animals which had been in a molybdenum toxic area retained 60% at this time. The molybdenum content in many forages in the Puerto Boyaca region is approximately 20 ppm. Also studies have been made using ceruloplasmin. This copper-containing enzyme was lower in animals with copper deficiencies and positively correlated with low hematocrits. This work was included in a thesis by Patricia Jiménez and Lucía Pabón and was published this year. Data in this particular thesis also published summarized data of copper in relation to samples taken from slaughterhouses and also from liver biopsy. It is apparent that copper deficiency is a severe problem in many regions of Colombia. The translated title of this thesis is "The Possible Deficiency of Copper in Beef Cattle."

At this time there are 11 mineral supplementation experiments distributed throughout the country. These experiments are being carried out at experiment stations of ICA, Fondos Ganaderos and selected ranches. One of the major thrusts of their supplementation trials is to compare specific mineral mixtures with commercial mineral mixtures. In evaluating

the results, there are summaries of mineral analyses of forages, blood serum, feces and liver (biopsy taken every 3 months). There is a comparison of the consumption of minerals, weight gains and cost of mineral supplements.

Table 1 presents averages of protein and mineral concentrations from different experiment stations of ICA.

The mineral mixtures being used in the mineral supplementation trials are being supplied by the Pfizer Company. They are making special mixtures as to specifications by ICA personnel.

One of the experiments at Carimagua is comparing the effects of mineral supplementation all year long versus only during the wet season. The results of this experiment for one year indicate that animals receiving minerals only during the wet season have equal or superior gains to animals which received mineral supplements all year. It will be interesting to see if this trend continues. This trend would suggest that animals do better with minerals just during the wet season rather than all year long, possibly suggesting a somewhat detrimental effect from mineral supplements during the dry season.

Figures 1 summarizes the mineral study and illustrates where mineral research studies in Colombia have occurred. Deficiency levels would be based on the following: less than 7% protein in forages; less than 10 ppm copper in forages and 75 ppm in liver; less than 40 ppm zinc in forages and 84 ppm in liver tissue; less than 0.25% phosphorus in forages; less than 0.30% calcium in forages. Molybdenum and selenium toxicities may occur on more than 5 ppm in forages. It is impossible at this time to make a general summarization. A large percentage of all forages are low in sodium and phosphorus, and less than 0.2% magnesium. The majority of the forages contain less than 30 ppm of zinc. The general statements for

TABLE 1. Averages of protein and minerals on the different farms of ICA

Locality	Material	C.P.	Ca	P	Mg	Na	K	Cu	Zn	Fe	Mn
Carimagua+	Forage	8.8N	.23D	.07S	1.6N	0.03S	1.7H	4.8D	11.1D	850N	90N
El Nus+	Forage	5.9D	.85N	.14D	0.4N	0.02S	1.8H	8.0L	31.0D	944N	318H
Turipaná+	Forage	5.6D	.33L	.25L	0.27PN	0.03S	3.2H	6.0D	51.0L	258N	37D
Macagual+	Forage	8.4N	.49N	.12D	0.17L	0.01S	3.3H	3.5D	11.2S	685N	384H
La Libertad+	Forage	5.2D	.56N	.21L	0.25PN	0.01S	1.6H	3.9D	12.9S	342N	237N
Obonuco+	Forage	17.9H	.49N	.48N	0.42N	0.40N	5.2H	9.0D	20.0D	355N	46L
Caldas (Reg.	Forage	9.7N	.71N	.26L	0.39N	0.04S	2.9H	41.0N	24.0D	494N	140N
Puerto Boyacá--	Forage	9.7N	1.00N	.28L	0.32N	0.01S	3.9H	8.8L	29.0D	206N	78N
Puerto Salgar-	Forage	8.7N	1.40N	.23L	0.31N	0.02S	2.5H	9.2L	20.0D	221N	59L
Valle Cauca--	Forage	9.1N	.87N	.23L	0.41N	0.01S	4.1H	9.0L	23.4D	919H	149N
Tolima+++	Forage	2.3S	.80N	.07S	0.08D	0.01S	1.0N	3.1D	12.6S	434N	153N

* Average of 5 to 20 observations: N = Normal; PN = Probably Normal; L = Low; D = Deficient; S = Severely deficient; H = High.

\+ ICA Experiment Stations
++ Particular Ranches
+++ Cattlemen's Organization

Mineral Supplementation Experiments *

Location		Treatment	Animals/Treatment	Duration
El Naz	1)	complete minerals	27 heifers	2 years
	2)	NaCl + Cu + Zn + phosphoric acid		
Turipana	1)	complete minerals	90 males	1 year
	2)	NaCl + Cu		
	3)	NaCl + dicalcium phosphate + Cu		
Obonuco**	1)	complete minerals	15 heifers	2 years
	2)	NaCl + Cu + Zn		
Macagual	1)	complete minerals	25 heifers	2 years
	2)	NaCl + dicalcium phosphate		
Carimagua	1)	complete minerals fed complete year	32 heifers	2 years
	2)	P + Ca fed complete year		
	3)	P fed complete year		
	4)	P + N fed complete year		
	5)	complete minerals fed wet season		
	6)	P + Ca fed wet season		
	7)	P fed wet season		
	8)	P + N fed wet season		
La Libertad	1)	complete minerals		
	2)	NaCl		
	3)	NaCl + dicalcium phosphate (15%), ammonium phosphate	20 heifers	2 years
	4)	NaCl + ammonium phosphate (30%)		
San Carlos de Guaroa	1)	complete minerals	40 cows	2 years
	2)	NaCl + phosphoric acid		

*Minerals supplied by the Pfizer Company.
**Experiment terminated after 1 month due to foot and mouth disease outbreak. Experiment was reinitiated with new animals.

specific regions are as follows: Los llanos - The most severe deficiencies are phosphorus and protein; Caqueta - There appears to be a calcium deficiency; Puerto Boyaca region - There are deficiencies of copper, phosphorus, calcium and toxicities of molybdenum and selenium; La Sabana region near Bogotá, Tolima and Huila - These areas are deficient in copper, zinc, perhaps cobalt, and have toxic concentrations of molybdenum; Turipana, Caribia and Montilonia - In this region the most severe deficiency is copper. Caribia appears to be adequate in phosphorus and calcium but Turipana and Montilonia are deficient; El Nus, Palmira and Obonuco - These three areas have similar problems with severe copper deficiencies and marginal zinc deficiencies; Antioquia - Phosphorus deficiency is the most noticeable problem; Valle and Nariño - The mineral status in regards to phosphorus seems adequate but copper is deficient.

Table 2 presents information on the cost of mineral supplements in relation to animal gains. Comparisons are made between commercial mineral supplements and supplements which can be formulated at a much lower cost. The data indicate that mineral mixtures can be formulated for much lower cost than commercial supplements available and, therefore, mineral supplements can be more economical for beef cattle production.

Apparently much of the data which includes mineral supplementation experiments and numerous mineral analyses will be further summarized and published in appropriate journals and experiment station reports.

During the last trip to Colombia (February) a visit was held with Mr. Wayne Miles. The Miles family has a very serious animal health problem on their ranch, "La Plata," in the llanos. They have had a very serious condition which is locally known as "secadera" (translated as dry up). This condition has been well recognized by cattlemen in the llanos for many

Sample Sites indicating Mineral Deficiencies and Toxicities in Colombia

Table 2. Weight gains, intake and cost of mineral salt in 5 ICA farms.

	El Nus		Turipana			Macagual		La Libertad		Obonuco	
	Salt Comerc. I	Salt ICA II	Salt Comerc.	Salt ICA II	Salt ICA III	Salt Comerc.	Salt ICA	Salt Comerc.	Salt ICA	Salt Comerc.	Salt ICA
Number of [illegible]	28	28	20	20	20	25	25	24	24	10	10
Time (days)	450	450	162	162	162	180	180	90	90	90	90
Initial w[illegible] $\bar{X}$ (kg)	208	218	159	163	160	157	163	188	189	229	229
Final weig[illegible] $\bar{X}$ (kg)	328	348	277	273	269	206	219	243	243	312	315
Total weig[illegible] in $\bar{X}$ (kg)	120	130	116	110	109	49	56	55	54	83	86
Gain/day $\bar{X}$ (g)	267	288	716	692	653	274	313	562	551	921	959
Salt consu[illegible]ion/day/animal (g)	75	57	21.8	21.0	12.7	56	48	58	48	35	33
Cost of salt/kg ($)	10.3	18.6*	10.3	3.2	7.6	10.3	7.2	10.3	19.8*	10.3	2.9
Cost/animal/day (cents)	77	1.06	23	3	10	58	30	60	95	35	9

*This high value is due to the use of pure phosphoric acid as a phosphorus source, since the cost of this one is too high ($80/kg). (It is possible to obtain a similar product at a lower cost).

I = Commercial salt (Pfizer).

II-III = (different preparation for each farm).

years. Dr. Nels Konnerup of AID noted that this was a problem in the early 1950s. The etiology of this problem is entirely unkown. The disease consists of gradual and continual loss of condition ending in death. It has some of the characteristics of wasting disease as a result of a cobalt deficiency. Most calves begin to lose weight at weaning but others do not start losing until later on. On Mr. Miles' ranch, one year ago, 65 calves from a lot of 95 weaned animals died of this condition. Many of the animals that did not die at that time died the following year. Also, it has been noted that animals brought from other areas seem to be all right for a year and then they develop this condition. Animals will go out of condition and then will develop diarrhea which leads to their eventual death. However, in some cases the diarrhea can be treated and prevented but the animals will still continue to waste away and will eventually die.

Unfortunately, not one sick animal has responded to any type of treatment and recovered. A variety of treatments have been given, such as antibiotics for general infection (oxytetracycline), for anaplasmosis (revevet), for babeosis (ganasec), for coccidiosis (sulmet), and for diarrhea (anti-diarrhea solutions).

One unconventional treatment which was reported to have worked on another farm was the administration of the detergent "Fab" in addition to an injection of vitamin B_{12}. Mr. Miles had given vitamin B_{12} injections to sick animals with no apparent response. We recommended that they continue trying vitamin B_{12} with higher dosages.

Some persons have associated the use of the forage Brachiaria decumbens as the main cause of this condition. However, in a thorough investigation, it has been shown that this condition also occurs on other forages. In Mr. Miles' case the sick animals have been taken off the Brachiaria decumbens grass and moved to pasture containing molasses grass with other native

grasses. Neither lot responded to the pasture. Those on native grass just seemed to die sooner. One rancher has made the observation that when there was a very high grazing pressure on the Brachiaria decumbens pasture, no problem of "secadera" resulted. However, when the stocking rate is low and the pastures becomes more mature the condition results. As previously noted, this condition is prevalent during the wet season. When the dry season comes, if the animals do not already have the symptons, the condition will not appear until the following wet season. Animals often take 2-3 months to die. The rainy season starts in early April, however, animals usually do not die until July. Also, it is noteworthy that this condition was recognized before Brachiaria decumbens was ever introduced into the llanos.

Others have thought that the "secadera" condition was due to Brachiaria decumbens because it was most common when this forage was used. Some have suggested that there is a fungus on the Brachiaria decumbens that causes the problem. Photosensitivity has been shown to be caused by this forage. There has been some swelling about the ears and neck and Mr. Miles feels that this has nothing to do with the "secadera" condition since taking animals off the Brachiaria decumbens would improve the other condition. However, animals will continue to "waste away" and die.

Sick animals have been posted by ICA and by CIAT veterinarians. Complete metabolic profiles have been made by CIAT without any hint of the etiology of the disease. Blood checks by ICA and CIAT have not indicated any serious problems with either anaplasmosis or babeosis. Internal parasites were also not serious. Ticks have been heavy for a short period but they are now controlled.

Criollo animals seem to have more of a problem with "secadera" than do those with Zebu blood. The condition is so serious that Mr. Miles may sell his ranch if a cure is not found within one year.

The exact geographical extent of the disease is unkown. However, it is very prevalent in the northern part of Meta state and continues into Vichada state. Some of the high incidence would be south of Villavicencio.

We had previously recommended that Mr. Miles use a very good mineral mixture containing adequate phosphorus and trace minerals. During that week the mineral mixture was formulated and given to the cattle. It contains all of the common trace minerals except iron, manganese and selenium. Of the three, only selenium might be a problem. Mr. Miles is being sent some sodium selenite. We are very hopeful that this complete mineral mixture may be part of the answer to the problem of "secadera." The mineral mixture will be beneficial to another problem on this ranch which is broken bones even if it does not prevent "secadera." We have been working with Mr. Miles in formulating a proper mineral mixture.

Prior to the current problems we had made recommendations to Mr. Miles on the possible use of triple superphosphate and also basic slag as phosphorus supplementations. We had made recommendations as to the quantities of triple superphosphate that could safely be included in mineral supplements due to the high fluorine content of this product. The recommendations had been to use a mineral supplement containing 40% bonemeal and 10% triple superphosphate with the remainder being salt.

We promised to analyze some of Mr. Miles' forages which will be sent through Dr. David Schaer. Also, we have broached the idea of trying to do some research to determine the mineral status of livestock in this region. This could possibly be part of an M.S. or Ph.D. degree research program. It would be important to locate farms which would be willing to provide liver, blood, forage and soil samples. There are several ranches in the area which may provide these samples. A proposal for doing research in

the area where "secadera" is a problem is included at the end of the Colombia portion of this report.

The AID-University of Florida program during the first two years was providing $7,000.00 a year to assist the ICA mineral research program. This amount has now been reduced to $4,000.00. These funds have been used for travel and the purchase of laboratory supplies. In addition, the Florida-AID program has provided additional consumable supplies and has completed analyses of some of the more difficult minerals (for example, cobalt and molybdenum).

A PROPOSED MASTER OF SCIENCE RESEARCH PROGRAM IN THE LLANOS AREA OF COLOMBIA

Title: The Mineral Status of Beef Cattle in the Llanos of Colombia whe "Secadera" is Encountered.

Introduction: A serious health problem with beef cattle in certain areas in the llanos of Colombia is "secadera". Since the early 1950s this condition has been recognized by the cattlemen in the llanos. The etiology of this problem is entirely unknown. This condition consists of a gradual loss of condition finally ending in death. It has similiar characteristics of wasting disease as a result of a cobalt deficiency. Most calves begin to lose condition at weaning but others do not start to lose weight until later. On one particular ranch 65 calves from a lot of 95 weaned animals died of this condition. Apparently, "secadera" is prevalent during the wet season and when the dry season starts, if the animals do not already have the symptoms, the condition will not appear until the following wet season. Animals often take 2-3 months to die. "Secadera" animals have been posted by both ICA and CIAT veterinarians with a complete metabolic profile done. Unfortunately, infectious diseases or internal parasites have not been shown to be related to this condition.

The efficiency of beef cattle production in the llanos of Colombia is low. These low production rates are influenced by many factors, some of which may be inadequate mineral nutrition. Limited mineral analyses of plant and animal tissues taken throughout Colombia indicate severe mineral deficiencies, including that of phosphorus, sodium and copper. Mineral supplementation trials carried out in the llanos by ICA and CIAT researchers have indicated dramatic response from mineral supplementation.

Research Objectives: 1) To establish if specific mineral deficiencies or

toxicities are related to the disease condition "secadera". 2) To compare the seasonal (wet versus dry season) mineral status of beef cattle. 3) To evaluate and compare the mineral status of beef cattle at different physiological states (growing steers or heifers vs. pregnant-lactating cows). 4) To study mineral soil-plant-animal interrelationships.

Location of Research: Six to ten ranches located in areas where the "secadera" condition is reported. This would likely be in the northern part of Meta state and into the Vichada state.

Institutions Involved: 1) ICA - Dr. Max Laredo. 2) Caja de Crédito Agrário - VECOL - Dr. Juan Salazar. 3) University of Florida - Dr. L. R. McDowell and Dr. J. K. Loosli.

Research Proposal: From each farm, soil, forage, blood, liver and bone samples will be collected twice during the year. Collections could be June-July (end of wet season) and November-December (end of dry season). The research could be modified so that collections are only made once per year (June-July) to represent the time of greatest death loss due to "secadera". Standardized questionnaires for farm description, animal identification and forage description can be used. The collection of samples could be as follows for each collection period:

1) Soil - 2-5 samples from different regions of the farms.

2) Forage - Separate samples of each of the major species should be taken. This would likely involve 2-5 species per farm. In sampling the aerial parts of the plants in a field, select at random at least 10 or more sample sites from each field depending on the size of the field with each species collected separately. A forage questionnaire should be filled out for each farm which includes the % of each species on offer. Pasture samples should be collected only after careful observation of cattle grazing patterns. It is necessary to watch the animal graze and hand pluck a sample to represent the animal's diet. From the composite forage sample, 2-5 samples each of the major forage species should be analyzed. For each sample, a total of 200 g should be available. Samples should be air-dried at 60°C, ground (using stainless steel equipment), and the sample should be transported to Florida.

3) Blood plasma - From each farm, 14 samples from each class should be collected from both randomly selected growing steers or heifers (1-2 years after weaning) and lactating cows. Approximately 20 ml of blood should be collected using California bleeding needles. As soon as the blood is collected, the container should be tipped and inverted and thoroughly but gently mixed with the anticoagulant. If lithium citrate (20% solution) is used, add 1/10 ml for each 10 ml of blood to be collected. Keep the sample cool and centrifuge within 2-3 hours of collection. If serum rather than plasma is collected, draw off serum as soon as a sufficient quantity is formed. For either serum or plasma keep cool and freeze when facilities are available.

4) Liver - Fourteen samples of liver (biopsy) can be collected from both cows and heifers at the same time as blood is collected. Samples would be stored in biopsy bottles under refrigeration (or freezing) or in 10% formaldehyde. If possible the same animals should be sampled each collection period.

5) Bone - If possible, bone samples should be collected from each ranch. Bone samples may represent animals that are normally being slaughtered for local consumption. Metacarpal bone and right ribs should be taken from each of the slaughtered animals. Bone samples should be stripped of all soft tissues. Four centimeters of the central part of the right ribs are cut and split into halves with the bone marrow removed using a jet of distilled water. Two centimeters of the central part of the left metacarpal bone should be cut. The density of all bone samples can be measured by weighing in air and in water. The bone sample should be placed in 10% formaldehyde prior to shipping to Florida.

Analyses: The following analyses would be recommended:

1) Soil - Complete soil analyses to include soil classification, soil structure, pH, organic matter and available forms of the following minerals: Al, Fe, Mn, Zn, Co, Cu, P, Ca, Mg, K, Na, Se, Mo and I.

2) Forage - Co, Se, S, Fe, Mn, Cu, Zn, Mo, P, Ca, Mg, K, Na, N and I.

3) Blood - Ca, P, Mn, Zn, Cu and Fe.

4) Liver - Zn, Cu, Se, Co, Mo, Fe, Mn and Mg.

5) Bone - Bone ash, specific gravity, P, Ca and Mg.

Schedule for Prospective Graduate Student: A prospective graduate student would take all course work at the University of Florida and would visit Colombia once or twice during the degree program. For an M.S. degree program this would probably be one trip of 1-3 months in duration while "secadera" is most prevalent. For a Ph.D. program 2 visits would be made. One would be made during the time when "secadera" is most prevalent and 6 months later.

During the time in Colombia, Dr. Max Laredo and Dr. Juan Salazar would be responsible for assisting the degree candidate in locating farms and making sample collections. Depending on the desires of the individual involved, probably most of the analyses would be completed at the University of Florida. A certain amount of sample preparation would be needed and probably Tibaitatá would be the ideal location for this.

Costa Rica

The mineral research program in Costa Rica has been highly active and one of the most productive for the mineral research program. The original leaders of the program were Prof. Hernán Fonseca and Ing. Emilio Vargas of the Animal Science Department, University of Costa Rica. Although still active in the program, Prof. Fonseca is currently the Minister of Agriculture in Costa Rica and effective early in 1979, Ing. Emilio Vargas accepted a position with INCAP in Guatemala. Dr. Carlos Campabadal is now one of the active leaders of the program. For the mineral research program, the Animal Science Department is receiving funds from CONICET, an organization which supports research. In addition, eleven Peace Corps volunteers have devoted a great deal of time to collecting liver, blood and forage samples from selected regions of Costa Rica. For the year 1978 only, 884 blood, 1128 forage and 661 liver samples were collected. In 1978, 15,000 analyses were carried out. Since the program began 4000 samples have been collected from 370 farms. The plans of the program are to conduct mineral research studies in all of the major dairy and beef cattle regions of Costa Rica. The University of Florida/AID program has contributed $7,000.00 per year for two years to assist with the mineral analyses.

This support was only needed for 2 years for the salary of a coordinator of the Costa Rican program. Since October, 1977, the University took over the salary support of the coordinator of the program. The Costa Rica mineral project no longer requires any direct financial support from the Florida-AID project. It is estimated by the Costa Rican project officials that an excess of $235,000 ($U.S.) has been spent on this special program.

The earliest stages of the mineral research program involved two University of Florida graduate students who did their M.S. research in Costa Rica.

The titles of these theses are "Phosphorus and Trace Mineral Status of Beef Cattle in the Guanacaste Region of Costa Rica" and "Mineral Status of Cattle in the San Carlos Region of Costa Rica". The results of this data were discussed in a previous annual report. Data from these theses have been published in 1978 in the "Journal of Dairy Science" and "Tropical Agriculture". Also this data was presented at the 1978 World Animal Production Meetings in Argentina. This data is also being written up as part of an extension bulletin for Costa Rica. Data from these papers have been presented as abstracts in one national meeting (Houston) and two international meetings (Maracaibo, Venezuela and Buenos Aires, Argentina).

Dr. Nestor Marciles of Argentina is temporarily working with the University with a grant from the Atomic Energy Commission. He will be working with the University until 1979. Dr. Marciles will be working on nuclear research techniques in the mineral area, particularly where there are suspected problems.

For quite some time it has been known that in certain regions of Costa Rica manganese forage concentrations are very high due to previous volcanic activity. Some studies have related high forage manganese to low reproduction rates in cattle. Dr. Marciles has been using isotopes to determine how manganese may be affecting reproduction. His conclusions noted that manganese was interfering with iodine metabolism. Depending on the level, rats fed diets with manganese from 200-1000 ppm have an abnormal thyroid condition. Up to 200 ppm there was no problem and beyond 500 ppm females had a hyperthyroid condition. High manganese diets increased T4 and decreased T3. Manganese is known to accumulate in the thyroid more than in any other tissue. Some of the future studies will involve taking thyroids from animals in slaughterhouses and relating these to particular farms with reproductive

problems. Cattle from some of these farms experienced early abortion (35%) within 3 months of pregnancy. The mechanism for manganese toxicity via thyroxine metabolism is not understood.

From the mineral research program it has been found that in the dairy cattle region of Coronado (just north of San José) cattle have low blood calcium levels. Phosphorus levels from these animals are high to normal with a large percentage of cows anemic as shown by low hematocrits (example, 24-25%). Dr. Marciles has been working with the radioisotapes (example, P^{32} and F^{59}) to evaluate the status of cattle in this area. Upon examination of animals it was found that there was hematuria. The bone marrow was not producing a sufficient quantity of red blood cells. Looking through the literature it is found that a particular forage genus, Peteridiun, was causing a similar condition in Germany. This particular genus is found in the areas where the condition is noted. However, further studies will need to be made to see if this can be reproduced under experimental conditions.

Samples collected by the Peace Corps volunteers are used for "Egresado" (B.S.) degree theses. Twelve "Egresado" theses have now been completed and at this date we have received each of these. The quality of these theses is excellent.

Conclusions from the first 3 theses are as follows:

Olger Murillo Bravo

The title of this thesis is "An Evaluation of Mineral Nutrition Status of Grazing Cattle in Cañas County, Guanacaste". In this experiment, 19 beef cattle farms were utilized from Cañas county with samples taken during the dry season. There were a total of 90 forage, 106 blood and 8 liver samples analyzed.

Conclusions:

a) Crude protein: 80% of the forages contained less than 7% protein with the average being 2.86%.

b) Calcium: The majority of the blood calcium values were normal being over 9 mg%. However, 68.9% of the forages contained less than 0.18% calcium.

c) Phosphorus: The average phosphorus concentrations were 4.27 mg%. 50% of blood phosphorus values were less than 4 mg%. Only 6 of 19 farms had normal average blood phosphorus levels. Approximately 89% of the forage samples contained less than .18% phosphorus. The average phosphorus was 0.09%. 100% of the farms had deficient average forage phosphorus levels.

d) Magnesium: Only 1.89% of the blood magnesium was less than 1.8 mg% and only 5.6% of the forage samples contained less than 0.05% magnesium. It could be concluded that magnesium status of these animals was adequate.

e) Potassium: Approximately one-third of the forage potassium samples were less than 0.6% with the average potassium forage concentrations of 1.15%. Four of these farms had average values of less than 0.60%.

f) Iron: The average forage iron for all farms was 148 ppm with all farms being adequate in forage iron. Liver samples were also adequate in iron concentration.

g) Copper: Approximately 81% of the forage samples contained less than 4 ppm copper. Over 99% of the samples contained less than 10 ppm. The overall copper forage mean was 2.81 ppm. Only 4 of the 19 farms had average copper forage values of 4 ppm or more. Six liver samples varied from 78 to 250 ppm with the average being 157.8 ppm.

h) Manganese: Forty percent of the forage samples contained less than 20 ppm with the overall average being 27 ppm. Eight of 19 farms had averages of less than 20 ppm. Eight liver samples ranged from 2-7 ppm averaging 4.75.

i) Zinc: Sixty percent of the forage samples contained less than 20 ppm with an overall average of 20.05 ppm. Twelve of 19 farms had averages less than 20 ppm. Six liver samples ranged from 99 to 150 ppm.

In this thesis forage species differences were noted for both protein and minerals. The overall conclusions would be that phosphorus and crude protein are severely deficient, copper is deficient with borderline to deficient

concentrations of manganese and zinc noted in forages and livers.

Manrique Alonso Guzmán

The title of this thesis is "Evaluation of Mineral Status of Beef Cattle in Pastures in the Districts of La Cruz, Cañas Dulces and Filadelfia in the Province of Guanacaste During the Dry Season". In this study three districts are involved. There are 5 farms from La Cruz, 1 from Filadelfia and 6 from Cañas Dulces. In general, there were 5 samples of blood, liver and forage collected and analyzed per farm.

a) Protein: 95% of the forages contained less than 8% protein.

b) Calcium: Approximately 27% of the blood values were low containing less than 8 mg/100 ml. Forage calcium levels were also quite low with 40% containing less than .18%.

c) Phosphorus: 27% of the phosphorus concentrations were less than 4 mg/100 ml. Forages were also low in phosphorus containing less than 0.18%

d) Magnesium: A large proportion of the animals (43%) contained low levels of blood magnesium (less than 2 mg/100 ml). Forage magnesium levels were also low with 43% containing less than .04%.

e) Potassium: 42% of the forage values contained less than .6% potassium.

f) Iron: 13% of the forages contained less than 10 ppm of iron.

g) Copper: Copper forage concentrations were low with 13% containing even less than 3 ppm. 4 of 9 liver samples contained less than 75 ppm of copper.

h) Manganese: 3% of forage manganese values were less than 6 ppm and 8 of 9 liver samples were also less than 6 ppm.

i) Zinc: 8% of the forage values contained less than 10 ppm while 2 of 9 liver samples contained less than 84 ppm.

The data from this thesis also contains correlation coefficients and shows differences among farms and forage species. The general conclusions would be that protein and phosphorus would be at insufficient concentrations. Magnesium levels suggest problems in this area, calcium levels were low for

a relatively large percentage of blood calcium analyses and manganese and zinc were relatively low in forages.

Luis Fdo. Palmer Francis

The title of this thesis is "Evaluation of the Mineral Nutrition Status of Cattle in the Province of Cartago". In this study 34 farms (mostly dairy) from the Province of Cartago were studied during the dry season. There were 2-6 farms utilized per county. Of the samples analyzed, there were 64 forage, 68 blood and 10 liver samples.

a) Crude protein: Approximately 94% of the forage samples contained more than 7% protein averaging 13.76%. This would be quite contrary to the areas where data was taken for the other two theses.

b) Calcium: 65% of the blood calcium values were less than 9 mg% and 98.4% of the forage samples were less than .44% calcium. For instance, 43.8% contained less than .16% calcium.

c) Phosphorus: 51.5% of the blood phosphorus levels were less than 4 mg% with the average being 4.17 mg%. 65.6% of forage samples contained less than .16% phosphorus (92.2% contained less than .30% phosphorus, averaging 0.15%).

d) Magnesium: 94.1% of blood magnesium was normal with forage magnesium levels averaging 0.22%.

e) Potassium: Forage potassium levels were normal ranging between 0.83 and 8% with an average of 3.44%.

f) Iron: 12.5% of the forage contained less than 100 ppm of iron averaging 297 ppm. Ten liver samples ranged from 58 to 196 ppm.

g) Copper: 75% of the forage samples contained less than 10 ppm averaging 8 ppm. Eight of 10 liver samples were below 75 ppm averaging 44 ppm. Copper liver ranged from 15 to 144 ppm.

h) Manganese: 78.1% of the manganese forage values ranged between 25 and 100 ppm averaging 111 ppm. However, the liver manganese values (10 samples) were low averaging 4 ppm.

i) Zinc: 82.8% of the forage contained less than 40 ppm averaging 33 ppm. Ten liver samples averaged 54 ppm ranging from 30 to 103 ppm.

This data also contains correlation coefficients and it shows differences among farms, forage species and animal classes. Phosphorus appeared to be the most severe mineral deficiency with low levels of forage and blood calcium noted. The analyses would indicate that copper, manganese and zinc are all borderline to deficient in these samples.

In 1978 and early 1979 nine additional theses were presented to the department. The most important results are as follows:

1) "Mineral Status of Bovine Cattle, Pastures and Blood Serum in the Central Pacific of Costa Rica During Dry Season". Student: Olga Salas, Professor: Carlos Campabadal H., Ph.D.

This work was based on an evaluation of the mineral status of Abangares (Guanacaste Province) and Canton Central, Esparza and Montes de Oro (Puntarenas Province).

Blood and pasture samples were analyzed in this zinc. Calcium, phosphorus and magnesium were analyzed in blood and calcium phosphorus, magnesium, potassium, iron, copper, manganese and zinc and protein in pastures. The average calcium level in blood serum was 10.9 mg/100 g of serum. No differences were shown ($P < 0.05$) among counties. Statistical variation did show in phosphorus level of serum among counties with an average of 5.7 mg/100 mg in serum. Mg level in serum was 2.8 mg/100 ml of serum, with significant differences ($P < 0.05$) among counties.

An average of 0.25% for Ca and 0.10% for phosphorus were found in pastures, with no variation ($P < 0.05$) among counties. Mg level was 0.178% with no significant differences among counties ($P < 0.05$). Potassium level was 1.5% with no variation among counties ($P < 0.05$). The iron average was 222 ppm with significant differences among counties ($P < 0.05$). The copper and manganese levels were 4 and 56 ppm with no significant variation ($P < 0.05$).

The zinc average was 28 ppm which did not show significant differences among counties ($P < 0.05$).

Protein showed significant differences among farms with an average of 5.0%. Protein, phosphorus, copper and zinc supplementation was recommended.

2) "Mineral Content in Pastures and Blood Serum of Bovines in Nicoya County During Dry Season". Student: Luis F. Wong R. Professor: Carlos Campabadal H., Ph.D.

This study had the main purpose of evaluating the mineral content in pastures of cattle in Nicoya County.

Eighty-one blood samples and 68 pasture samples were collected at random at Nicoya and Mansion Districts. Collecting period was from December, 1976 to April, 1977.

Ca, P and Mg averages in blood serum were 9.7, 5.0 and 2.5 mg/100 ml, respectively. The results indicated an average for pastures of 3.71, 0.24, 0.08, 0.13 and 0.99% in protein, calcium, phosphorus, magnesium and potassium, respectively. Iron, copper, manganese and zinc averages were 175, 2.4, 49, and 26 ppm, respectively.

Based on this information the following supplements were recommended in this zone: a) a liquid supplement containing urea, b) direct phosphorus supplementation (bonemeal) through a mineral salt or H_3PO_4 in a liquid supplement, c) direct copper supplementation (sulfate, carbonate or oxide) through a mineralized salt.

3) "Evaluation of Mineral Nutrition Status of Bovine Grazing Cattle in San Carlos County". Student: Francisco Alpizar. Professor: Carlos Campabadal, Ph.D.

This investigation was done with the purpose of determining the mineral status in pastures and blood of bovines during dry season in the districts of

Pital, Aguas Zarcas and Colon, San Carlos.

Sixteen farms were studied as follows: 6 farms in Pital, 5 farms in Aguas Zarcas, and 5 farms in Colon.

Blood samples were analyzed for calcium, phosphorus and magnesium and pasture samples for protein, calcium, phosphorus, magnesium, potassium, iron, copper, manganese and zinc. The average calcium, phosphorus and magnesium levels in blood were 8.6, 4.4 and 2.4 mg/100 ml of serum, respectively. Protein, calcium, phosphorus, magnesium and potassium levels in pastures were 12.6, 0.22, 0.11, 0.20 and 2.86% in dry matter, respectively, while iron, copper, manganese and zinc levels were 193, 8, 115 and 25 ppm, respectively.

Supplementation with Ca, P, Cu and Zn was suggested in this zone.

4) "Determination of Mineral Content of Pastures in Bovine Blood in Guacimo, Siquirres and Pococi Counties". Student: Carlos A. Martínez. Professor: Juan Coward L., M.Sc.

This investigation was done with the purpose of evaluating the mineral content of the different forage species and grazing beef cattle in Guacimo, Siquirres and Pococi. Pasture and blood samples were collected from 17 farms during the months of November, 1976 to April, 1978.

Calcium, phosphorus and magnesium contents were determined in blood and protein, calcium, phosphorus, magnesium, potassium, iron, copper, manganese, and zinc in pastures. The results show an average of 12.1, 7.2 and 3.0 mg/100 ml of serum for calcium, phosphorus and magnesium blood and 9.3, 0.21, 0.11, 0.25 and 3.2% in protein, calcium, phosphorus, magnesium and potassium in pastures, respectively, and 557, 7, 114, and 28 ppm in dry matter in iron, copper, manganese and zinc in pastures, respectively. Significant differences ($P < 0.05$) were found in calcium, phosphorus and magnesium in blood among counties, districts, farms, sex and age of animals.

Also significant differences among species were found in pastures in potassium, copper, manganese and zinc. Phosphorus supplementation is recommended as well as copper and zinc in order to correct deficiencies.

5) "Mineral Content in Pastures and Blood Serum of Bovine in the Districts of Fortuna and Venado, San Carlos". Student: Luis E. Alvarez. Professor: Carlos Campabadal H., Ph.D.

A study was made in the zones of Fortuna and Venado, San Carlos County with the purpose of diagnosing the mineral status of animals and forages in the zone.

Blood samples were analyzed for calcium, phosphorus and magnesium, averaging 9.1, 5.5 and 2.[illegible] mg/100 ml in serum, respectively.

Pasture samples were analyzed for protein, calcium, phosphorus, magnesium and potassium with averages of 9.35, 0.24, 0.11, 0.17 and 3.27%. In iron, copper, manganese and zinc the averages were 322, 7, 51 and 28 ppm in dry matter, respectively.

Results showed that 45, 89, 25 and 20% of samples did not meet calcium, phosphorus, zinc and copper requirements, and therefore, supplementation was recommended. Also 7 and 11% of samples showed iron and potassium levels above requirements (1000 ppm and 5% in dry matter). These values might be considered toxic for animals. A more in depth study on this matter was suggested.

6) "Mineral Nutrition Study of Cattle and Pastures in Bagaces and Abangares Counties, Guanacaste Province." Student: Edgar Vargas M. Professor: Carlos Campabadal H., Ph.D.

This research was made in Bagaces (Bagaces, Mongote and Fortuna Districts) and Abangares (Juntas, Colorado and San Juan Districts) in Guanacaste Province, Costa Rica during the dry season in order to evaluate the mineral

status in these counties.

Blood serum and pasture samples were collected for this purpose. Blood serum samples were analyzed for calcium, phosphorus and magnesium, and pastures samples were analyzed for calcium, phosphorus, magnesium, potassium, iron, copper, manganese and zinc. The crude protein percentage in pastures was also analyzed.

The average calcium level in blood serum was 12.1/100 ml, phosphorus 4.83 mg/100 ml and magnesium 2.60 mg/100 ml. In pastures there was an average of 0.27% calcium, phosphorus level was 0.07%, 0.12% in magnesium, 1.0% in potassium, 130 ppm in iron, 3 ppm in copper, 40 ppm in manganese and 25 ppm in zinc. The average protein level was 2.90%. Phosphorus, copper, crude protein deficiencies were found in this study, as well as high levels of iron and manganese.

7) "Evaluation of Bovine and Forages Mineral Nutritional Status, Central Pacific of Costa Rica During Wet Season". Student: Olman Diaz S. Professor: Lic. Emilio Vargas G., M.Sc.

This study was made in the Central Pacific region of Costa Rica during the wet season in 1977 with the purpose of evaluating the mineral content in pastures and bovine blood.

Blood samples were analyzed for calcium, phosphorus and magnesium with averages of 10.6, 4.8 and 2.6 mg/100 ml of serum, respectively.

Pasture samples were analyzed for protein, calcium, phosphorus, magnesium and potassium contents, with averages of 6.9, 0.22, 0.13, 0.10 and 0.82% in dry basis, respectively. Iron, copper, manganese and zinc showed averages of 129, 2, 25 and 8 ppm, respectively. Pastures showed phosphorus, copper, zinc and protein concentrations that do not meet the requirements of grazing cattle. Therefore, phosphorus, copper, zinc and protein supplementation were recommended.

8) "Evaluation of Mineral Nutrition Status of Cattle and Forages in Atlantica Norte Zone". Student: Horacio Chi Chan. Professor: Lic. Emilio Vargas G., M.Sc.

This research was made with the purpose of evaluating the mineral content of forages and animals in Venecia (San Carlos), Rio Cuarto (Grecia) and Horquetas and Virgen (Sarapiqui) Districts.

Pasture and blood samples were collected from 18 farms of this zone and indicated averages in calcium, phosphorus and magnesium in serum of 10.48, 4.52 and 2.52 mg/100 ml. Based on these results a deficiency of calcium and phosphorus is suspected in Venecia and Rio Cuarto Districts. Pastures showed averages in protein, calcium, phosphorus, magnesium and potassium of 10.2, 0.22, 0.16, 0.17 and 2.0%, respectively. The averages in iron, copper, manganese and zinc were 114, 15, 112 and 19 ppm in dry matter, respectively.

Based on these results calcium, phosphorus and zinc deficiencies were found. Also copper deficiency was found in Horquetas and Virgen Districts. Supplementation with all these minerals was recommended in dairy cattle.

9) "Evaluation of the Mineral Status of Blood and Forages in the Districts of Liberia Centro and Nacascolo, Guanacaste During the Dry Season". Student: Norman Alvarez G. Professor: Carlos Campabadal H., Ph.D.

This research has the purpose of evaluating the mineral content of blood and forages in the districts of Liberia Centro and Nacascolo, Guanacaste during the dry season.

Minerals analyzed in two tissues were as follows: calcium, phosphorus and magnesium in blood serum; and calcium, phosphorus, magnesium, potassium, iron, copper, manganese and zinc in forages.

The average calcium level in blood was 11.0 mg/100 ml, with significant differences ($P < 0.05$) among districts and farms. Phosphorus content was 4.6 mg/100 ml with differences among farms ($P < 0.05$). Magnesium and calcium

showed significant differences ($P < 0.05$) with an average of 2.6 mg/100 ml.

In forages, calcium average level was 0.20% and phosphorus was 0.07% with significant differences ($P < 0.05$) among districts and farms for these two elements. Magnesium average level was 0.13% with differences only among farms. Potassium, iron and copper averages were 1.14%, 207 ppm and 3.0 ppm, respectively. Differences ($P < 0.05$) were found in potassium among districts and farms; in iron only among districts and in copper among farms.

Manganese level was 50 ppm and zinc level was 21, showing manganese differences among districts and farms.

Phosphorus, potassium, copper and zinc were the deficient minerals in this zone.

The following positive correlations were found: P:K, P:I, Cu:K, Cu:Mn, Cu:Zn, Zn:I and negative correlations in Ca:K. Protein, phosphorus, copper and zinc supplementation was recommended.

Abstracts of the theses are presented in the appendix. In 1978 12 abstracts dealing with the mineral research program were presented at the 3rd National Agronomy Congress (III Congreso Agronómico Nacional). These abstracts are also presented in the appendix. The 3rd National Agronomy Conference for Costa Rica lasted a week with many research papers presented. Also, at this conference a meeting of all animal science personnel was held at which time research priorities were stated. The top of the research priorities were to continue with mineral research programs for the next five years. The next most important priorities were work with forages and by-products.

Data from the program were lacking in cobalt and molybdenum analyses. Because of this, the University of Florida has done a large number of the Costa Rican forage samples for cobalt and molybdenum. Molybdenum values are

all low and therefore present no problem of toxicity. Cobalt values, unfortunately, are also relatively low. Therefore, deficiencies might be expected, particularly on farms with good management and high production.

The Facultad de Agronomía has recently learned that they will receive a new atomic absorption (Perkin-Elmer 372). This costs $25,000 and is being donated by the Atomic Energy Commission. This instrument is equipped with a graphite furnace, therefore, cobalt and molybdenum analysis will be possible in Costa Rica. Next year plans will be made to determine selenium concentrations of selected samples. A specialist in the chemistry department will assist with this analysis.

Starting in 1979 much more emphasis will be placed on mineral supplementation trials. Now that many areas are suspected for mineral deficiencies, the second phase of the mineral research program emphasizing supplementation will commence.

The Costa Rica mineral research program has a strong extension area. Research data is used for extension bulletins. In order to explain to farmers the importance of the research findings, eleven conferences have been held with farmers and agricultural agents in different cities of the country. These conferences have been presented by Lic. Emilio Vargas at the following cities:

1) Venecia, San Carlos (2)
2) San Isidro del General (2)
3) Cartago Centro (1)
4) Esparza (1)
5) Tilaran, Guanacaste (1)
6) Cañas, Guanacaste (1)
7) Liberia, Guanacaste (2)
8) Tambor, Puntarenas (1)
9) San Isidro, Coronado (1)

Ecuador

Florida personnel are working directly with researchers of the Instituto Nacional de Investigaciones Agropecuarias (INIAP). The main contacts are Ing. O. Molina, Ing. Telmo Oleas and Ing. Thelmo Hervas O. in the highlands region of Quito and Dr. Raúl de la Torre in the tropical region headquartered at Pichilingue.

Research in the Pichilingue Area - Four beef cattle ranches in the Santo Domingo region and 5 in the Quevedo area were selected to determine the mineral status of cattle in these regions. Blood samples have been taken during 3 different periods of the year. In addition, 1/2 of the cattle on ranches in the Santo Dominto region received injections of selenium-vitamin E due to reports of white muscle disease in this area. During the year the selenium-vitamin E injected animals did not gain better and calf deaths and abortions were still in evidence.

Muscle and liver tissues sent to Florida for necropsy work did not reveal white muscle disease. One of the necropsy reports indicated hepatic lesions that probably are caused by a toxic substance. The selenium status of these cattle cannot be confirmed until blood and forage selenium analyses are completed at Florida. There was a report concerning cattle at the ranch Santa Marianita in the Santo Domingo region. Apparently some of the cattle have misshapen feet and missing tails which suggest a possible selenium toxicity.

Much of the mineral and statistical analyses have now been completed. With the exception of phosphorus there were significant seasonal differences among minerals. The experiment demonstrated that the selenium-vitamin E injections had no effect on the incidence of white muscle disease. The condition in the Santo Domingo region had been described as a "weak calf

syndrome". Statistical evaluation of the experiment in the Quevedo and Santo Domingo regions was carried out at the University of Florida. In the experiment, blood samples had been collected three times during the year. The collections periods represented the rainy season, the dry season and an intermediate period. For the Quevedo area, with the exception of blood phosphorus, there was a definite season (period) effect. There was no interaction among the farms and seasons for phosphorus. The most clearly visible seasonal effect was with copper. The serum copper levels for the periods of July and November were markedly lower than those of April. April represents the wet season, while July and November are the intermediate and dry seasons respectively. It was apparent that the majority of the cattle in both the July and November periods were borderline to deficient in copper.

It can be considered that around 80 mg% is a borderline zinc deficiency. During April, all of the zinc plasma concentrations were normal. However, during July and November a large number of animals would be considered borderline to deficient in zinc. This would be particularly true with animals from the farms Manguila and El Encuentro.

As expected, these cattle would not be deficient in iron. According to Underwood, the serum iron levels for normal cattle would average 145 mg%, ranging from 89 to 207 mg%. The values during April were very high, while the concentrations for cattle taken in July and November fell within the normal range.

A magnesium deficiency is expected when the magnesium plasma levels are less than 1.8 mg%. On this basis, magnesium would not be expected to be a problem for these cattle. Likewise, calcium would be adequate since by and large all animals contained above 8 mg%.

On the basis of the phosphorus data this mineral would not appear to be a problem during the April period. However, during July and November collections some animals were at a low or critical level of less than 4.5 mg%. During the July period three out of nine animals would be in the deficient range (less than 4.5 mg%) at the farm El Encuentro.

Data from the Santo Domingo area was analyzed several months later than from the Quevedo area. Apparently, with and without selenium-vitamin E injections resulted in some significant differences in the various mineral concentrations between seasons, animals and interactions. Some of these interactions could be very difficult to explain. Probably a more meaningful indication of the value of the selenium-vitamin E injections would be growth differences observed as a result of this experiment. However, unfortunately, weights were not taken on any of the farms. This had been part of the original design, however, this had not been carried out.

The phosphorus concentrations during the three collection periods for all farms looked quite good (Santo Domingo). In April only 7 or 8 were below 4.5 mg%, while in July and November only 12 of 80 were below the critical level. In all, phosphorus blood concentrations were much better than might be expected. There did not seem to be very significant differences between the farms or seasons.

As expected, none of these cattle would be deficient in iron. As previously noted from the Quevedo data, iron concentrations were all very high in April while the values for cattle taken in July and November all fall within the normal range. There were significant season and farm differences for iron concentrations.

For calcium there were significant differences among farms and seasons. However, all of the blood calcium values were above 8 mg% and would,

therefore be considered normal. On the basis of the blood magnesium concentrations, a deficiency of this mineral would not be expected since these levels are 1.8 mg% or more.

There were definite seasonal differences in copper concentrations between farms and seasons. The seasonal effect is very obvious with copper blood values for April being much higher than those for July and November. As previously noted, and also true in Quevedo, the majority of the cattle in both the July and November periods would be considered borderline to deficient in copper. Zinc blood concentrations are also found in the same pattern for the Quevedo data. During April, zinc concentrations were in the normal ranges. However, during both July and November, in some cases the zinc concentrations are quite low. A high percentage of cattle have about 80 mg% or lower for the periods of July and November. There were significant differences between farms and seasons for zinc blood concentrations.

From both the Santo Domingo and Quevedo data, the two minerals most likely deficient are copper and zinc. Phosphorus, which would be expected to be a problem appears to be in adequate concentrations.

Examination of the forage data taken from both the Quevedo and Santo Domingo regions indicates that the majority of the forages are adequate in all minerals analyzed. An exception would be phosphorus. A high percentage of the forages were around 20% phosphorus or less. However, blood data would not support a phosphorus deficiency. Some forage analyses (Co, Mo, Se) are still to be completed. Protein concentrations of the forages were all in adequate range, being above 7%.

There is one animal at the Pichilingue experiment station which exhibits clinical signs of a selenium toxicity. This animal was very

emaciated, had lost hair from the bush of the tail and had very long, misshapen hooves. However, analysis of tissues from this animal do not reveal a selenium toxicity.

From a ranch in the Santo Domingo region (Santa Marianita) there are further suggestions of a selenium toxicity. On this ranch at least twenty animals have misshapen hooves and missing tails which suggests a possible selenium toxicity.

In December, 1977 an experiment with criollo cattle was iniciated and entitled "Benefits of Mineral Supplementation to Beef Cattle at Pichilingue". One hundred and twenty Criollo, three and one-half years of age, were allotted to three treatments as follows: 1) common salt only, 2) salt plus a phosphorus source and 3) a complete mineral mixture. Liver, blood and forage samples will be taken three times per year in December, March and July. These animals have all had one calf and the object is to determine if the complete minerals or phosphorus treatment will increase the calving percentage over animals receiving salt only. Each treatment is allotted to a 32 hectare pasture. For each treatment the pasture is divided into four sections for rotational purposes. In this rotation system 16 to 18 heifers precede the 40 cattle into each pasture. This system provides higher nutritive value pastures to the younger animals. The calving season will start in several months, and, therefore, it will be possible to make some conclusions in relation to these treatments. The expected duration of this experiment is four years. In September, 1978 the mineral consumption was approximately 28.3 g per head per day with all treatments being quite similar.

Plans are being made for expanding mineral research into other areas of tropical Ecuador. El Puyo which is in the Oriental near Limoneocha will be

a location for mineral research. It has been noted that the calving percentage is less than 50% in this area. When minerals were fed to one group of cows the calving percentage was increased to 90% the first year and 84% the second year. From El Puyo blood and liver samples will be collected twice a year from slaughterhouses. The collection periods will be August and March. The total rainfall in this region is very high at 5,000 mm annually. August will represent the dryest and March the wettest times of the year. Samples from steers will be collected from 4 farms from each of 4 zones. Ten animals will be collected per farm. At the slaughterhouse farms will be identified and visited where questionnaires will be filled out and forage samples taken. It is now unclear as to when the research in El Puyo will be initiated due to the accidental death of Dr. Wilson Olmedo. Dr. Olmedo was to be in charge of this particular program.

Later this year or next year mineral research will be in the Manabí state (north coast of Ecuador). This is the largest area of beef cattle numbers in Ecuador. Twenty percent of all cattle and 40% of cattle from the coast are in this state. Research will be carried out in the Chone region of Manabí where the greatest concentration of cattle are located. Research will be conducted by Ing. Carlos Forfon from the Portorrejo experiment station in Chone. He will be working with veterinarians collecting samples from slaughterhouses and farms. Cattle production from the area is very poor with calving percentages estimated at 40% and heifers not bred for the first time until 4 years of age.

It has been observed that many mineral supplements sold in Latin America and specifically, Ecuador, were of poor quality and did not meet the guarantees on the labels. Dr. de la Torre has recently done some analysis of several mineral supplements which definitely supports this view. The following

table illustrates mineral companies guaranteed phosphorus analysis in relation to the actual analysis which has been completed by Dr. de la Torre

Mineral Phosphorus Guarantees and Analysis

	% of P on Mineral Label	% of P Analyzed
Concentrado mineral	10.0	0.04-0.07
Pecutrin	19.6	16.8
Agrifos	19.0	14.6
Agrifos reforzado	15.0	12.8
Brand X	6.0	2.6

Research in the Quito Region - Recent research has attempted to relate mineral status to reproduction in dairy cattle in the Machachi Valley and the Santa Catalina experiment station. The data compared the mineral status between cows with reproductive problems and normal animals (thesis of Ing. Hervas). Some of the animals in both groups were low in blood phosphorus. Limited data indicated that manganese blood levels were significantly lower for cattle with reproductive problems. Serum iron, copper and zinc appeared to be quite high for both groups. Forage levels of copper were highly variable with some being quite low. It was suggested that liver biopsy be employed for some of their future studies.

Future mineral supplementation experiments are being considered. With the type of dairy farms involved phosphorus supplementation trials are very difficult. Although not an experiment in the true sense, observations could be made between years on various farms. The records could be compared between years of with and without mineral supplementation for a particular farm.

A completed experiment at Santa Catalina involved 37 heifers divided into 2 groups receiving 1) pasture + 1/2 kg of molasses + 100 g of minerals and 2) pasture + minerals. The group which also received molasses had a calving percentage of 83.3 versus 42.9 for the minerals alone. In this

experiment diammonium phosphate (18-46-0) and triple superphosphate (0-46-0) as the phosphorus source was used. Diammonium phosphate was later substituted for triple superphosphate due to its lower fluorine content. Aluminum sulfate was added to the mineral mixture to counteract a fluorine toxicity.

Recent problems have arisen with the use of the phosphorus supplement, triple superphosphate. This fertilizer phosphorus source is very high in fluorine and, as a result, fluorosis problems have been observed. It had been recommended that triple superphosphate be used and as a result some farms in the area are now suffering from fluorosis. In the case of the herd at Santa Catalina four years were required for the clinical signs is the lameness resulting from the fluorosis.

Ing. Thelmo Hervas, from the Santa Catalina Experiment Station, is planning to come to the University of Florida in June, 1979 and his main interest is studying mineral nutrition. Ing. Hervas is planning to do his course work at Florida and return to Ecuador to collect samples for his research. One possibility would be for him to obtain liver, blood, forage, soil, hair and feces samples from approximately 8 to 10 beef cattle farms in Ecuador. Two or three regions would be a possibility. One region might be in Manabí state (north coast of Ecuador). If this site or El Puyo, near Limonocha, are used, Dr. de la Torre and Angel Anzules could help him with his sample collections. Ing. Hervas has also noted two additional areas which have mineral problems. These are the eastern and western chain of the Cordillera mountains. In the eastern chain there is a city named Pillaro where selenium deficiency signs have been observed. This area is located 150 km south of Quito. An additional area which is the western chain of the Cordillera is approximately 200 km south of Quito. In this area the opposite

problem exists with selenium toxic plants of the Astragalus genus being noted. We suggested that at least two farms need to be taken from each area where a study is undertaken. A research proposal for Ing. Hervas in relation to mineral research is located at the end of the Ecuador section of the report.

An experiment designed to establish if a manganese deficiency is responsible for poor reproduction in dairy cattle is being considered. Ing. Oleas had previously sent us a research proposal in relation to this program. They have been trying to determine if manganese injections are a practical method of supplying this mineral. The difficulty is separating animals into two groups and to study the effects of manganese supplementation on tissue levels and also reproductive rates. We discussed the various way of administering the manganese. Obviously, the best way is to separate the animals into two groups. Approximately 80 animals will be worked with.

It was noted that one particular farm in the area was suffering from an iodine toxicity. Someone had recommended mixing a high level of iodine (1 kg of potassium iodate per 1000 pounds of salt) for dairy cattle. This level was given as a free choice mineral supplement and was also administered in a grain mixture. The result was an iodine toxicity characterized by severe diarrhea, loss of hair, loss of weight, breaking of bones and other signs.

A PROPOSED MASTER OF SCIENCE RESEARCH PROGRAM FOR
ING. THELMO HERVAS ORDOÑES

Title: The Mineral Status of Cattle in Selected Regions of Ecuador.

Introduction: In the cattle producing regions of Ecuador the efficiency of beef and milk production is low. Low production rates are influenced by many factors, some of which may be inadequate mineral nutrition. The majority of beef and dairy cattle in Ecuador receive no mineral supplementation, with the exception of common salt.

Research Objectives: 1) To establish if specific mineral deficiencies or toxicities exist in selected regions of Ecuador. 2) To compare the seasonal mineral status of beef and/or dairy cattle among 2-4 different regions of Ecuador. 3) To evaluate and compare the mineral status of cattle at different physiological states (growing steers, 1-2 years after weaning and pregnant lactating cows). 4) To study mineral soil-plant-animal interrelationships.

Location of Research: Eight to 10 ranches located in 2 to 4 distinct ecological regions. Possible selected regions could include: 1) El Puyo (in the Oriental near Limoncocha), 2) Manabí state (north coast), 3) Pillaro (eastern chain of Cordillera) and 4) western chain of Cordillera. Each region selected should be represented by a minimum of 2 farms each.

Ecuador Project Leaders: Santa Catalina - Ing. Telmo B. Oleas
Pichilingue - Dr. Raúl de la Torre, Egr. Angel Anzules.

Research Proposal: For each farm, soil, forage, blood, liver, hair and feces samples will be collected. Standardized questionnaires for the farm description, animal identification, and forage description can be used. Samples should be collected between now and anticipated entrance at the University of Florida. The time most appropriate for collections would be the middle to

end of the wet season. Exploratory trips should be made to the intended regions for selection of participating ranches prior to sample collections. The collection of samples would be as follows:

1) Soil - 2-5 samples from different areas of each farm.

2) Forage - Separate samples of each of the major species should be taken. This would likely involve 2-5 species per farm. In sampling the aerial parts of the plants in a field, select at random at least 10 or more sample sites from each field depending on the size of the field with each species collected separately. A forage questionnaire should be filled out for each farm which includes the % of each species on offer. Pasture samples should be collected only after careful observation of cattle grazing patterns. It is necessary to watch the animal graze and hand pluck a sample to represent the animal's diet. For carotene determination, forage samples should be kept cool (i.e., dry ice). From the composite forage samples, 2-5 samples each of the major forage species should be analyzed. For each sample, a total of 200 g should be available. Samples should be air-dried at 60° C, ground (using stainless steel equipment), and one-half of the sample should be transported to Florida.

3) Blood plasma (or serum) - From each farm, 12-14 samples from each class should be collected from both randomly selected growing steers (or heifers) (1-2 years after weaning) and lactating cows. Approximately 20 ml of blood should be collected using California bleeding needles. As soon as the blood is collected, the container should be tipped and inverted and thoroughly but gently mixed with the anticoagulant. If lithium citrate (20% solution) is used, add 1/10 ml for each 10 ml of blood to be collected. Centrifuge the samples using a portable centrifuge within 2-3 hours of collection. Pipet off 1 ml of plasma and mix thoroughly with 10% trichloracetic acid (1 ml

plasma and 9 ml of 10% trichloracetic acid). Refrigerate or freeze until needed. Transport 10 ml of the unused plasma to Florida. Heat plasma at 56° C for at least 30 minutes prior to bringing it into the U. S. (to meet U. S. requirements). A questionnaire describing each animal should be completed.

4) Feces - Feces can be collected at the time of bleeding by taking a grab sample. After collection, feces samples should be kept cool, until they can be dried. Samples can also be frozen until analyses can be performed. Samples could be put in solution before transporting to the U. S.

5) Liver - Sixteen representative liver (biopsy) samples will be collected from both cows and steers (or heifers). Liver samples can be stored in formaldehyde or frozen. Prior to transport to the U. S. they should be put in formaldehyde. For vitamin A determination 2 samples per class of animal per farm should be analyzed (a total of 4 samples/farm).

Records - The following records should be kept:

1) Farm identification and description forms.

2) Individual animal and health observations.

3) Forage identification records.

4) Slaughtered animal description records (if slaughtered animals used).

Possible Analysis

Type

1) Soil - Complete soil analyses to include soil classification, soil structure, pH, organic matter and available forms of the following minerals: Al, Fe, Mn, Zn, Co, Cu, P, Ca, Mg, K, Na, N, Se, Mo and I.

2) Forage - Fe, Mn, Zn, P, Ca, Mg, K, Na, N, I, Co, Se, Mo, S, Cu, *in vitro* dry matter digestibility, acid detergent fiber, neutral detergent fiber, cellulose and lignin.

3) Blood - Ca, P, Mg, Zn, Fe, Se, Cu and Blood Urea Nitrogen (optional)

4) Liver - Co, Cu, Se, Mo, Zn, Fe, Mn, Mg and vitamin A.

5) Bone - Ca, P, Mg, bone ash and specific gravity (only if slaughter animals used).

6) Feces - Ca, P, Mg, Zn, Fe (others if time permits).

El Salvador

The mineral research program in El Salvador was slow in getting started but at this time considerable progress has been made. Dr. Ferdinando Perla, the Ministry of Agriculture (Ganadería), is chairman of the mineral research program. The mineral research is a cooperative endeavor between Ganadería and the University of El Salvador. The Florida-AID program is providing $4,000.00 per year for the purchase of laboratory supplies. Ganadería has the responsibility of collecting the samples from various farms throughout Central America. Analyses are completed by personnel at the University of El Salvador. Some of the more difficult analyses such as cobalt and molybdenum have been completed at Florida. There have been two laboratory technicians who have come to the University of Florida for training in mineral research techniques. In 1977 one technician spent three months at Florida analyzing samples that originated in El Salvador.

For the past year the research organizations of Ganadería and the University of El Salvador have dedicated a considerable portion of their resources to mineral research. As many as 10-12 man years have been put into this program in the calendar years of 1977 and 1978.

During 1978 forage, blood and liver samples have been taken from 12 ranches during both the wet and dry seasons. During each of these times 120 liver biopsy samples were collected without any difficulties. The general design of the experiment was to collect samples from 10 farms which had traditional management, where no mineral supplementation existed and 2 ranches which had good management including the use of mineral supplements. Samples were collected both during the wet and dry seasons and from 2 classes of animals. The 2 classes of animals represented young animals aged 1-2 years and cows, 1-5 months in lactation.

In another experiment liver and blood samples were collected from 8 slaughterhouses located throughout the country. These samples were analyzed for the typical minerals and represented different classes of animals.

Some of the research data was written up in an abstract and published in the 1977 ALPA proceedings meetings. The translated title of the abstract was "Mineral Status of Cattle from Slaughterhouses Located Throughout El Salvador". A second abstract from this work was presented at the 1978 American Society of Animal Science meetings.

Some of the data was statistically analyzed in El Salvador and the remainder was sent to Florida for statistical evaluation.

Some of the major conclusions from this data is as follows: Phosphorus - Forage phosphorus levels are very low indicating a deficiency, however, this is not completely supported by blood phosphorus values which, in some cases, are relatively high. This is consistent with other studies, due to the problems of collecting and handling blood samples prior to separation of the plasma from the whole blood. We discussed various methods to help alleviate this problem so that better samples could be collected in the future. Even though, in general, blood phosphorus levels were higher than would be expected, 17.6% were borderline to deficient during the wet season. Magnesium - More than one-half of the blood magnesium levels were considered low, however, forage magnesium levels were not particularly low. There were significant differences between ranches. Calcium - All forage calcium levels were high suggesting an adequacy of this mineral. Iron - Both forage and liver iron concentrations were relatively high. Three of the four farms contained forage iron averages of more than 400 ppm. Copper - Of all minerals copper was the most deficient. Deficient levels in both forages and liver samples indicated a problem with this element. Zinc -

Zinc liver concentrations were not particularly low, however, forage levels were extremely low ranging between 13.7 and 39 ppm. The majority of the zinc forage concentrations were less than 30 ppm.

Liver calcium, phosphorus, and magnesium analyses were also completed. Due to little variation, we concluded that these analyses on liver samples should be eliminated for future studies. Liver cobalt and molybdenum concentrations were normal for all cattle. Our final conclusion was that this mineral research data did answer some questions about the mineral status of the cattle in these regions and could be used as a basis for more specific research.

In El Salvador it is very difficult to undertake mineral supplementation work due to the small size of the farms. It seems almost impossible to divide cattle on any farm into two distinct groups for feeding minerals.

However, Ing. José Romero, one of our former graduates, has now volunteered to provide cattle for a supplementation trial. Forty bred animals will be divided into two groups, with one receiving only salt and the other receiving a complete mineral supplement. We have assisted with the mineral formulations that would be needed for the experimental mixture. The plan for the experiment is for the animals to be all together on one pasture. However, for one day (or one night) the two groups will be separated so that each will have access to their respective mineral mixture.

The analysis for the mineral supplementation experiment on José Romero's ranch would be as follows:

Priority	Analyses	Times/Year
High	Pastures - calcium, phosphorus, potassium, magnesium, sodium, nitrogen, cobalt, copper, selenium, molybdenum, zinc, carotene	12 (monthly)

Priority	Analyses	Times/Year
High	Blood - phosphorus, copper, zinc, iron, manganese, hemoglobin (?), calcium (?).	2
High	Liver - cobalt, copper, zinc, iron, molybdenum, manganese.	2
Lower	Feces - calcium, phosphorus, magnesium, copper, zinc, manganese.	2
Lower	Soils - all of the normal minerals analyzed.	1
Lower	Water - all of the minerals that are possible to analyze in water.	2

In evaluating the mineral data from the previous experiment it is obvious that copper is one of the main deficiencies. There are three farms that are particularly deficient in copper. With this in mind, an attempt is being made to do copper supplementation work with these three farms. Uniform animals will be selected and half will receive copper injections, administered every four months. Both performance and tissue analysis data will be taken for animals on experimentation. Forage and liver samples will be taken two or three times per year for each ranch. Florida has sent copper injections along with ear tags for identification. Due to various problems these experiments have been postponed and are now underway starting in March.

Guatemala

The mineral research program in Guatemala started in January, 1975. The organization doing mineral research is INCAP. Their laboratory has a Perkin-Elmer 305 Atomic Absorption Spectrophotometer with a graphite furnace and a fluorometer for conducting selenium analyses. The Florida-AID program is providing $6,000 per year for 3 years. Dr. Marco Tulio Cabezas is in charge of the mineral research program and Ing. J. Antonio Flores, an M.S. graduate from INCAP, is working full time on the program. The $6,000 has been used to pay the salary of Ing. Flores. At the end of 1978, the Florida-AID program no longer paid the salary of Ing. Flores. Fortunately, INCAP picked up the salary for him, at least for the next two years. Ing. Flores, along with Dr. Marco Tulio Cabezas, Dr. Ricardo Bressani, Ing. Beatríz Murillo and students from the Facultad de Veterinaria Medicina and Zoologia (University of San Carlos) have been active in a mineral research program.

During the next two years, Ing. Flores will be stationed in Sonsonate, El Salvador. In this regard, he will be responsible for mineral research that is being carried out at a large dairy and beef cattle ranch near Sonsonate. The name of the farm is "El Jobo". A considerable amount of data has been collected from the ranch "El Jobo" near Sonsonate. Sometime each month Ing. Flores will be returning to INCAP in Guatemala for the purpose of coordinating the mineral research programs in Guatemala. While in El Salvador, Ing. Flores will also do work with swine and beef cattle programs not related to the mineral research.

A special field day was held at "El Jobo" in which the mineral research data to date was summarized. Thirty people attended this meeting, including researchers and government personnel. From this research a local publication was written which will be meant for extension personnel and other scientific

articles are published in the scientific journals.

Looking at the pasture data from the ranch, El Jobo, calcium, copper, zinc, and cobalt were found to be inadequate. From this particular ranch forage calcium concentrations, at most samplings, were found to be lower than phosphorus. Soils in this area are not as acid as many others, having a pH of around 6.7. Some of the phosphorus values were low and blood phosphorus concentrations were lower during the wet season. Copper concentrations, on the contrary, were lower during the dry season. During the dry season 60% of the dairy cattle and 20% of the beef cattle had low copper blood concentrations. Blood and other tissue mineral concentrations could be misleading from this ranch in relation to the mineral status of the region since all animals are receiving mineral supplements.

New experiments have just recently been initiated at "El Jobo". The experiment consisted of a total of 42 dairy animals. The animals were divided into two groups. One group received the standard mineral mixture that is used on this ranch while mixture number two is a more highly fortified mixture containing higher concentrations of copper, phosphorus and zinc. Blood and liver samples will be taken three times per year, in February (dry season), April (start of rainy season) and September (towards the end of the rainy season). Blood will be analyzed for hemoglobin, calcium, phosphorus, magnesium and zinc, while liver will be analyzed for cobalt, copper, manganese, iron and zinc. Forage samples will be taken every 18 months and analyzed for most all minerals.

The titles of the six mineral sub-projects now in progress are as follows: 1) "The content of minerals in natural pastures from the Departments of Huehuetenango and San Marcos. Calcium, phosphorus, magnesium, sodium and potassium". 2) "The content of minerals in natural pastures from

the Departments of Huehuetenango and San Marcos. II. Iron and manganese, copper and zinc". 3) "Preliminary study for detection of the mineral deficiencies in beef cattle managed extensively from the Pacific coast of Guatemala". 4) "The study of the mineral nutrition of beef cattle from three farms in the Deaprtments of Retalhulen and Suchitepéque on the Pacific coast of Guatemala". 5) "The mineral nutrition status of beef cattle from three farms in the Department of Santa Rosa on the Pacific coast of Guatemala". 6) "The diagnostic determination of the mineral nutrition for dairy cattle and beef cattle managed intensively in the Republic of El Salvador II".

At this time 9 abstracts on the results have been published (see appendix). The studies indicate some of the main areas of beef cattle and sheep producing areas of Guatemala. For the sheep regions an evaluation is being made by analyzing pasture forage species while in the beef cattle areas evaluations include also blood plasma and liver biopsies. The forage data represents samples from 9 farms within the three departments. There are 9 samples for each farm. The sheep pasture data can be summarized as follows: San Marcos - a) Calcium - Calcium forage values ranged from 0.18 to 0.45%. b) Phosphorus - Forage phosphorus levels were very low ranging from 0.08 to 0.26%. c) Magnesium - Forage levels ranged from 0.07 to 0.22%. d) Sodium - Forage sodium levels were very low ranging between 0.04 and 0.07%. e) Potassium - Potassium levels ranged between 0.5 to 2.7%. f) Iron - Forage levels ranged from 180 to 380 ppm. g) Manganese - Forage levels ranged from 33 to 244 ppm. h) Copper - Forage copper levels were low ranging between 3.1 and 6.5 ppm. i) Zinc - Forage zinc levels were extremely low ranging between 5.2 and 20.6 ppm. The majority of these were less than 10 ppm. Huehuetenango - a) Calcium - Forage levels ranged between 0.15 to

0.65%. b) Phosphorus - Forage phosphorus levels were extremely low ranging between 0.05 and 0.24%. c) Magnesium - Concentrations ranged from 0.04 to 0.19%. d) Sodium - Forage levels ranged from 0.06 to 0.08%. e) Potassium - Levels ranged from 0.3 to 1.6%. f) Iron - All of the iron levels were above 317 ppm. g) Manganese - Forage levels ranged between 31 and 331 ppm. h) Copper - The vast majority of the copper levels were very low being less than 5 ppm. i) Zinc - Forage zinc levels were between 4.8 and 25.7 ppm. Suchitepéque - a) Calcium - Forage calcium levels ranged between 0.27 and 0.30%. b) Phosphorus - Forage levels were once again low ranging between 0.11 and 0.18%. c) Magnesium - Concentrations ranged from .17 to .20%. d) Sodium - Levels were from 0.01 to 0.1%. e) Potassium - Values ranged from 1.3 to 1.7%. f) Iron - Values ranged from 188 to 197 ppm. g) Manganese - Concentrations ranged from 21.7 to 51.4 ppm. h) Copper - Forage levels ranged from 2.4 to 8.4 ppm. i) Zinc - Levels ranged from 21 to 38 ppm. The zinc concentrations from this region were generally higher than in the other two. This could be because this area is near volcanoes. In addition to being high in zinc, it is also higher in aluminum than other areas.

The overall conclusions from the data were that the forage phosphorus, copper and zinc concentrations were very low. In one zone it was also noted that cobalt forage concentrations were also low. In addition to the ongoing projects future research will involve evaluation of mineral status of livestock in the Atlantic zone. With the data being collected, it is planned to make an overall map of the individual regions noting which mineral are deficient.

Blood phosphorus levels were normal. We questioned the procedures under which blood was collected and found that often 24 hours passed before plasma

is separated from the whole blood. However, usually the blood is kept cool during this period. We believe that these phosphorus values are unreasonably high and do not represent the status of this mineral.

One farm from the Pacific region has had obvious copper deficiencies with low tissue and forage concentrations combined with the clinical signs of hair color changes. Several years ago copper supplementation had been given to cattle on this ranch with a dramatic increase in fertility and hair color changes. However, the owner of the ranch has been away for several years and copper supplementation was discontinued. Now, however, copper supplementation will be started again by administrating mineral salts containing this element. In addition, copper injections will be given. This particular ranch is close to El Salvador but has very sandy soils which is in contract to the ranch in Sonsonate and also many of the other beef cattle ranches.

Due to a reduction of funds received from the Florida-AID program, the mineral research is being reduced. If more funds are forthcoming in the future, mineral research will be increased. At the present time there is some possibility of obtaining funds for a project of sheep development in the highlands. It is hoped that funds can be obtained from AID as part of Title XII. If this is possible, part of the program will also include additional mineral research in the highlands regions.

Haiti

Sixteen liver and eight bone samples were collected from the Hampco slaughter facilities April 18, 1978. Analyses of these samples support the following conclusions.

1. Phosphorus is probably the most limiting mineral. Rib bones ash phosphorus values were 14% compared to normal values of 18%. Mean calcium values were 33% compared to 38% normal values for rib bone ash calcium.
2. Copper levels below 100 μg/gram were found in 6 of the 16 samples indicating copper is a problem in a number of areas.
3. Cobalt, manganese and zinc do not appear to be limiting in animals under present conditions.
4. The iron levels in some livers were relatively low which reflects more of a parasite load rather than a dietary deficiency.

These samples from the areas of Cayes, Island of Gonave, Central Plateau and the Artibonite Valley indicate the need for mineral supplementation and more detailed studies.

Indonesia

Contacts were not made until last November, 1977. There are four research groups that have potential to undertake mineral research with grazing ruminants. These would be the Gadjah Mada University at Yogyakarta, Bogor Agriculture University and the National Atomic Energy Agency (Pasar Jum'at Research Centre) located near Jakarta and Universitas Udayana at Denpasar, Bali.

Gadjah Mada University - The main contact at Gadjah Mada University is Dr. Soekanto Lebdosoekojo. Dr. Lebdosoekojo recently received his Ph.D. degree from the University of Florida in ruminant nutrition.

Mineral nutrition with ruminants has not become a major endeavor in Indonesia. However, there are indications that there are mineral deficiencies in Sulawesi and Sumatera and possibly other places. There are reports of "unthrifty" cattle on a ranch near Palembang on the island of Sumatera. The quality of feed appeared to be sufficient but the animals were in poor condition. Also, there are incidents of broken bones on fattened cattle in the eastern islands, especially in Timor and goiter is an endemic disease among the people of Java. However, cases of iodine deficiency have never been found in animals.

In Sulawesi, both at the Bila River Ranch and at Maiwah, exotic legumes do not grow well unless phosphorus, sulfur and molybdenum are added. They also reported that *Pennisetum purpureum* at Maiwah failed to grow until the sulfur and molybdenum were added; phosphorus addition alone was not effective. With the addition of all three minerals, the yields of the legumes were increased approximately two and one-half times.

It has been observed that Bali cattle on the Bila River Ranch, which were grazing a native grass, were in very poor condition. The annual calving

percentage was less than 50%. The annual calving percentage for all cattle in Indonesia is suspected to be less than 50%. In this particular instance, it was suspected that phosphorus was the first limiting mineral for these Bali cattle.

The possibilities for a comprehensive mineral research program is as follows: a) Sulawesi - 1) the Bila River could conduct mineral supplementation trials using cows on pasture. 2) Their feedlot could conduct mineral supplementation trials. 3) P. T. United Livestock (BULOG) will build a slaughterhouse in Pare-Pare. Bones, tissues and blood samples could be obtained from the control and mineral fed cattle. 4) UNHAS could cooperate by supplying animals. b) Sumatera - There are several universities which could cooperate here. Also the P4 research center and the University in Bogor have an interest. c) Java - The Kampung cattle train would offer possibilities for collecting samples. Cattle in this area go to slaughterhouses in various cities. Tissue samples could be collected at these sites.

It is fairly certain that the Gadjah Mada University will have a superior laboratory with good equipment by 1979. This laboratory will contain equipment for making mineral analysis including an atomic absorption spectrophotometer. This is an Australian atomic absorption unit and will arrive in approximately one year. However, at the present time, there are facilities to do phosphorus analysis and several other minerals. Since a large number of mineral analyses could not be accomplished immediately, emphasis will start with supplementation trials.

Unfortunately there had been little progress made toward mineral research between our first visit in late 1977 and 1 year later. Dr. Soekanto has written a mineral research proposal and it was rejected but it is hopeful

that it will be approved in the near future. In this proposal, research was intended to be undertaken in the following locations: 1) south Sulawesi, 2) central and east Java, 3) eastern Nusa, Tenggara and Bali, 4) Sumatra ranches, 5) Kalimantan ranches. A translated mineral research, as prepared by Dr. Soekanto, is at the end of the Indonesia section of this report.

At the present time the mineral research program looks more promising and will center around the two supplementation trials in Sulawesi. Also, phosphorus analyses will be completed since equipment for this procedure is available. An iodine procedure will also be undertaken since they have now received the chemicals needed for this method. Also, it is promising that Dr. Soekanto may work with Dr. Edwardly at the Atomic Energy Commission in order to determine some mineral analyses.

The Atomic Energy Commission located in Jakarta is also involved in mineral research. The main contact is Dr. Jenny S. Edwardly. Dr. Edwardly had developed exudative diathesis, a selenium deficiency, by feeding local feed ingredients to poultry. Dr. Edwardly noted that there are clinical signs of selenium deficiencies in the area of Palembarg, which is south of Sumatra. In the very near future they will be collecting samples of poultry animal tissues from this area to establish if there is a deficiency.

Dr. I. Made Nitis of the Universitas Udayana at Denpasar, Bali is an additional agriculture institution in Indonesia. Dr. Nitis is very interested in undertaking some mineral research. He is now attempting to do some mineral analysis of local forages. However, the only minerals that he can routinely analyze are calcium and phosphorus. Dr. Nitis has expressed great interest in doing some limited supplementation studies by the use of injections of copper and selenium-vitamin E in addition to cobalt bullets. Florida has sent Dr. Nitis a number of these minerals for use in mineral

supplementation studies.

Bogor Agriculture University - The main contact here is Dr. Toha. It was suggested that Dr. Toha might work in cooperation with Dr. Soekanto in initiating a comprehensive mineral research program. There appeared to be great interest in the overall mineral research program.

From this region, some of the mineral related problems appeared to be related to the fact that soils were extremely low in calcium, phosphorus and copper. Just recently Dr. Toha has been working with iodine deficiency in western Java. Several minor trials had been done and one of these indicated good response to iodine supplementation for growing bulls and heifers. It was noted that the chief human nutrition problems were deficiencies of vitamin A, protein-calories, iodine and the occurrence of anemia.

INDONESIA MINERAL RESEARCH PROPOSAL

(Gadjah Mada University)

Project Outline

Project title: Deficiency, toxicity and imbalance of minerals in beef cattle production.

Faculty responsible: Fakultas Peternakan Universitas Gadjah Mada.

Project coordinator: Soekanto Lebdosoekojo.

Expected cooperating agencies: Department of Soils, Gadjah Mada University
Department of Animal Nutrition I.P.B.
Directorate General of Animal Husbandry
Atomic Energy Commission
University of Florida/AID

Duration of the project: 3 years

Locations: Potential beef producing areas.

Justification:

An important factor causing low productivity of cattle in Indonesia is poor nutrition, as it is true in other tropical countries. The nutritional factors may include low levels of energy, low levels of protein, as well as mineral imbalances in forages, and especially during the late dry and early rainy seasons. McDowell (1976) reported that in the tropical zone, deficiency of phosphorus (P) occurs in 28 countries, magnesium (Mg) in 17 countries, sodium (Na) in 14 countries, cobalt (Co) in 21 countries, and calcium (Ca) in 20 countries. He also reported that there is a deficiency of P and an interaction between copper (Cu) and molybdenum (Mo) in Malaysia. There are no reports of mineral imbalances in Indonesia. However, problems in mineral nutrition are indicated. P deficiency is most likely to occur in acid soils (Blue, 1974), therefore, the problem could be expected on cattle raised on acid soils in Sumatra, Kalimantan and other areas. Broken bones of fattened cattle have been observed in Timor. Also, deficiencies of

P, S, and Mo have been identified in South Sulawesi (Suyadi, personal communication). A deficiency of I is indicated in Central Java. The importance of these should be established.

Mineral supplementation has been reported to increase liveweight gains and fertility of cattle on the Colombian savanna (Lebdosoekojo, 1977). Reports from Africa, (Van Schalwyk and Lombard, 1969 and Ward, 1968), Peru (Echevarria et al., 1974), Australia (Kaizer, 1975 and Little, 1970) and other places, indicated a beneficial effect of mineral supplementation. Mineral supplementation is relatively easy and to accomplish is inexpensive, however, it should only be used when the mineral status has been properly identified.

Objectives: 1) To identify mineral deficiency, mineral toxicity and mineral imbalance in cattle-producing areas. 2) To compare mineral status of the animals in these areas during rainy season and dry season. 3) To increase cattle productivity through mineral supplementation. 4) The long run objective is to establish a "Mineral Map" for cattle production in Indonesia.

Locations: Depending on the level of financial support provided, the selected locations will be based on the priority order as follows: 1) South Sulawesi, 2) Central and East Java, 3) Eastern Nusa Tenggara and Bali, 4) Sumatra, ranches and transmigration areas and 5) Kalimantan, ranches and transmigration areas.

Methods of Procedures: The study will involve two steps in which the first step is designed to explore the possibilities deficiencies, toxicities and imbalances of minerals in selected locations, while the second step is to conduct supplementation trials using selected minerals, as follows:

First Step: Samples of the soils, forages and blood, liver and bone from cattle will be selected and analyzed for their contents of Ca, P, Fe, Cu,

Zn, Mn and possibly I, Co, Mo and Se. The forages will also be analyzed for nitrogen and IVOMD. The samples will be collected twice yearly once during each of the dry and the rainy seasons. The description of the ranches and the management systems will be carefully noted. The results of the analyses will be compared with the acceptable normal values.

Second Step: This step could be conducted along with the first step but preferably after a deficiency has been found. Supplementation trials with minerals previously shown to be deficient, will be carried out using group comparisons. Supplementation of Ca, P, Mg, Zn, Mn, and Fe can be incorporated with salt or as mineral lick, while Co may be applied as a "cobalt bullet" placed in the rumen. Iodine, Se and Co may be injected to the animals. Responses observed will be: gain in weight, improvement in reproduction rates, decrease in mortality rates, appearance of clinical symptoms if any and cost benefit ratio of the supplementation.

Budget: a) Travel

b) Labor

c) Supplies - chemicals

- mineral supplements
- plastic and glasswares
- rent for AAS
- stationary, postal, tax, etc.

References:

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Malawi

Mineral research has been started in Malawi. Initial contact was made with Dr. Martyn Butterworth, Head of Animal Production Department, Bunda Agricultural College at the World Animal Production Meetings August, 1978 in Buenos Aires. A recent trip to Malawi by J. H. Conrad resulted in Mr. Joshua Mtimuni planning to come to Florida to study mineral nutrition in September, 1979. During this visit experimental plans were outlined for a project to study mineral status of cattle in the major cattle producing areas of Malawi. Mr. Mtimuni is now collecting liver, bone, soil and forage samples to be analyzed for part of his Ph.D. dissertation.

Inquiries and interest have been shown by research workers in Botswana, Kenya, Mali, Mozambique, Nigeria and Sudan.

Funding and available mineral research personnel will determine to what extent this project will become involved in mineral research in these countries.

Malaysia

The first visit to determine the possibilities of cooperative mineral research was not until December, 1977. There are two research groups that have the potential to undertake mineral research with grazing livestock. These are the University Pertanian Malaysia and the Malaysian Agriculture Research and Development Institute (MARDI) both of which are located at Serdang, Selangor (near Kuala Lumpur). The chief contacts would be Dr. Rudy I. Hutagalung of the University and Dr. C. Devendra and Mr. Thomas Lee Kok Cho of MARDI.

Very little mineral research has been done with the ruminant livestock. In the 1950s some preliminary work showed a phosphorus deficiency based on low serum phosphorus levels. Also, later work has shown low blood copper concentrations. However, these low levels did not correlate with low levels in hepatic tissues. Low molybdenum concentrations are also reported in soils for forages. Some of the best research has shown that there is a cobalt deficiency in one region of Malaysia. This research was carried out by MARDI on its research station near Kluang, Johore. Friesian crossbred and Kedah-Kelantan cattle failed to thrive in this region. The animals were listless, had rough coats and lost weight leading to emaciation, often resulting in death. In the experiment there was a dramatic increase in live weight gain as a result of vitamin B_{12} and cobalt administration. However, there were no effects from copper or terramycin administration.

Apparently in late 1979 or early 1980 Mr. Hew from the University Pertanian Malaysia will be coming to the University of Florida for laboratory training. Most likely Mr. Hew Peng Yew will bring selected animal and forage tissues for analysis. With the research institution, MARDI, there is a possibility of a student coming for an advanced degree. One possibility is

for a student to collect forage and animal tissues for ruminant livestock areas of Malaysia and bring these samples to Florida for analysis. Samples from three distinct regions of Malaysis could include the central, western, northeastern and southern regions. Many of the animals in these areas are imported breeds, however, they have been in these areas for more than one year. One suggested possibility was to collect samples from water buffaloes and cattle grazing on the same pastures.

Dr. Hutagalung is planning on feeding mineral supplements to Jersey cattle to determine the response. He will be feeding these minerals in addition to two levels of concentrates (3 and 6 kg per day).

Dr. Hutagalung and Mr. Yew have written a preliminary report on the mineral status of cattle forages and soil at the farm of the University of Agriculture of Malaysia. The data is included in the appendix. From the data copper liver and blood concentrations were low.

Arrangements are being made for a mineral supplementation experiment at a large cattle ranch 124 miles southeast of Kuala Lumpur near the town of Segamat. Mr. Kee Siang of the ICI Company is providing minerals for supplementation on this particular ranch. The three treatments will be as follows: salt only, salt + calcium and phosphorus (10-12%) and salt + a complete mineral supplement. Mr. Kee Siang has noted that his company would like to produce a mineral salt block which contained more than 10% phosphorus. He feels that he can produce one that contains 12% phosphorus but this is difficult. Upon evaluation of the present mineral supplement which he is using, it seems quite adequate in some of the trace minerals with 10% phosphorus and 8.5% calcium. However, the greatest limitation is that there is no copper or selenium added to this mixture. Mr. Kee Siang noted his personal experiences with the benefits of phosphorus supplementation. He

noted through personal observations how beneficial phosphorus has been to increase growth and reproductive rates. He gave one example from a region named Ipoh which is 134 miles north of Kuala Lumpur. On one particular farm there were 40 cattle which had not cycled for 2 years. After giving a mineral supplement high in phosphorus, 80% of these animals cycled within 2 months. He noted that they had had a tremendous mineral consumption within a 2 week period. This consumption would calculate out to be 179 g per day.

Peru

The mineral research program in Peru did not start until February, 1977. However, a Peruvian student, Dr. Ricardo Valdivia, has been working toward his Ph.D. since 1975. Dr. Valdivia's thesis is entitled "Effect of Dietary Aluminum on Phosphorus Utilization by Ruminants." Dr. Valdivia has now returned to Peru.

Three research groups are now investigating the mineral status of ruminants in Peru. The main contacts of these institutions are as follows:

a) Universidad Nacional Mayor de San Marcos (IVITA) - Dr. Oswaldo del Valle and Dr. Ricardo Valdivia.

b) Universidad Nacional Agraria (La Molina) - Dr. Juan Kalinowski.

c) Universidad Nacional Pedro Ruiz Gallo (Lambayeque) - Ing. Hélido Vidal.

Universidad Nacional Mayor de San Marcos Research (IVITA)

This institution has a great interest in mineral research and has had experience with analyses. The atomic absorption equipment is available and technicians are well trained.

Mineral research is underway at the tropical experiment station at Pucallpa. One of the main experiments involved phosphorus supplementation with improved pasture and native pasture. The various treatments included a phosphorus fertilizer supplementation at rates of 100 kg per hectare, 500 kg per hectare, 100 kg plus direct phosphorus supplementation and 500 kg plus direct phosphorus supplementation. The direct phosphorus supplementation used a mixture of 40% dicalcium phosphate and 60% salt. Animals consumed approximately 50 g of mineral supplement per day. Almost double the gains were noted for the treatments with 100 kg of phosphorus per acre plus the direct mineral supplementation over that of the control of 100 kg per acre. The treatment with 500 kg per hectare was slightly better, however, this proved not to be as economical as the treatment with only 100 kg plus

the direct phosphorus supplementation.

In an additional experiment a dramatic increase in fertility was noted. This experiment involved Nellore cattle with a control group having a calving percentage of approximately 50%. When a mineral supplement containing 60% salt and 40% dicalcium phosphate was administered to the second treatment the calving percentage was 75%. This particular experiment will continue for an additional year.

Additional observations at Pucallpa have noted apparent zinc deficiencies. In some cases the animals have lost the majority of their hair and this has been cured by the addition of zinc. Apparently the incidence of this condition is low and infrequent.

Recently a mineral research project has been written up with a translated title of "Mineral Deficiencies - Evaluation of Effects of Mineral Deficiencies on Cattle Production." There are 3 subprojects under this:

I - Determination of Mineral content of soil, forage and animal tissues obtained from the tropical zone at Pucallpa. In this experiment samples will be taken from 5 farms during both the wet and dry seasons. The samples will be collected from animals that are taken to slaughterhouses. A complete history of these animals will be known. The 5 farms will include the IVITA farm at Pucallpa, San Jorge, Tournavista, Bella and Tupac Amaru. Samples will be taken from both growing animals versus those in pregnancy and/or lactation.

II- Evaluation of the Effect of Mineral Supplementation on the Growth of Beef Cattle (Nellore). The duration of this experiment is 15 months and started in August of 1978. In this experiment steers 8 months of age are given the following treatments: a) control pasture without mineral supplementation, b) pastures with salt only, c) pastures with salt + a calcium phosphorus source, and d) pastures + salt + calcium and phos-

phorus + copper + cobalt + zinc. Approximately 200 animals will be used in this experiment. Samples of blood, liver, forages and soils will be collected every 4 months for analysis.

III- The Effect of Mineral Supplementation on Live Weight Gains and Reproduction in Nellore Heifers. The duration of this experiment is 24 months and will be initiated in August of 1978. This experiment is approximately the same as experiment II except in this case heifers are used and effect of mineral supplementation on reproduction will be evaluated. The treatments are the same as those of experiment II.

The majority of the mineral analyses for these experiments will be completed in Lima at the San Marcos University. A limited number of analyses of cobalt, selenium and molybdenum, however, will be made at the University of Florida. The University of Florida-AID program has assisted the University of San Marcos by providing laboratory consumable supplies and by purchasing some needed parts for their atomic absorption unit.

Much of the mineral research involved with cattle will be carried out at the Pucallpa experiment station. At this experiment station there are 1500 cattle. Soils on this experiment station are very acid and average a pH of 4.3. The soils are low in organic matter, magnesium, calcium and potassium. They are moderately low in phosphorus and available nitrogen as expected. Since the soils are acid they contain considerable quantities of iron and aluminum. The research at the experiment station already completed notes that forages are low in phosphorus as well as copper. Cobalt, however, appears to be in adequate concentrations.

An experiment station, named La Raya, which is part of IVITA is located on the Altiplano between the cities of Puno and Cuzco. The elevation is 4,314 meters. The experiment station has been quite an active program in research with alpacas. More recently, additional research has been devoted

to llamas. The high elevation is a problem for cattle and horses. Generally, they need a gradual adaptation before going to the higher elevations of 4,500 meters of this area. Cattle have been known to develop Brisket disease, which is also called high altitude disease. There is a herd of Brown Swiss cattle at the experiment station. The cattle seem to be in good condition but are only giving 2-3 liters of milk per day.

There is interest in studying the nutritional status of the cameloids at the experiment station. Some limited data indicates that copper is low in forages with averages of approximately 4.8 ppm. The cobalt status looks to be adequate while phosphorus values are low being .17% in the wet season and .07% during the dry season. The blood calcium levels in alpacas during the wet and dry seasons have ranged between 10 and 10.9%. Phosphorus levels have ranged between 4.5 and 7.3%. Further information on the digestibility of dry matter between sheep and alpaca indicated that during the dry season alpaca digestibility was approximately 5 to 7% better than sheep.

Mineral supplenentation for all llamas and alpacas in the Altiplano region is essentially zero. One problem is trying to develop experiments with mineral supplementation is that these cameloids will not consume minerals. Also, they are very reluctant to consume concentrates. Observations have shown that, when in confinement, they will consume mixtures containing molasses. However, when turned out on pasture they will consume only pasture, ignoring the concentrate mixture. One recommendation was to attempt to determine what supplements these cameloids would be willing to consume. Some observations have concluded that these animals do consume silages. The following experiments are being considered: 1) Title: "Determination of the Mineral Status of Alpacas and Llamas." Objective: To determine the mineral status of these cameloids by analysis of soils, plants and animal tissues. Procedure: 5 farms will be sampled with collections of

soils, forages and approximately 20 liver and blood samples per farms. The samples will be collected in October, representing the dry season and April, representing the wet season. 2) Title: "The Effect of Mineral Supplementation on Reproduction in Cameloids." Objectives: To determine if administered minerals will alter the reproduction of alpacas and llamas. Procedure: Comparisons will be made between natural pasture and improved pasture with both herds of alpacas and llamas. There will be control treatments in addition to injections of combinations of copper, cobalt bullets and selenium-vitamin E injections. 3) Title; "Species Differences in Mineral Concentrations between Cattle, Llamas and Alpacas." Objective: To determine the mineral status and differences between Brown Swiss cattle, alpacas and llamas in liver and blood concentrations. Procedure: Liver and blood samples will be taken from the herds of Brown Swiss, alpacas and llamas at the La Raya experiment station. These samples will be taken 2-3 times per year. 4) Title: "The Effect of Supplemental Iodine on Reproductive Performance of Dairy Cattle in the Region Northwest of Cuzco." Objective: There are severe reproductive problems in the northwest region of Cuzco. Calves are born with goiter and there are various fetal death losses. Frequently there is a high consumption of plants of the Brassica family which are known to be goitrogenic. Often calves will be born dead or will die in 2-3 days from goiter. Procedure: Injections of iodine will be administered to dairy cattle in this region. Half of the animals will receive injections while the remainder will serve as controls.

Universidad Nacional Agraria Research

The National Agrarian University at La Molina has been responsible for a great deal of agriculture research in the past years. Part of this research included some studies with mineral deficiencies.

There is now a sheep experiment underway with 1200 animals in the Central Highlands. The treatments are as follows: 1) salt + iodine + copper + cobalt, 2) salt + iodine + copper + cobalt + zinc, 3) salt + iodine + copper + cobalt + zinc + phosphorus. Another experiment is involved with growing lambs and will last 6 months. The treatments are the same as the first experiment. A third experiment is at Pucallpa on a large ranch. Here Nellore cattle, 6 years of age, are being used. The treatments for this experiment include: 1) sodium + iodine, 2) sodium + iodine + copper + cobalt, 3) sodium + iodine + zinc, 4) sodium + iodine + zinc + copper + cobalt + phosphorus.

In the area of Junín, neonatal ataxia in sheep has been observed. It was felt that this was not caused by a simple copper deficiency or a molybdenum induced copper deficiency. Some thought is that possibly high zinc levels may cause a copper deficiency. Additional research has noted low cobalt and zinc areas in the Cuzco region.

The staff at La Molina would like to be more involved in a mapping type of mineral research using liver, blood and forage samples, and also more mineral supplementation experiments. It is hoped that the staff of La Molina will cooperate with IVITA in carrying out mineral experiments.

The University of Florida-AID contract has provided cobalt bullets and other consumable supplies to La Molina.

Universidad Nacional Pedro Ruiz Gallo Research

Mineral research is now underway in the Lambayeque region. The German government has donated laboratory equipment to the Universidad Nacional Pedro Ruiz Gallo which included an atomic absorption spectrophotometer. The laboratory facilities and equipment are now adequate to undertake mineral research.

Mineral research is being carried out on dairy cattle farms in a cooperative program between the University Nacional Pedro Ruiz Gallo, Centro Regional de Investigaciones Agropecuarias CRIA-II and the Mission from the German government. The first stage of research is to collect liver, blood and forages from 5 to 10 farms where cattle graze and also those on a zero pasture system. The collection system will be employed in both the wet and dry seasons for Chacupe and Sasape regions of the Lambayeque state. The University will be responsible for sample collection and analyses. Personnel of Centro Regional de Investigaciones Agropecuarias CRIA-II assist in locating farms and taking sample collections while the German mission will provide equipment and some chemical supplies. Florida will assist with coordination when needed and supply expendable supplies, mostly for collecting samples.

The mineral research program to date is going along very well. There were some early problems with equipment but now the analyses are proceeding well. Liver, blood and forage samples have been taken from the regions of Lambayeque, Chiclaye and Ferreñafe. From 142 total samples, blood phosphorus levels were deficient in 18.8, 30.9 and 28.6 (av. 25.4) of the regions, respectively. From 92 liver samples, 53.5% and 61.8% were deficient in copper and manganese, respectively. The research to date has been summarized in a translated article entitled "Deficiencies and Toxicities of Minerals in Livestock in the North of Peru." This article has been submitted for publication.

The institution is also planning to look into the possibilities of mineral research in the region of the Amazon. It is felt that there is great potential for cattle in this area. Likewise, Ing. Vidal is assisting an University in Cajamarca (Universidad Nacional Técnica de Cajamarca) with a mineral research program. During the last visit to Peru, this institution was visited and materials were supplied so that samples would be collected.

The Philippines

The first visit was made in December, 1977 to the Philippines and was followed up in November, 1978. The organizations responsible for research are the University of the Philippines and the Philippines Council for Agriculture and Resources Research (PCARR), both located at Los Baños. The main contacts from the Department of Animal Science are Dr. Vicente Momoñgon (Head), Dr. Arsenio D. Calub and Dr. Perla L. López. Contacts at PCARR are Dr. Joseph C. Madamba and Dr. Alfonso N. Eusebio.

There has not been a lot of mineral research done in the Philippines. There is currently a three-year trace element research program but this is for soils only and it is supported by the Atomic Energy Commission. There is no atomic absorption unit at the nutrition laboratory. Soils are prepared in the nutrition lab and then sent to the Soils Department. In the future equipment requirements for mineral research should be less of a problem since equipment has been ordered under the World Bank loan program.

It has been observed that mineral nutrition was important for the local forages. Based on lack of response, apparent sulfur and trace element deficiencies were suspected. Some soil mapping has been done throughout the Philippines but many of the results are inconclusive. It is apparent, however, that phosphorus levels are quite low.

It was noted that in order to carry out mineral research, funds would need to be secured from somewhere for a laboratory technician. Also funds were needed for visiting farms for collection of samples. We were asked if the AID-Florida program will provide $5,000 a year for this undertaking.

Later in 1979 Dr. Perla Lopez is planning to visit Florida for the purpose of laboratory training.

During the second trip to the Philippines visits were made to cattle

ranches in the Mindanao region.

On one ranch that was visited (Allah Valley) the mineral supplementation program was less than desirable. The total mineral consumption was only 25 g per animal per day. The supplement was not fed on a regular basis but fed all at once with supplies in the feeders lasting as long as 3 or 4 months. As a result, the mineral supplement became wet quite frequently and, apparently, unpalatable. The particle size of the salt was fairly large, thereby, resulting in less desirable mixing with trace minerals. The two outstanding limitations of this mixture were the use of limestone and the small percentage of trace minerals. In calculating how the trace minerals were meeting the requirements of the cattle it was calculated that all of the trace minerals would provide less than 1% of the animal's requirement with the exception of copper. Copper would provide approximately 2% of the animal's requirement. Another limitation of the trace mineral mixture was that cobalt was not included. On the ranch several calves were found that exhibited goiter. Therefore, iodine deficiency was a problem.

It was agreed to set up a mineral supplementation trail on the Ansa cattle ranch. Details of the experiment are located at the end of the Philippines section of the report.

We noted that they probably could eliminate the iron sulfate entirely if they wanted.

A second ranch which was visited was near the town of General Santos. The ranch is the Sarangani Cattle Company and the contact is Mr. Enrico Pepito. Actually, this is a group of 7 ranches with a total of 4000 head of cattle. A mineral supplementation experiment is being planned for this organization. Three different ranches will be considered as three treatments. The experiment will be as follows:

Farm Number	Treatment	Number of Breeding Cattle
1	Salt only	900
2	Salt + bonemeal	1800
3	Salt + bonemeal + trace minerals	2000

All animals will be weighed twice per year, in November and May. Records can then be kept as to weight gains and performance. The duration of this experiment will be 2 years. Blood, forage and liver samples will be taken. Liver and blood samples will be taken from approximately 12 animals per treatment.

At the University, liver samples have been taken from slaughterhouses in different areas of the Philippines. Looking at their liver data, it was obvious that copper and manganese liver concentrations were low. The majority of the copper liver concentrations were low with the high percentage being in the deficient range. Discussions during the last visit to the University have centered around various problems of analysis, such as working with the small sample size of the liver biopsy. Also, the greatest limitation is time because of the lack of an automatic diluter. An automatic diluter was purchased by the AID-Florida mineral program.

A mineral supplementation program which will be carried out by Mr. Clenio T. Dhmlao and his advisor, Dean Pérez, was discussed during the last trip. This experiment was to be carried out at a farm in the northern part of Mindoro. The design of the experiment would be for the following treatments: 1) salt only, 2) salt + phosphorus, 3) salt + molasses, 4) salt + molasses + urea, and 5) salt + molasses + urea + phosphorus. There were to be 16 animals per treatment (4 bred heifers, 4 bred cows, 4 nonbred animals). Several recommendations, mostly that this number of animals was too small to detect breeding differences, were made. A suggestion would be to use one class of animals and reduce the number of treatments so there would be more

total animals per treatment. This may be modified to go with only heifers and use these possible treatments: 1) salt only, 2) a complete mineral supplement, 3) a complete mineral supplement + urea + molasses. An additional treatment could be a control + phosphorus only. Another limitation in the original experiment would be that a controlled quantity of phosphorus was desired. This may be difficult using a free choice system of a phosphorus supplement mixed with salt.

At this time there are five B.S. students working on mineral research. Much of their research is taking samples of liver, blood and forage and evaluating the mineral concentrations of these samples. An additional area where mineral research looks promising is the island of Nespate. Dr. Calub has a good relationship with a particular farm which has good facilities for carrying out mineral research. The calving percentage on this farm is only 50%. The farm is divided into 14 paddocks and there are facilities, such as weighing scales, for carrying out mineral research. Dr. Calub will investigate the possibilities of initiating a mineral supplementation trial at this location. There is a possibility that these minerals will be supplied by the Pfizer Company.

Proposed Mineral Supplementation Experiment in Mindanao, Philippines

Introduction: In many areas of tropical countries, numerous mineral deficiencies, imbalances and toxicities are severely inhibiting the cattle industry. Grazing livestock do not often receive mineral supplementation and most depend largely upon forages to supply their mineral requirements. Only rarely, however, can forages completely satisfy all the mineral requirements. Borderline or deficient levels of certain elements were noted for many forages in the 1974 Latin American Tables of Feed Composition: Co, 43%; Cu, 47%; Mg, 35%; P, 73%; Na, 60%; and Zn, 75% (McDowell *et al.*, 1974). Phosphorus deficiency has been reported in 38 developing tropical countries, Mg in 17, Na in 14, Co in 21 and Cu in 20 countries (Fick *et al.*, 1976; McDowell *et al.*, 1976; McDowell *et al.*, 1976).

Phosphorus supplementation has dramatically increased fertility levels of grazing cattle in many parts of the world. Latin American countries reporting increased fertility rates resulting from phosphorus administration include Bolivia (B. Bauer, unpublished data, 1976), Brazil (Conrad and Mendes, 1965), Colombia (Stonaker *et al.*, 1975), Panama (Ríos Aráuz, 1972; R. G. Poultney, personal communication, 1972), Peru (Echevarría *et al.*, 1974), and Uruguay (Schiersmann, 1965; De León Lora, 1963). In Panama (R. G. Poultney, personal communication, 1972) supplemental phosphorus increased calving percentage from a range of 42 to 80%. A study conducted in Brazil resulted in a 77% calf crop when bonemeal was fed compared to 55% for the controls up to 84% when a complete mineral mixture was fed to cattle in the Colombian llanos (Stonaker *et al.*, 1975).

Attempts to raise livestock productivity in tropical countries will be unsuccessful unless the nutritional environment, including protein, minerals

and vitamin A is adequate. Mineral supplementation is a least cost input to improvement of livestock production. Economical return on mineral investment has been at least two to one in some studies (Conrad, 1976).

In the Mindanao region of the Philippines cattle production is likewise often suboptimal. Little mineral research has been undertaken in the Philippines to determine which minerals are limiting and the biological response resulting from mineral supplementation.

Purpose of Research

1) To establish the mineral status of grazing cattle during growth, pregnancy, and lactation in a cattle producing region in Mindanao, Philippines.

2) To evaluate the biological response of cattle receiving mineral supplements.

3) To determine the economic benefit of mineral supplementation to grazing cattle.

Location - Ansa Cattle Ranch owned by Mr. Tony Nocom in eastern Mindanao.

Treatments - 1) Salt only (NaCl)
2) Complete mineral supplement, or

1) Salt only (NaCl)
2) A mixture of 2 parts of salt to 1 part of bonemeal
3) Complete mineral supplement.

The complete mineral supplement could be as follows:

Ingredient	% in Trace Mineral Salt	Amount for 100 kg of Mixture
Bonemeal	40	40 kg
Salt	57.72	57.72 kg
$CoCl_2$ (100% of req)	0.008	8 g
ZnO	0.615	615 g
MnO	0.288	288 g
CuO	0.125	125 g
KIO_3 (100% of req)	0.026	26 g
$FeSO_4$ (25% of req)	1.24	1240 g

Animals and Experiment Duration:

1) 3-4 year old heifers that average 3-6 months of pregnancy. The duration

of the experiment would be 2 years, or

2) 6-8 month old weaned heifers (and/or bulls). The duration of the experiment would be 3 years. If bulls are included they would be separated from the heifers during years 2 and 3.

A minimum of 25 animals per treatment would be desirable for the growth portion of the experiment, while a minimum of 50 animals per treatment would be more desirable for the breeding aspects of the trial.

Evaluation Periods: Animals should be weighed and randomly (or randomly blocked, i.e., by weight) allotted to treatments. At this time, forage and animal tissue samples should be taken. Sample collection would be repeated every 6 months to represent both the wet and dry seasons. Calves should also be weighed at an appropriate time.

The samples collected could be as follows: a) Animal tissue - 8-10 representative samples of both blood serum and liver biopsy (optional) could be collected from animals on each treatment during each sampling period. If possible, the same animals should be sampled each collection period. b) Forage - Pastures should be sampled at each collection period. Two samples each of the major pasture species should be collected. Each sample should be a composite and will be collected only after careful observation of cattle grazing patterns. c) Soil (optional) - A composite sample, in duplicate, should be taken from each paddock only once per year.

Analyses

Blood serum - Ca, P, Mg, Cu, Zn and Se.
Liver biopsy (optional) - Co, Cu, Fe, Zn, Mo, Mn and Se.
Forage - Protein, NDF, *in vitro* dry matter, Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mo and Se.
Soil (optional) - Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mg, Se, Al, N, organic matter and pH. The available forms of these minerals should be determined.

Management - Management of the cattle should remain the same in relation to insect and disease control. However, no substance containing a mineral or

vitamin should be administered. The dates that a bull is kept with cattle should be recorded so that accurate records of mineral consumption will be maintained.

Records - The following should be kept:

1) Individual animal performance including weights and calving dates.
2) Health observations
3) Mineral consumption.

Thailand

The first visit to Thailand in relation to mineral research was in November, 1978. Our chief contact, Dr. Pravee Vijchulata, is a recent graduate of the University of Florida who majored in ruminant nutrition. Dr. Vijchulata is with the University of Kasetsart. The University has access to new laboratory facilities which had only been in operation for one month at the time of our visit. The facilities are outstanding with every type of instrument for nutrition analyses provided. The equipment is all new and is now being tested by a number of qualified technicians. This is a central laboratory which would be used by all departments of the University. This central facility has two atomic absorption units including a graphite furnace. These instruments are Perkin-Elmer with an additional instrument located in the Animal Science Department.

Other contacts include Dr. Southcombe of the New Zealand World Bank Team located on Khon Kaen, Thailand. Also working in northern Thailand is Mr. Lindsay Falvey. Mr. Falvey is on a Thai-Australian Highland Agriculture project. He is with the faculty of Agriculture at Chiangmai University. Both Dr. Southcombe and Mr. Falvey have been involved in a limited amount of mineral and nutrition research in northeastern and northern Thailand.

Dr. Southcombe has done mineral research with both buffalo and cattle both the wet and dry seasons. The majority of effect seems to be in the wet season although this portion of the study has not been completed. During the dry season cows supplemented with minerals lost only 10g per day while controls lost 100 g. Calves on the experiment gained 258 g while the controls gained only 188 g. For buffaloes, animals receiving minerals gained 21 g daily during the dry season while the controls lost 22g. There was little difference in the calves, with the supplemented groups gaining 282 g and the

controls gaining 242 g. There were definite problems with this experiment in than animals were taken for sale prior to completion of the experiment. The experiment started with 10-15 animals per treatment but was reduced to 6 by the time of experimental termination. Dr. Southcombe noted that minerals were extremely expensive, costing $7.50 for 10 kg. The observations with these cattle seem to indicate that the animals cycle better when receiving minerals.

Mr. Falvey has done several nutritional experiments in northern Thailand. One experiment involved animals 1-2 years of age on 5 treatments. There were 6 animals per major treatment. Five treatments were as follows: 1) concentrates fed with pasture available during the day, 2) two-thirds of a kilogram of improved pasture fed during the night in addition to daily pasture, 3) nitrogen, phosphorus and sulfur given as a drench for animals on pasture only during the wet season, 4) the same treatment only during the dry season, 5) control animals on pasture only. For a sub-treatment, one-half of the six animals have been given a trace mineral drench which represents one-half of the animal's daily requirement. This experiment has only been going for 4 months and it is too early to make any conclusions. Obviously, one major problem will be lack of sufficient animal numbers. However, growth differences are likely to be detected.

In a second experiment there were two treatments with and without phosphorus administration. Animals were drenched daily with phosphorus to equal one-half of their daily requirement. Also, fecal samples were collected for phosphorus determination. The main effect from this experiment was that phosphorus increased the calving percentage to 80% versus 60% for the control group. Mr. Falvey will be sending me a report describing this experiment.

In other experiments underway, urea, molasses and mineral mixtures are

given to animals using a drum lick in combination with improved pastures.

Dr. Vijchulata will be working with others to write up mineral research proposals.

Uruguay

Three short trips have been made to Uruguay after we found that they were interested in mineral research. Three working days March 28, 29 and 30, 1977 and four working days November 22-24, 1977 and three working days August 16, 17 and 18, 1978 were spent there.

Dr. Ian Newsam who is project manager of the United Nations Special Fund Project with the Rubino Veterinary Research Centre has been very interested and helpful. The analytical laboratory is under the direction of Dr. Teresita Sonia Alonso, who plans to come to Florida in September to participate in our mineral training program. Their new Varian Techtron Model AA-6 has become operational. Dr. Fernando Riet has blood serum phosphorus levels from several ranches in Uruguay indicating osteomalacia is a serious problem.

Eight forage samples were analyzed at the University of Florida Nutrition Laboratory. All samples were deficient in calcium and phosphorus with the phosphorus values being extremely low. Only two magnesium levels were below the requirements but 5 of 8 sodium values were below the requirement. Four of the 8 zinc levels were low but information on the other trace elements are inconclusive due to possible contamination during grinding.

Supplemental trials are in progress comparing treatments of 1) salt, 2) salt + dicalcium phosphoate and 3) salt + mineral-protein block.

The University of Florida has analyzed 40 forage samples and plans to analyze about 250 more forage samples. There is much interest in mineral research and mineral supplemental trials in the cattle and sheep raising areas of the northwest part of the country.

Venezuela

Contacts were first made in December, 1975, concerning cooperative mineral research. Three research groups are interested in investigating the mineral status of cattle in Venezuela.

Maracaibo - The Veterinary and Agronomy faculty at the University of Zulia are interested in studying the mineral status of cattle in the Lake Maracaibo region. They plan to collect soil, forage and animal tissue samples from ranches in each of the 4 different regions.

One mineral supplementation program has now been completed. This experiment involved 196 animals (both steers and bulls). These animals were divided into combinations of treatments to include steers vs. bulls, Ral-Grow, selenium-vitamin E and copper. The results of this experiment showed that there was no positive effect of copper supplementation, since this group was slightly lower than the controls. However, the selenium-vitamin E treatment had a positive effect with the animals losing less weight during the dry season. This experiment was undertaken in the Pereja region west of Lake Maracaibo.

During this mineral supplementation program an interesting development occurred with 6 of the animals. At one time, these animals were down with what appeared to be grass tetany. Magnesium sulfate was administered and 5 of these animals responded quickly with the sixth animal responding more slowly.

A second experiment using the same design was located 280 km southwest of the lake in a region of higher rainfall and better forage quality. This study had 100 steers on the same treatments as the previous trial with the addition of cobalt bullets as an extra treatment. The results were similar to the first trial in that good results were not obtained from the copper

injections. Also, selenium-vitamin E again provided a positive effect with approximately 40 g/day more weight gain for these animals over the controls. There appeared to be only a slight response from the cobalt supplementation.

In another experiment blood samples have been taken from cattle on 14 farms in the Pereja region during both the wet and dry seasons. Forty-five samples were taken from farms as follows: 15 heifers, 15 dry cows and 15 lactating cows, and analyzed for calcium, phosphorus and magnesium. The summary of these analyses follows:

Blood Mineral	Wet Season	Dry Season
Calcium	12 mg%	15-20 mg%
Magnesium	2 mg%	4.5 mg%
Phosphorus	5.5-6 mg%	2.0-2.5 mg%

The results indicate that calcium and magnesium were very high during the dry season but normal during the wet season. The calcium values during the dry season were especially high. With these high levels the possibility of error exists. Phosphorus was normal during the wet season but was extremely low, contrary to calcium and magnesium, during the dry season. Lactating cows had lower blood phosphorus levels than dry cows or heifers.

Dr. Capote is interested in future research to study the effects of minerals on decreasing long calving intervals. He has ordered 2 tons of dicalcium phosphate and will have treatments of salt, only, dicalcium phosphate plus salt and dicalcium phosphate plus salt plus trace minerals.

The possibility of doing some experiments feeding minerals all year long versus just during the wet or dry seasons is being investigated. The Pfizer Company will probably be willing to provide minerals for well organized experiments. Dr. Capote will be looking for some farms with this possibility in mind. Also he will be looking further at the effects of supplemental

cobalt and selenium-vitamin E on animal performance at a large ranch in Machiques. The manager is willing to provide Dr. Capote with 100 steers. These will be divided into groups containing 25 animals each with the various combinations of: cobalt, selenium, cobalt + selenium and a control group. In another experiment, Dr. Capote will be working with lactating dairy cattle feeding protein-energy supplements with or without calcium and phosphorus supplements to determine the effect of these nutrients on calving intervals. The two treatments would likely be: 1) protein + calcium and phosphorus, 2) energy + protein. The source of protein that might be used is blood meal which is low in phosphorus.

Maracay - The main contacts in Maracay are Dr. J. T. Perdomo of the Universidad Central de Venezuela and Dr. Claudio Chicco of the Sección de Zootecnia, Centro de Investigaciones Agronómicas. Unfortunately at this time, there appears to be no mineral research taking place in Maracay. It is unfortunate that there have been no follow-up on the mineral research in the Apure state related to "falling disease". There are symptoms of a long-hair syndrome from some cattle in the llanos. A mineral analysis has been done but no differences between normal and abnormal animals could be found. Dr. Perdomo has been considering a supplementation trial using copper, selenium-vitamin E and iodine.

The main mineral research which will be coming out of the Maracay region is the thesis results of Ing. David Morillo. While in Maracay David Morillo spent one year collecting samples from distinct areas in the llanos in which efficiency of production is low. One of these ranches has a severe problem of "falling disease".

Ing. Morillo has collected forage, blood, liver, feces and soil samples from 9 farms in the llanos states of Apure and Guarico. These collections

have been made for 2 classes of animals: pregnant-lactating animals and growing animals, twice a year (wet and dry seasons). Some of Ing. Morillo's experiences illustrate logistical and other problems related to collecting samples from ranches in remote areas. As an example, several farms which provided samples during the wet season would not permit the collection of animal tissue samples because they did not want the animals moved. Often when animals are moved during the dry season broken bones will result. In another example, forage samples could not be collected since the owner was not at home. Permission could not be obtained from the owner.

Ing. Morillo is now at the University of Florida taking course work and doing the analysis towards his M.S. degree which should be completed this summer. Early results indicate severe nutritional limitations including protein, phosphorus and copper deficiencies.

Jusepin - In Jusepin Ing. José Velásquez of the Universidad de Oriente has undertaken a very active mineral research program. Ing. Velásquez received funds from CONICIT to carry out this mineral research program. Ing. Velásquez is involved in taking soil, forage and blood samples from 5 of the states of the llanos. These collections first were in the state where Jusepin is located, Monagas. Ing. Velásquez has finished his collections in Monagas for both the wet and dry seasons for 7 farms. He compared pregnant lactating animals to steers and heifers. Also, Ing. Velásquez collected samples from 27 farms in the states of Bolivar (10 farms), Antioquia (7 farms) and Guarico (10 farms) during the wet season. In March he will be starting collections for the dry season and next year he will cover a larger part of Guarico state and will start to make collections in the state of Apure. The organization, CONICIT, has given Ing. Velásquez additional funds so that he can continue his work in these additional states.

In the state of Antioquia there are observations from 5 farms which stopped their regular mineral supplementation programs. The result was extreme weight loss and bone problems. There are also very severe bone problems on farms in Guarico state. This observation had also been confirmed by research undertaken by David Morillo from Maracay.

Ing. Velásquez published a 58 page document summarizing the results of sample collection and analysis in the state of Monagas, "La Situación de la Nutrición Mineral del Ganado Bovino en el Estado Monagas" (abstract in appendix).

The average soil values obtained for pH, organic matter, calcium, magnesium, potassium, aluminum, phosphorus and cation binding capacity during the dry and wet season, respectively were as follows: 5.06 and 4.82; 1.39 and 1.18%; 0.68 and 0.88; 0.37 and 0.22; 0.13 and 0.09; 0.51 and 0.30 meq/100 g; 3.52 and 4.10 ppm and 4.48 and 3.83 meq/100 g. The average forage content of nitrogen, calcium, phosphorus, magnesium, iron, manganese, zinc and copper for the 2 seasons were as follows: 0.62 and 1.18%; 0.16 and 0.19%; 0.08 and 0.09%; 0.08 and 0.14%; 176.21 and 567.54 ppm; 105.97 and 143.23 ppm; 22.91 and 40.43 ppm; and 2.89 and 6.53 ppm, respectively. The average concentration of calcium, phosphorus and magnesium in the blood plasma for the two seasons respectively, were as follows: 10.47 and 10.36, 3.15 and 4.10; [illegible].05 and 2.87 mg/100 ml.

To summarize this publication further, the majority of the pH samples were less than 5. As expected, organic matter was low. The following data illustrates the results of the pasture analyses in the wet season: Phosphorus - Virtually all of the forage samples were deficient in phosphorus. Only 7 out of 1000 contained more than 0.20%. The majority were less than 0.1% phosphorus. Calcium and magnesium - The majority of these samples were

adequate, however, some farms did have low levels. Copper - 95.7% of the forage samples contained less than 10 ppm and approximately 11% contained less than 5 ppm. Zinc - Of 1000 samples, 330 contained less than 30 ppm (33%). Iron - All of the samples were well above the requirement with some samples being higher than 1500 ppm. Manganese - All samples were adequate with the majority above 100 ppm.

With both the wet and dry seasons, blood phosphorus levels are very low, being less than 4.5 mg%. For the wet season specifically, only 3 minerals were evaluated in blood plasma and the results are as follows: Phosphorus - 11 out of 106 samples contained more than 4.5 mg% (10.4%). The majority of the blood samples, as in the dry season, contained less than 3.5 mg%. Calcium and magnesium - All of the calcium and magnesium concentrations fell within the normal range.

Another experiment that Ing. Velásquez initiated was a six month trial designed to evaluate the effects of injections of copper, selenium-vitamin E or cobalt bullets on cattle 8 to 18 months of age. The results indicated that the control group of animals lost considerable amounts of weight while those groups receiving any of the supplements either maintained or gained weight. Since this experiment involved a small number of animals an additional experiment has been formulated. The new experiment will involve 24 animals per treatment and the duration will be approximately 1 year. Animals will be weighed every 28 days and liver samples will be collected. This experiment started in January and contained the following treatments: 1) cobalt + copper + selenium-vitamin E, 2) cobalt, 3) copper, 4) selenium-vitamin E, and 5) control.

New data taken during the wet season from the three main states under investigation is now being summarized. In general, many of the results seem

similar to the data from Monagas. The general conclusions seem to be that calcium, magnesium, manganese and iron are in concentrations adequate for these animals. However, the remaining minerals definitely or likely are limiting animal production.

It is quite obvious that mineral deficiencies are limiting livestock production in the various states of the llanos. Likewise of equal importance is the low protein concentrations of these forages. On the basis of many analyses, the average protein values for the wet and dry seasons are 7.4 and 3.9%, respectively. As might be expected from the data, there were animal class differences in some of the tissue mineral concentrations. Cows had lower levels of blood phosphorus than did steers in the Monagas study.

During our last visit (February) we discussed with Ing. Velásquez some of his procedures for sample collection. In a considerable number of studies, we have had difficulties in getting reliable blood phosphorus data. However, in all of Ing. Velásquez's work, low blood phosphorus levels have been noted. One possible reason for this may be that Ing. Velásquez is able to spin down his samples within one-half hour of collection. He has several portable centrifuges which he uses.

The University of Florida-AID program is mainly providing consumable supplies, mostly used for sample collections and injections of various minerals. Also at Florida, analyses are being completed of selected samples of the difficult minerals of Se and Co.

2. Interpretation of Data and Supporting Evidence: Available research data indicates that phosphorus is the most widespread mineral deficiency for grazing livestock. Calcium deficiencies are rare under grazing conditions and this is an important fact because many older textbooks in Latin America emphasize calcium deficiencies rather than phosphorus.

Copper and cobalt deficient regions extend over wide areas of Latin America, but these areas are poorly defined. Inadequacies of magnesium, sodium, iodine, selenium, and zinc and toxicities of molybdenum, selenium and fluorine are encountered in diverse areas of Latin America.

The soil-plant-animal relationship helps to make the interpretation of mineral research data complex. In addition, the many soil types and forage species necessitate an intensive mineral research effort. The mineral research abstracts in the Appendix emphasize some of the data which are available and the need for more specific data.

3. Research Design: Currently we are cooperating with mineral research programs in sixteen countries and each country has a number of different regions. Research people in these countries have certain problems and priorities. We are making a major effort to assist each country in developing and applying acceptable mineral research design and scientifically based research techniques.

Research emphasis is being placed on regions where reported "problem" areas exist which suggest mineral deficiencies or toxicities. This approach is more feasible than attempting to map large areas where deficiencies or toxicities are not apparent. As a result, emphasis has been placed on the following "problem" areas:

a. Bolivia - Beni region low production and phosphorus deficiency.

b. Brazil - Mato Grosso apparent mineral deficiency or toxicity, Ceará cobalt deficiency and Rio Grande do Sul selenium deficiency.

c. Colombia - Central selenium toxic, llanos (low production) and in large areas copper deficiency alone or molybdenum induced copper deficiencies. "Secadera" (wasting disease), a possible mineral deficiency in one region of the llanos.

d. Costa Rica - Guanacaste (low production), San Carlos high forage oxalates, volcanic soils - manganese toxicity and throughout the country severe phosphorus deficiencies.

e. Ecuador - Highlands, reproductive problems and western, selenium inadequacies or toxicities.

f. Indonesia, Malaysia, Thailand and the Philippines - Cobalt deficiency in Malaysia and clinical signs resembling mineral deficiencies in each country.

g. Venezuela - Llanos low production and clinical signs resembling copper deficiency.

Sample collection and preservation under field conditions are problems. Separation of the serum or plasma from whole blood rapidly and without hemolysis under field conditions is difficult. Undertaking mineral supplementation studies on private farms are often necessary but can be unproductive. Experiments on private farms in some instances have been initiated and several months later the animals were sold prior to obtaining useful data. Collecting forage samples which represent what the animals consume is difficult. Logistics of carrying on field research at locations distant from research institutions is complicated. However, we were aware of these problems at the beginning of the program and better methods of improving sample collection, storage and analysis

are constantly being evaluated. Many worthwhile research publications in Latin America such as theses and symposia proceedings are not readily available to libraries and abstracting journals.

E. Dissemination and Utilization of Research Results

More than 1000 copies of the manual entitled "Methods of Mineral Analysis for Plant and Animal Tissues" were distributed in English, Spanish and Portuguese throughout Latin America and other regions of the world. In April of 1979 the English second edition of this manual was ready for publication. Later in 1979 the Spanish second edition will be ready for distribution.

Nearly 500 copies of the proceedings entitled "Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants" have been distributed in Portuguese throughout Brazil. In May, 1979, translations to English and Spanish were completed. Approximately 2000 English and 1500 Spanish copies are now being distributed. Other articles that have been presented at symposia and scientific meetings have been widely distributed.

In 1978, a review article entitled "Trace Mineral Nutrition in Latin America" was published in the "World Animal Review". This publication has a large circulation in developing countries. An additional 500 copies were ordered and distributed to interested researchers.

Large quantities of theses and other reports are also sent to collaborators and other interested persons. For example, 200 copies of the thesis entitled "Mineral supplementation of grazing beef cattle in the Eastern Plains of Colombia" were distributed to interested persons. From Brazil, two theses entitled "Mineral status of beef cattle in the northern part of Mato Grosso, Brazil as indicated by age, season and

sampling technique" and "Interrelationships among mineral levels in soil, forage and animal tissues on ranches in northern Mato Grosso, Brazil" have also been widely distributed. These particular theses illustrated mineral research procedures very well.

1. This project has stimulated tremendous interest in the mineral problems of grazing ruminants in the countries in which we have cooperated. Research, extension, producers and commercial personnel have known they had problems; now they see the possibility of finding the correct solution to these problems.

All personnel directly associated with the mineral project are constantly answering questions concerning formulation of mineral mixtures and the correct use of mineral mixtures. During country visits most meetings with researchers are in small groups. However, seminars on mineral research are often requested and given to large audiences.

It is significant and noteworthy that organizations not directly involved with the AID/Florida contract request information on methods and procedures for mineral research.

Most of the information which is being distributed has direct application and we see evidence that this information is being applied as we travel within the cooperating countries.

2. A cooperative mineral research symposium attended by 250 people was our most effective way to expand the use of research results. For five days these participants heard and discussed mineral research results and mineral problems. Many people are interested in finding the solution to mineral problems. This project has encouraged them, provided standard techniques and provided some materials for them to get started. We frequently find the following situation. They have the interest and many

of the materials for doing mineral research. Governmental personnel recognize that minerals are limiting, but this is not a top priority. Research reviews and sample research designs, often written in Spanish or Portuguese, are provided by the University of Florida. This information along with personal visits is often sufficient to stimulate an in-country mineral research program. By starting with the areas where mineral problems are clearly evident, there is a good possibility that the solution can be found and that it will be applied by the livestock producers in the area.

Mineral research in Latin America is an extremely ambitious program. We are currently working in sixteen countries and some of these programs are just beginning to gather momentum. We would like to expand this program into other countries as time, personnel and funds permit. It requires several years of concentrated effort to identify and correct these mineral problems.

3. All research in progress is in full cooperation with LDC personnel and institutions within the respective countries. During the reconnaissance and recruitment phase of this contract only interested personnel at institutions capable of supporting mineral research were selected. The majority of both human and physical resources for mineral research are provided by the cooperating countries.

a. Planning the project. This mineral research program does not have a standard research plan that can be used in every country. However, we do have models which personnel can modify to best coincide with their specific conditions in their own country.

b. The execution of the field work. Limited human and financial resources are available within the framework of this project. What is

available is used primarily to supply technicial information and ideas, expendable materials which are difficult to obtain within the cooperating country and in some cases seed money with which to initiate mineral programs.

c. The analysis and reporting of results. Data generated within each country is the property of this country. The University of Florida assists with some of the more difficult analyses, interpretation, and summary of data as requested. Permission must be obtained in writing and credit given as co-author and cooperating agency when applicable.

4. Recent abstracts related to mineral research can be found in the appendix.

F. Work Plan and Budget Forecast for Coming Year

1. Each of the sixteen cooperating countries are in a different stage of their mineral research programs. Comparatively speaking, the most effort is in Brazil, Costa Rica and Colombia. The greatest effort for a mineral supplementation program is in Bolivia. A second supplementation program will be attempted in the Trinidad region of Bolivia with emphasis on the season effect of mineral supplementation. Mineral research programs are all going well in Ecuador, El Salvador, Guatemala and Venezuela. Cooperating with five countries (Indonesia, Malaysia, Peru, the Philippines and Uruguay) is at a modest beginning, while programs in Malawi and Thailand are still in the discussion phase. Mineral research in the Bahamas is of a very limited nature.

In Ecuador a graduate student program will be initiated to determine the mineral status of selected regions. A graduate student program concerned with "secadera" (wasting disease) will be attempted in Colombia. Research with llamas and sheep will be carried out in Bolivia. If

future research is approved an attempt may be made to start a graduate research program in Malawi and the Sudan.

Anticipated accomplishments for the coming year include initiating research programs in Malawi and Thailand, establishing more comprehensive research programs in Indonesia, Malaysia and the Philippines and for all countries assistance with analyzing samples for mineral concentrations, analyzing and interpreting data, and publishing results. If the program is extended then anywhere from 1 to 3 trips are needed for each country annually in order to adequately supervise and encourage the mineral research programs. For some Latin American countries and regions, visits could be reduced to 1 time per year while other countries would require 2 to 3 visits per year. If the program is to be terminated in November, 1980, fewer trips should be scheduled so that more time for program summarizations can be made.

2. Procedures to be used and activities to be carried out include the following: Finish publishing and then distributing the symposium proceedings "Latin American Symposium on Mineral Nutrition Research with Grazing Ruminants" in English and Spanish.

Finish revising and distributing the second edition of the manual "Methods of Mineral Analysis for Plant and Animal Tissues" in Spanish and English to appropriate persons and institutions.

Provide personnel and facilities at the University of Florida to help train 2 to 3 technicians during 3 months or more in analytical procedures for mineral analyses.

Continue to improve analytical methods for analysis of selenium, cobalt, molybdenum and sulfur.

Encourage and assist cooperating country personnel to present

results at conferences and to publish results and write extension type publications for the producers.

Work with producers and companies in the formulation and feeding of mineral supplements.

Continue to stimulate mineral research through correspondence, publication of popular articles and the attendance at conferences, seminars and workshops.

Make personal visits to cooperating countries from one to three times annually and provide limited financial resources and difficult to obtain expendable materials. Locate new contacts in Africa.

3. Cooperating country personnel and the degree of commitment by their governments are the principle factors which will promote or impede accomplishments. Mineral programs in the cooperating countries will progress in relationship to the number of dedicated scientists working in the mineral program and the support which they obtain from their host governments and industry.

4. Dissemination and utilization of expected research results will continue to be emphasized through publications, field days, conferences, seminars and workshops. Approximately 3500-4000 copies of the "Latin American Symposium on Mineral Research with Grazing Ruminants" is being distributed in Spanish and English. The revised second edition of the manual "Methods of Mineral Analysis for Plant and Animal Tissue" will be completed shortly and will be distributed in participating countries and other parts of the world in English, Spanish and Portuguese.

The majority of the individual country research information will be written in Spanish and Portuguese which will be published locally and regionally. It is anticipated that this information will be

presented at meetings of ranchers and producers whenever appropriate.

Producers are seeking economical ways of increasing the level of production and correcting mineral deficiencies has been shown to return at least $2.00 for every dollar invested in many studies.

5. Budget Statement:

a. Current budget

b. Proposed budget beginning November 2, 1980

a)

FISCAL REPORT
January 1, 1979 - March 31, 1979

Contract No. AID/ta-c-1153
Between the United States of America and the University of Florida

Category	Funds Available 11/1/74-10/31/79	To Date 3/31/79	This Period 1/1/79-3/31/79
Salaries	$ 247,983.00	$195,440.44	$ 12,028.65
Fringe Benefits	30,899.00	24,487.89	1,805.78
Overhead	125,102.00	98,790.34	6,225.49
Cooperating Country &/or 3rd Country Nationals	57,250.00	33,069.91	548.64
Travel & Transporation	124,106.00	103,064.50	3,452.77
Equipment, Materials & Supplies	133,273.00	159,867.23	9,471.31
Other Direct Costs	30,359.00	21,765.38	173.00
Totals	$ 748,972.00	$636,485.69	$ 33,705.64

Overhead:
On Campus: 45% x 13,834.43 = 6,225.49

The undersigned hereby certifies: (1) that payment of the sum claimed under the cited contract is proper and due and that appropriate refund to A.I.D. will be made promptly upon request in the event of disallowance of costs not reimbursable under the terms of the Contract, and (2) that information on the fiscal report is correct and such detailed supporting information as the cognizant paying office or the Contracting Officer may reasonably require will be furnished upon request by the Contractor to A.I.D. at the Contractor's home office or base office, as appropriate.

By _____
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Date _____

b) Cost Proposal for Development of Efficient Mineral Supplementation Regions for Grazing Ruminants in the Tropics.

November 1, 1980 - October 31, 1981

	Man-Months	Estimated Cost
I. Salaries		
A. U.S. Personnel		
Home Office Personnel		
Associate Professor	12	$27,000.00
Assistant Professor	12	22,000.00
Short Term	6	17,500.00
Home Office Nonprofessional		
Laboratory Technician	12	9,400.00
Secretary	12	8,200.00
Total U.S. Salaries		$84,100.00
B. Cooperating or Third Country Nationals		
Field Staff Nonprofessional		
Latin American Technician	12	8,000.00
Total Salaries		8,000.00
II. Fringe Benefits 16% of 84,100		13,456.00
Total Fringe Benefits		13,456.00
III. Overhead		
Home Office (51% x 97,556)		49,754.00
Field Staff (29% x -0-)		-0-
Total Overhead		49,754.00
IV. Travel and Transportation		
U.S. Travel (2 RT tickets)		800.00
International (8 RT at $1,000 + 5@$2,000 average/trip)		18,000.00
Total Travel and Transportation		18,800.00
V. Allowances		
Per diem - U.S. (15 days at $35/day)		525.00
- International (130 days at rates av $50/day)		6,500.00
Total Allowances		7,025.00
VI. Other Direct Costs		
Bilingual Secretary (Contractual Agreement)		5,000.00
Total Other Direct Costs		5,000.00
VII. Equipment, Vehicles, Materials and Supplies		
Material and Supplies		
Postage, phone & misc. office supplies		5,000.00
Computer rental		1,000.00
Cooperating County Materials		8,000.00
Chemical supplies		29,865.00
Total Equipment, Vehicles, Materials and Supplies		43,865.00
GRAND TOTAL		$230,000.00

G. Appendix

1. Contacts visited in Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Indonesia, Malawi, Malaysia, Peru, the Philippines, Thailand, Uruguay and Venezuela.

2. Titles and authors of papers presented at the 1976 Latin American Symposium on Mineral Research with Grazing Ruminants, Belo Horizonte, Brazil. Publication of Symposium Proceedings, available in both English and Spanish, were published in 1979 and are presently being distributed.

3. Bibliographic list of publications from November 1974 through December 1977.

4. Abstracts (or summaries) of selected papers submitted for publication or published in 1978 to June 1, 1979. Abstracts dated 1977, but which were not part of the last annual report are also included.

5. Annual estimated cost of mineral research in Latin American countries.

   a) Current Budget

   b) Proposed budget beginning November 1, 1980.

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2. Latin American Symposium on Mineral Research with Grazing Ruminants

Belo Horizonte, Brazil
March 22-26, 1976
(Listed in Order of Presentation)

1. Mineral Problems as Related to Tropical Climates, J. K. Loosli (Florida) and Antonio Carlos Guedes (UF Santa Maria).

2. Classification and Distribution of Tropical Soils, Raimundo Costa de Lemos (OESA and SEEBIA - Rio de Janeiro).

3. Methods of Analyzing Soil Fertility, José Mario Braga (UF Viçosa).

4. Properties of Soil which Affect the Availability of Minerals for Plants and Animals, S. J. Volkweiss (UFRGS - Porto Alegre).

5. Mineral Composition of Tropical Grasses and Forage Legumes, José Alberto Gomide (UF Viçosa).

6. Water as a Source of Minerals, R. L. Shirley (Florida) and Jose Herculano de Carvalho (MA, Teresina, PI).

7. Magnesium in Ruminant Nutrition, J. A. Carneiro Viana, (UF Minas Gerais).

8. Copper and Molybdenum in Ruminant Nutrition, José Fernando Coelho da Silva, (UF Viçosa).

9. Sample Preparation and the Analysis of Animal Tissues, R. M. Silva (UF Minas Gerais).

10. Calcium, Phosphorus, and Fluorine in Ruminant Nutrition, D. J. Thompson (International Minerals and Chemical Corp. Joaquim C. Werner (Nova Odessa, S.P.).

11. Sodium and Chlorine in Ruminant Nutrition, J. K. Loosli (Florida) and José Ribeiro (UFRGS - Porto Alegre).

12. Sample Preparation and Soil Analyses, Victor Gonçalves Bahia, (USP - Piracicaba).

13. Potassium and Iodine in Ruminant Nutrition, D. J. Thompson (International Minerals and Chemical Corporation) and João M.S. Andrade (EPAMIG - Belo Horizonte).

14. Sulfur in Ruminant Nutrition, R. L. Shirley (Florida) and Artur Mariante (EMBRAPA-Brasília).

15. Selenium in Ruminant Nutrition, C. B. Ammerman (Florida), S. M. Miller (Florida), L. R. McDowell (Florida) and Edvaldo Correca de Araujo (EMBRAPA-Recibe).

16. Iron, Manganese and Zinc in Ruminant Nutrition, L. R. McDowell (Florida), R. H. Houser (Florida), K. R. Fick (Florida) and Marcelo O. Mendes (EMBRAPA - Rio de Janeiro).

17. Cobalt in Ruminant Nutrition, R. H. Houser (Florida), K. R. Fick (Florida), L. R. McDowell (Florida) and José Herculano de Carvalho (MA - Teresina - PI).

18. Newer Elements, Essential and Toxic, in Mineral Nutrition, L. R. McDowell, K. R. Fick, C. B. Ammerman, S. M. Miller, R. H. Houser (Florida) and Júlio Cesar de Sousa (EMBRAPA - Sete Lagoos).

19. Biological Availability of Macro Elements, D. J. Thompson (International Minerals and Chemical Corporation) and Marcelo O. Mendes (EMBRAPA - Rio de Janeiro).

20. Biological Availability of Micro Elements - A review, C. B. Ammerman, S. M. Miller (Florida) and José Herculano de Carvalho (MA - Teresina - PI).

21. Soil, Plant, and Animal Tissue as Predictors of the Mineral Status of Ruminants, J. H. Conrad (Florida) and Júlio Cesar de Sousa (EMBRAPA - Sete Lagoos).

22. Evaluation of Mineral Supplements for Ruminants, R. H. Houser (Florida) and Leonidas Valle (EMBRAPA - Brasília).

23. Current Status of Mineral Research in Latin America, K. R. Fick, L. R. McDowell, R. H. Houser (Florida), and Hamilton da Silva (UFMG - Belo Horizonte).

24. Mineral Deficiencies of Cattle under Range Conditions in Brazil, Carlos Hubinger Tokarnia (UFF - Niteroi) and Jürgen Dobereiner (EMBRAPA - Rio de Janeiro).

25. Mineral Research Studies of Ruminants in the Amazon Region, Nelson S. Fernandes and Waldemar V. Camargo (Biological Institute, São Paulo).

26. What Type of Information Do the Mineral Companies Need from the Researchers, João Soares Veiga (TORTUGA - São Paulo).

27. Identification and Supplementation of Limiting Nutrients for Grazing Ruminants B. D. H. Van Niekerk (Voermol Products - South Africa) and E. Adilson S. Serrão (EMBRAPA, Belém).

3. Bibliographic list of publications from November, 1974 through December, 1977.

a) McDowell, L. R., J. H. Conrad, J. E. Thomas and L. E. Harris. 1975. Nutritional composition of Latin American Feeds. Proceedings of a conference on "Animal Feeds of Tropical and Sub-tropical Origin," p. 253-254. Tropical Products Institute, London, England.

b) McDowell, L. R., J. H. Conrad, J. E. Thomas and L. E. Harris. 1975. Latin American forages. J. Anim. Sci. 41:282. (Abstr.).

c) Lang, Carlos E., L. R. McDowell, J. H. Conrad and Hernán Fonseca. 1975. Estado mineral del ganado en Guanacaste, Costa Rica. ALPA. R2 (Abstr.).

d) McDowell, L. R. 1975. Niveles minerales relacionados al crecimiento animal en América Latina. 3rd. Latin American Meats Short Course, pp. 33, Gainesville, Florida.

e) Gil, Arturo, Lee McDowell y Joseph Tritschler. 1975. Deficiencias y toxicidades de minerales para bovinos en las principales áreas ganaderas del país. p. 110-115. Informe anual del programa nacional de nutrición animal. ICA - Tibaitatá.

f) McDowell, L. R. 1976. Mineral deficiencies and toxicities and their effect on beef production in developing countries. Beef cattle production in developing countries. p. 216-241. Edited by A. J. Smith. Edinburgh, Scotland.

g) Fick, Karl, Sarah M. Miller, John D. Funk, Lee R. McDowell and Richard H. Houser. 1976. Methods of mineral analysis for plant and animal tissues. 60 pp. University of Florida, Gainesville, Florida (English, Spanish and Portuguese).

h) Mangeye K., L. R. McDowell, K. R. Fick, H. Fonseca, J. A. Camacho and J. K. Loosli. 1976. Mineral status of cattle in San Carlos, Costa Rica. J. Anim. Sci. 43:326 (Abstr.).

i) Gil, Arturo, Lee McDowell and Joseph Tritschler. 1977. Deficiencias y toxicidades de minerales para bovinos y ovinos en las principales áreas ganaderas del país. Programa Nacional de Nutrición Animal. Informe Anual de 1976. Bogotá, Colombia.

j) McDowell, Lee R. 1977. Investigaciones minerales en ganado en Latinoamérica. Segundo Curso en Nutrición y Alimentación. p. 1-24. Lima, Perú.

k) McDowell, L. R., J. A. Froseth, R. C. Piper, I. A. Dyer and G. H. Kroening. 1977. Tissue selenium and serum tocopherol concentrations in selenium-vitamin E deficient pigs fed peas (Pisum sativum). J. Anim. Sci. 45:1326-1333.

l) McDowell, L. R. 1977. Current mineral research in Latin America. Eleventh Annual Conference on Livestock and Poultry in Latin America. p. B10-25, University of Florida, Gainesville (in English and Spanish).

m) Alonso Guzmán, Manrique. 1977. Evaluación del estado mineral del ganado y los pastos en los distritos de La Cruz, Cañas Dulces y Filadelfia de la provincia de Guanacaste durante la época seca. Tesis. Facultad de Agronomía, Universidad de Costa Rica, San José.

n) Ammerman, C. B. and Ricardo Valdivia. 1977. Mineral supplementation for beef cattle in Latin America. Eleventh Annual Conference on Livestock and Poultry in Latin America. p. B1-9, University of Florida, Gainesville (in English and Spanish).

o) Conrad, Joe H. and Lee R. McDowell. 1977. Research in mineral deficiencies for grazing ruminants. Annual report for AID mineral research project contract number AID/ta/c/1153. Gainesville, Florida.

p) Döbereiner, Jürgen, Jerônimo Alves Chaves, Ivan Valadão Rosa and Richard H. Houser. 1975. Efeito de transferência de bovinos com cara inchada (doença peridentária) para pastos de região indene. Pesq. Agropec. Bras., Sér. Vet., 10:99-103.

q) Gil, Arturo, Lee McDowell and Joseph Tritschler. 1977. Deficiencias y toxicidades de minerales para bovinos y ovinos en las principales áreas ganaderas del país. Programa Nacional de Nutrición Animal. Informe Anual de 1976. Bogotá, Colombia.

r) Lebdosoekojo, Soekanto. 1977. Mineral supplementation of grazing beef cattle in the Eastern Plains of Colombia. Ph.D. thesis. Gainesville, Florida.

s) Lebdosoekojo, S., C. Ammerman, N. Raun, J. Gómez and R. Littell. 1977. Suplementación mineral del ganado en pastoreo en los llanos orientales de Colombia. ALPA. R-52.

t) Loosli, John K. 1977. Utilización de suplementos de nitrogeno no proteico para rumiantes. Segundo Curso en Nutrición y Alimentación. p. 1-19, Lima, Perú.

u) McDowell, L. R. 1977. Current mineral research in Latin America. Eleventh Annual Conference on Livestock and Poultry in Latin America. p. B-10-25, University of Florida, Gainesville (in English and Spanish).

v) McDowell, Lee R. 1977. Investigaciones minerales en ganado en Latinoamérica. Segundo Curso en Nutrición y Alimentación. p. 1-24, Lima, Perú.

w) McDowell, Lee R., Joe H. Conrad, Jenny E. Thomas, Lorin E. Harris and Karl R. Fick. 1977. Nutritional composition of Latin American forages. Trop. Anim. Prod. 2:273-279.

x) McDowell, L. R., J. A. Froseth, R. C. Piper, I. A. Dyer and G. H. Kroening. 1977. Tissue selenium and serum tocopherol concentrations in selenium-vitamin E deficient pigs fed peas (Pisum sativum). J. Anim. Sci. 45:1326-1333).

y) McDowell, L. R., Carlos E. Lang, J. H. Conrad, Frank S. Martin and Hernán Fonseca. 1977. Mineral status of beef cattle in Guanacaste, Costa Rica. Trop. Agric. 343-350.

z) Mendes, M. O. 1977. Mineral status of beef cattle in northern part of Mato Grosso, Brazil, as indicated by age, season and sampling technique. Ph.D. dissertation, University of Florida, Gainesville.

aa) Molina, E. Orlando and Vicente León V. 1977. Melaza y minerales en la suplementación alimenticia de vaconas. Boletín Técnico No. 19, Santa Catalina, Ecuador.

bb) Murillo Bravo, Olger. 1977. Evaluación del estado de nutrición mineral del ganado bovino en pastoreo en el cantón de Cañas, Guanacaste. Tesis. Facultad de Agronomía, Universidad de Costa Rica, San José.

cc) Palmer, Francis, Luis Fdo. 1977. Evaluación del estado de nutrición mineral del ganado bovino de la Provincia de Cartago. Tesis. Facultad de Agronomía, Universidad de Costa Rica, San José.

dd) Pate, F. M. and J. R. Crockett. 1977. Honduras beef cattle project nutritional evaluation studies summary report-1977. Belle Glade, Florida.

ee) Perdomo, J. T., R. L. Shirley and C. F. Chicco. 1977. Availability of nutrient minerals in the form of tropical forages fed freshly chopped to sheep. J. Anim. Sci. 45:1114-1119.

ff) Perla, Ferdinando, Luis A. Silva, Guillermo Acosta M. and Francisco de Moreno. 1977. Estado de minerales en ganado de abasto de El Salvador. Submitted abstract for 1977 ALPA meetings, Habana. Cuba.

gg) Valdivia, Ricardo, 1977. Effect of dietary aluminum on phosphorus utilization by ruminants. Ph.D. Thesis, Gainesville, Florida.

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4. Abstracts (or summaries) of selected papers submitted for publication or published in 1978 to June 1, 1979. Abstracts dated 1977, but which were not part of the last annual report are also included.

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b) Alpízar López, Francisco Alberto. 1978. Evaluación del estado de nutrición mineral del ganado bovino en pastoreo en el cantón de San Carlos, Alajuela. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia, San José, Costa Rica.

c) Ammerman, C. B., R. Valdivia and P. R. Henry. 1978. Influence of dietary aluminum on growth rate and tissue mineral composition in ruminants. Proc. IV World Conference on Animal Production, P. 96.

d) Campabadal H., Carlos, Manrique Alonso G., Emilio Vargas G., Carlos Jiménez, Hernán Fonseca Z., Ismael Pontigo A. 1978. Contenido de calcio, fósforo y magnesio en el suero sanguíneo y factores que afectan estos minerales en bovinos en pastoreo en La Cruz, Cañas Dulces y Filadelfia, Guanacaste, Costa Rica. Vol. 1:5 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

e) Conrad, J. H., J. C. Sousa, M. O. Mendes and L. R. McDowell. 1978. Trace element interrelationships among soils, plants, and ruminants. III World Conference on Animal Feeding. Madrid, Spain.

f) Conrad, J. H., J. C. Sousa, M. O. Mendes, W. G. Blue and L. R. McDowell. 1978. Fe, Mn, Na and Zn interrelationships in a tropical soil, plant and animal system. IV World Conference on Animal Production. Buenos Aires, Argentina (In Press).

g) Echevarría, Mariano, Ricardo Valdivia, Oswaldo del Valle, K. Santhirasegram, Lilia Campos y Teresa Arbaiza. 1977. Efecto de suplementación de fósforo sobre los niveles séricos y crecimiento de vaquillas en Pucallpa. VI Reunión ALPA, Habana, Cuba.

h) Echevarría, Mariano, Alfredo Riesco, Víctor Morales, Oswaldo del Valle y Mario García. 1977. Los minerales en la alimentación del ganado en el trópico de Pucallpa, Perú. 1977 ALPA proceedings, R-53. Habana, Cuba.

i) Flores, J. A., B. Murillo, M. T. Cabezas y R. Bressani. 1978. Estudio de la composición química y del valor nutritivo del pasto Pangola manejado en forma intensiva en la República de El Salvador. INCAP, República de El Salvador.

j) Flores, J. A., B. Murillo, M. T. Cabezas y Ricardo Bressani. 1978. Diagnóstico del estado de nutrición mineral del ganado de leche y de carne manejado en forma intensiva en la República de El Salvador. INCAP, República de El Salvador.

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y) McDowell, Lee R. and Joe H. Conrad. 1978. Trace mineral nutrition in Latin America. World Animal Review, No. 24:24-33.

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ee) Mendes, M. O., J. H. Conrad, C. B. Ammerman, L. R. McDowell and R. C. Littell. 1978. Mineral liver concentrations in cattle as affected by age, physiological state, and season. XI International Congress of Nutrition. Rio de Janeiro, Brazil.

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Sumario

El presente trabajo de investigación evaluó el estado mineral de los distritos de La Cruz, Cañas Dulces, y Filadelfia de la provincia de Guanacaste.

El material de trabajo de este estudio consistió en muestras de suero sanguíneo, hígado y pasto. Se analizaron en el suero, los minerales calcio, fósforo y magnesio; en el hígado, hierro, cobre, manganeso y zinc; en los pastos, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc.

El nivel promedio del calcio en el suero sanguíneo en los animales de la zona estudiada fue 11.52, no presentándose variación ($P< .05$) entre los diferentes distritos. Tampoco se encontraron variaciones estadísticas en el nivel de fósforo en el suero, cuyo promedio fue de 5.88 mg/100 ml de suero. El nivel de magnesio en el suero fue de 2.92 mg/100 ml de suero.

En relación a los minerales encontrados en el tejido hepático se obtuvo un promedio para el hierro de 313 ppm, para el cobre de 114 ppm, para el manganeso de 6 ppm y para el zinc un promedio de 93 ppm.

En los pastos se obtuvieron promedios de 0.241% para el calcio y de 0.097% para el fósforo, no mostrándose diferencia significativa alguna para los diferentes distritos. El promedio para el magnesio fue de 0.182%, encontrándose diferencias significativas entre las fincas, pero no entre los distritos. Lo mismo se encontró para el potasio con un promedio de 1.89%. El promedio para hierro fue de 194 ppm, para el cobre de 5 ppm, para el manganeso de 39 ppm v para el zinc de 31 ppm. No se obtuvo ninguna variación ($P< .05$) para ninguno de los casos anteriores. El promedio para proteína fue de 3.76%, presentándose diferencias significativas para cantón, distrito, finca, especie y edad de pasto.

Alpízar López, Francisco Alberto. 1978. Evaluación del estado de nutrición mineral del ganado bovino en pastoreo en el cantón de San Carlos, Alajuela. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia, San José, Costa Rica.

Sumario

La presente investigación fue realizada con el fin de determinar el estado nutritivo mineral en los pastos y en la sangre de los bovinos durante la época seca en los distritos de Pital, Aguas Zarcas y Colón de San Carlos, Provincia de Alajuela.

Se utilizaron 16 fincas distribuídas de la siguiente forma: 6 fincas en el distrito de Pital, 5 fincas en el distrito de Aguas Zarcas y 5 fincas en el distrito de Colón.

Las muestras de sangre fueron analizadas para determinar los minerales en calcio, fósforo, magnesio, potasio, hierro, cobre manganeso y zinc. Además se recolectaron muestras de tejido hepático, y se les analizó hierro, cobre, manganeso y zinc.

El trabajo de recolección de muestras se inició en el mes de diciembre de 1976 y se concluyó en mayo de 1977.

Para el análisis estadístico se utilizó un diseño anidado, para cada una de las variables se obtuvieron correlaciones totales, intraclases y entreclases. Además se hicieron correlaciones entre las variables pasto y animal, intraclase y entreclase.

Para determinar la relación entre cada una de las variables en la sangre con las demás variables pasto-animal se realizó un análisis de regresión para obtener el mejor modelo de predicción que explique esta relación. El modelo de predicción se obtuvo por medio del proceso Stepwise y Máxima R^2.

Las concentraciones promedio por cantón para cada uno de los minerales evaluados fueron las siguientes:

	Pasto	Sangre	Hígado
Ca	0.22% MS	8.56 mg/100cc	-
P	0.11% MS	4.38 mg/100cc	-
Mg	0.20% MS	2.41 mg/100cc	-
K	2.86% MS	-	-
Fe	193 ppm	-	165.5 ppm
Cu	8 ppm	-	124.5 ppm
Mn	115 ppm	-	5.5 ppm
Zn	27 ppm	-	95 ppm

En cuanto a los niveles sanguíneos, el calcio resulta deficiente en promedio para el cantón, el fósforo y el magnesio no mostraron problemas de deficiencias.

En los pastos sólo el fósforo se presentó deficiente en las muestras analizadas del cantón.

El calcio en la sangre fue afectado, según el modelo de regresión múltiple de mejor ajuste por el manganeso del pasto, el zinc del pasto, muestra, edad, magnesio del pasto, la proteína, fósforo del pasto, calcio del pasto.

El fósforo de la sangre fue afectado, según el modelo de regresión múltiple de mejor ajuste por la proteína, calcio del pasto, magnesio del pasto y fósforo del pasto.

El magnesio de la sangre se vio afectado por las variables fincas, magnesio del pasto, fósforo del pasto y potasio del pasto.

Ammerman, C. B., R. Valdivia and P. R. Henry. 1978. Influence of dietary aluminum on growth rate and tissue mineral composition in ruminants. Proc. IV World Conference on Animal Production, P. 96.

Abstract

The importance of soil ingestion by grazing cattle and sheep has been emphasized by various researchers in recent years. Aluminum represents a major mineral element of soils and two studies conducted to determine the influence of a relatively soluble form of aluminum (aluminum chloride) on growth rate and tissue mineral composition in cattle and sheep. Twenty-four steers with an average body weight of 226 kg were allocated to four treatments and fed for 84 days. The treatments included 0, 300, 600 and 1,200 ppm supplemental aluminum. Feed consumption, body weight gain, and feed conversion ratios for all treatments averaged 5.85 kg, .87 kg and 6.74, respectively, and were not affected by treatment. Aluminum, iron, manganese, and phosphorus concentrations in liver, and longissimus muscle, were not influenced by treatment. Zinc concentrations in liver were increased ($P<.05$) by dietary aluminum. Twenty wether lambs averaging 36.7 kg live weight were assigned to four treatments in a factorial arrangement, with two levels of phosphorus (.15 and .29 o/o) and two levels of aluminum (0 and 2,000 ppm) in the diet. During a 56-day feeding trial, average daily gains for the four treatments (low P/low Al, high P/low Al, low P/high Al, and high P/high Al) were 109, 117, -39 and 15 g, and average daily dry matter intakes were 1,280, 1320, 780 and 1,080 g, respectively. Both dietary aluminum and phosphorus influenced ($P<.05$) these values. At the end of the feeding trial, plasma phosphorus was lower ($P<.05$) for high aluminum diets and higher ($P<.01$) for high phosphorus diets. The aluminum deposited in liver increased ($P<.05$) with the high aluminum diet, and also tended to increase in the longissimus muscle.

Campabadal H., Carlos, Manrique Alonso G., Emilio Vargas G., Carlos Jiménez, Hernán Fonseca Z., Ismael Pontigo A. 1978. Contenido de calcio, fósforo y magnesio en el suero sanguíneo y factores que afectan estos minerales en bovinos en pastoreo en La Cruz, Cañas Dulces y Filadelfia, Guanacaste, Costa Rica. Vol. 1:5 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

El presente estudio se realizó con el objeto de determinar el contenido mineral en el suero de bovinos en pastoreo en los Distritos de La Cruz, Cañas Dulces y Filadelfia durante la época seca, así como los factores que afectan dicho contenido.

Se analizaron tres minerales (calcio, fósforo y magnesio) en un total de 12 fincas. La toma de muestra se realizó por punción en la vena yugular colectando un total de 15 ml de sangre por animal.

Los resultados presentan valores promedio de calcio en el suero de 11.76, 11.47 y 11.32 mg/100 ml para los Distritos de La Cruz, Cañas Dulces y Filadelfia respectivamente. El contenido de fósforo fue de 6.18 mg/100 ml para el Distrito de la Cruz, 6.24 para Filadelfia y 5.22 para Cañas Dulces. Mientras que el promedio de magnesio en el suero fue de 3.05, 2.32 y 3.38 mg/100 ml para La Cruz, Cañas Dulces y Filadelfia respectivamente.

El análisis de Step Wise dio el siguiente modelo para los factores que afectan el nivel de calcio en el suero: CaS = 10.60 + 0.14 (finca) 0.123 (proteína en pastos) + 0.38 (potasio en pastos) + 0.011 (manganeso en pastos). El modelo para el fósforo fue: PS = 5.328 = 0.331 (finca) 0.942 (distrito) + 0.36 (potasio en pastos) + 0.014 (zinc en pastos). El modelo para el magnesio fue de: MgS = 2.298 + 0.055 (cantón) - 0.184 (finca) - 0.006 (manganeso en pastos) + 0.008 (zinc en pastos) + 0.243 (especie).

Conrad, J. H., J. C. Sousa, M. O. Mendes and L. R. McDowell. 1978. Trace element interrelationships among soils, plants, and ruminants. III World Conference on Animal Feeding. Madrid, Spain.

Abstract

Copper (Cu), molybdenum (Mo) and cobalt (Co) levels were determined in 312 soil, 312 forage and 37 liver samples collected from six ranches in northern Mato Grosso, Brazil, to study these mineral relationships in a tropical soil, plant and animal system and to determine the mineral status of grazing beef cattle. Low Co and Cu levels were widespread and high forage Mo levels were found on one ranch. Forage Cu was negatively correlated with soil Cu (r=-.12). Liver and forage Cu were not correlated. Liver Mo was correlated with forage Mo (r=.67). Forage Mo was correlated with several soil factors but not soil Mo. Forage and soil Co were correlated (r=.56). These and other interesting correlations reaffirm the complex Co, Cu and Mo interrelationships within the soil-plant-animal system.

Conrad, J. H., J. C. Sousa, M. O. Mendes, W. G. Blue and L. R. McDowell. 1978. Fe, Mn, Na and Zn interrelationships in a tropical soil, plant and animal system. IV World Conference on Animal Production. Buenos Aires, Argentina (In Press).

Abstract

Iron (Fe), manganese (Mn), sodium (Na) and zinc (Zn) levels were determined in 312 soil, 356 forage and 492 liver samples collected from six ranches in northern Mato Grosso, Brazil, to study these mineral relationships in a tropical soil, plant and animal system, to determine the mineral status of grazing beef cattle, to compare mineral levels during the wet and dry seasons and to determine the best type of cattle to sample. Significant differences for forage Na were found among ranches, between ranch and season and among grass species. Forage Na means ranged from 84 to 194 ppm and would supply only 14 to 32% of the Na requirement. Significant forage Fe differences were found among ranches and among grass species. Forage Fe means were high 553 and 487 ppm for native grass and molasses grass, respectively. Liver Fe means ranged from 311 to 430 ppm. Significant liver Fe differences were found among rnaches, between seasons and an interaction between type of animal and season. Forage Mn means ranged from 83 to 233 ppm but liver Mn means were deficient and ranged from 5 to 8 ppm. Significant liver Mn differences were found among ranches, between seasons and an interaction between ranch and season. Forage Zn did not vary significantly among ranches, between season nor among species. Liver Zn means varied significantly between wet season (68 ppm) and dry season (113 ppm). Soil, forage and liver were Zn deficient. These data indicate that correlations among soil, plant and liver are low or nonexistent for the minerals studied and that liver samples collected from the most productive animals toward the end of the wet season are best for determining the mineral status of grazing cattle.

Echevarría, Mariano, Ricardo Valdivia, Oswaldo del Valle, K. Santhirasegra, Lilia Campos y Teresa Arbaiza. 1977. Efecto de suplementación de fósforo sobre los niveles séricos y crecimiento de vaquillas en Pucallpa. VI Reunión ALPA, Habana, Cuba.

Sumario

Con la finalidad de determinar el efecto de la fertilización y/o suplementación fosforada sobre los niveles séricos de fósforo inorgánico y crecimiento de vaquillas Nellore de 8-9 meses de edad recién destetadas, mantenidas en pasto nativo mientras estuvieron con sus madres, se empleó un diseño de bloques al azar con dos repeticiones y tres animales por tratamiento. Los niveles séricos de fósforo inorgánico y los pesos vivos fueron al destete 7.0 ± 1.0 mg/100 ml, 151.3 ± 19.8 kg., descendiendo de dos meses en que se mantuvo a las terneras sobre pasto nativo, a 4.8 ± 1.1 mg/100 ml y 141.7 ± 20.1 kg. respectivamente. Para el período experimental se empleó la asociación Yaragua (Hyparrehenia rufa) Kudzu (Pueraria phaseoloides) en los siguientes tratamientos: A.- Control, pastura sin fercilizar, B.- Pastura fertilizada: 100 kg. super fosfato simple/ha/año, C.- Pastura fertilizada: 500 kg. super fosfato simple/ha/año, D.- Pastura no fertilizada y como suplemento mineral fosfato dicálcico, E.- Pastura fertilizada: 100 kg de superfosfato simple y como suplemento mineral fosfato dicálcico. Los niveles de fósforo sérico no fueron afectados por ninguno de los tratamientos durante la época seca, pero si por el último durante la época lluviosa. Las ganancias diarias de peso fueron 0.19, 0.28, 0.18, 0.38, 0.45 y 0.14, 0.14, 0.15, 0.43 y 0.46 kg. para las épocas secas y lluviosas. Los diagnósticos de preñez positivos tres meses después del empadre fueron 1. 1. 1. 5 y 6.

Echevarría, Mariano, Alfredo Riesco, Victor Morales, Oswaldo del Valle y Mario García. 1977. Los minerales en la alimentación del ganado en el trópico de Pucallpa, Perú. 1977 ALPA proceedings, R-53. Havana, Cuba.

Sumario

En la selva Peruana existen zonas cuyas pasturas contienen bajos niveles de fósforo, cobre y cobalto. La suplementación directa de fósforo produjo ganancias de peso (0.59 kg/día/animal) superiores que las obtenidas en el lote control (0.27 kg/día/animal) usando gramíneas nativas o naturalizadas. Por otro lado la suplementación fosforada produjo mayores ganancias que la fertilización fosforada con 100 kg/ha cuando se pastoreaba pasturas asociadas (yaragua Hyparrhenia rufa y kudzú Pueraria phaseoloides) y que la fertilización afecta positivamente la ganancia de peso sólo en los primeros 6 meses. Al introducirse la leguminosa "Stylo" Stylosanthes guyanensis fertilizada con 100 kg/ha a una pastura con sólo gramíneas, la suplementación fosforada disminuyó o prácticamente desaparecieron los efectos positivos sobre la ganancia de peso indicando que la deficiencia de proteína y de fósforo que limitan la producción animal en Pucallpa pueden salvarse introduciendo una leguminosa y/o suplementando fósforo; igualmente la suplementación fosforada aumenta la tasa de natalidad y permite obtener mejores pesos al destete de terneros. El suministro de cobre y/o cobalto produjo ganancias de peso similares al lote control cuando se pastoreo gramíneas nativas o naturalizadas.

Flores, J. A., B. Murillo, M. T. Cabezas y R. Bressani. 1978. Estudio de la composición química y del valor nutritivo del pasto Pangola manejado en forma intensiva en la República de El Salvador. INCAP, República de El Salvador.

Sumario

El presente estudio se llevó a cabo en una finca de ganado bovino dedicada a la producción intensiva de carne y leche, situada en Sonsonate, El Salvador. Su finalidad fue establecer los cambios en composición química y digestibilidad in vitro que ocurren en el pasto pangola en potreros manejados de acuerdo a un sistema de rotación de ganado de 18 días, abonados con urea a razón de 20 qq por manzana, por año.

Así, en los meses de junio, septiembre y noviembre de 1976, se obtuvieron muestras de pasto provenientes de suelos húmedos (H), semi-húmedos (SH) y secos (S). En cada oportunidad se tomaron de cada potrero 2 muestras de 1 kg las que fueron deshidratadas a 60°C, molidas y analizadas para establecer su contenido de paredes celulares (PC), fibra ácido detergente (FAD), hemicelulosa (HC), celulosa (C) y lignina (L), así como el grado de digestibilidad in vitro de la materia seca (DIVMS). En primer lugar, se encontró que la época del año tuvo efecto sólo sobre el contenido de PC y HC, disminuyendo la primera fracción de 67.5% en junio a 64.7% en noviembre, y la segunda de 26.4% en junio a 23.9% en noviembre. En cuanto a la digestiblidad in vitro, se observó una tendencia no significativa a disminuir a medida que la época lluviosa avanzaba (54.4% en junio, 53.6% en septiembre y 52.2% en noviembre). El tipo de suelo no ejerció efecto alguno sobre la composición química ni sobre la digestibilidad in vitro, promediando las muestras 65.9% de PC, 40.7% de FAD, 25.2% de HC, 30.9% de C, 6.1% de L y 53.5% de DIVMS. Al analizar todos los valores encontrados se establecieron correlaciones altamente significativas ($P<.01$) entre PC/DIVMS y FAD/DIVMS, y a un nivel más bajo de significancia ($P<.05$), entre L/DIVMS y HC/DIVMS, pudiendo estimarse la DIVMS

(Y) del pasto bajo estudio mediante cualquiera de las siguientes ecuaciones: Y=102.0-0.73 (% de PC); Y=132.9-1.94 (% de FAD).

Flores, J. A., B. Murillo, M. T. Cabezas y Ricardo Bressani. 1978. Diagnóstico del estado de nutrición mineral del ganado de leche y de carne manejado en forma intensiva en la República de El Salvador. INCAP, República de El Salvador.

Sumario

Con la finalidad de establecer el efecto de sistemas intensivos de manejo de pastos y animales sobre el estado de nutrición mineral y la productividad del ganado bovino de una finca del departamento de Sonsonate, El Salvador, se llevaron a cabo muestreos seriados de sangre y pasto que coincidieron con los dos cambios climatológicos básicos de la zona verano (V) e invierno (I). Para el efecto, la población animal sometida a muestreo para la obtención de sangre fue dividida en 2 grupos: ganado de leche (L), raza Holstein y ganado de carne (C), raza Brahman. A su vez, el grupo L se dividió en 3 subgrupos: de alta (A), mediana (M), y baja (B) producción láctea. La sangre fue obtenida por punción yugular, analizándose su contenido de hemoglobina (Hb) y fósforo (P). Las muestras de pasto (pangola o estrella) provenían de potreros destinados a la crianza de ganado de leche o de carne, sembrados en suelos húmedos (H), semi-húmedos (SH) o secos (S), manejados bajo un sistema de rotación de 18 días y fertilizados con urea a razón de 20 qq por manzana por año. En cada potrero se recolectaron 2 muestras de pasto de 1 kg cada una, las cuales fueron deshidratadas, incineradas y analizadas para determinar su contenido de P, Na y K. Los análisis de Hb permitieron detectar incidencias de 25% de anemias en el hato en los meses de verano, y de 40% en los de invierno, encontrándose niveles de Hb más bajos en el ganado de leche (10.7 g%) que en el de carne (11.5 g%). Los niveles de P sanguíneo disminuyeron de 6.1 mg% en V, a 5.6 mg% en I, guardando una relación directa con el nivel de producción de leche (A: 6.44-5.52, M: 5.88-5.37, y B: 5.31-4.98 mg%). En los pastos se encontró que el nivel promedio de P era sumamente bajo (305.5 mg de P/100 g de MS), siendo más crítico en el caso de los potreros destinados al ganado de carne (263.4 mg de P/100 g de MS) que al lechero (349.5 mg de

P/100 g de MS). No se encontraron diferencias en el contenido de P entre las épocas de muestreo, pero sí entre los tipos de suelo (H: 309.21; SH: 332.07 y S: 343.10 mg de P/100 g de MS). En cuanto a Na, se encontró una diferencia muy marcada entre los potreros del ganado lechero (372.05 mg/100 g de MS) y los de carne (9,103.83 mg/100 g de MS), y lo mismo ocurrió entre los tipos de suelo (H: 263.8; SH: 234.5 y S: 445.43 mg/100 g de MS) pero no así entre las épocas de muestreo. En lo referente a K, se encontraron diferencias entre la época del año (V, 2.59 é I, 2.18 g/100 g de MS), utilización de los potreros (L, 2.45 y C, 2.10 g/100 g de MS) y del tipo de suelo (H, 2.21; SH, 2.34 y S, 2.56 g/100 g de MS). En estos momentos se está analizando un mayor número de elementos minerales (Ca, Mg, Mn, Co, Cu, Zn y Mo) con la finalidad de dilucidar el efecto de los diferentes factores bajo estudio sobre la concentración de dichos elementos en sangre y pastos. En base a los resultados que se obtengan se podrán establecer sistemas más racionales de suplementación del ganado bovino en fincas con sistema intensivo de producción de carne y leche que se encuent en en zonas similares a la estudiada.

Flores, J. A., B. Murillo, M. T. Cabezas y R. Bressani. 1978. Diagnóstico del estado de nutrición mineral del ganado de leche y de carne manejado en forma intensiva en la República de El Salvador. INCAP, República de El Salvador.

Sumario

Bajo el mismo titular se presentó en el Informe Anual de INCAP-1976, un avance de los resultados obtenidos en este proyecto hasta el mes de diciembre del mismo año. El objetivo de este resumen es el de complementar dicha información con los resultados de los análisis de Mg y Cu plasmático y la integración de los datos bioquímicos con los de productividad de la finca bajo estudio.

Se encontró en primer lugar, que los niveles de Mg en el plasma promediaron 32.6 ug/ml no habiéndose detectado diferencias ni entre hatos (de leche, L y de carne, C) ni entre épocas del año (invierno, I; verano, V). El contenido plasmático de Cu para los dos hatos fue estadísticamente mayor en I (0.95 ug/ml) que en V(0.80 ug/ml), encontrándose diferencias entre hatos ($P<.05$) sólo en V. Este último fenómeno se reflejó aún más al establecer las incidencias de hipocupremia, la cual fue del orden del 60.0% para L y 19.8% para C en V; mientras que en I fueron de 3.2 y 14.3% para los mismos hatos, respectivamente.

Las incidencias de anemias e hipofosfatemia encontradas en L que fueron presentadas en el informe de 1976, se analizaron en función de la productividad del hato, y se comprobó que ambos fenómenos son factores que influyen negativamente en la producción láctea y la fertilidad. El aumento de la deficiencia de P, así como la mayor incidencia de anemias en los meses de agosto-octubre, coincidieron con una reducción promedio de 1 litro de leche por vaca por día y una disminución de la tasa de fecundidad de 20 unidades porcentuales durante esos meses. Con respecto al Cu, se pudo comprobar que

la falta de suplementación de este elemento por medio del concentrado en los meses de febrero a mayo de 1977, produjo una reducción de la tasa de fecundiada al primer servicio a valores que oscilaron entre 15.0 y 21.0% en comparación a los mismos meses del año 1976 en que fue de 60.0% bajo un sistema regular y constante de suplementación.

Se demostró mediante los resultados obtenidos en el presente trabajo que, bajo sistemas intensivos de producción de leche, en condiciones similares a las existentes en la finca bajo estudio, se pueden presentar en el ganado deficiencias de P y Cu, con una mayor incidencia de las mismas en I y V, respectivamente.

Flores, J. R., J. A. Flores, M. T. Cabezas y R. Bressani. 1978. Estado de Nutrición mineral del ganado de carne de tres fincas de los departamentos de Retalhuleu y Suchitepeque en la costa del Pacífico de Guatemala. Facultad de Medicina Veterinaria y Zootecnia, Universidad de San Carlos de Guatemala.

Sumario

El presente trabajo se está llevando a cabo en 3 fincas dedicadas a la producción de carne (F1, F2 y F3) de la costa de los departamentos de Retalhuleu y Suchitepeque y tiene como objetivos principales los siguientes: a) Establecer el grado de adecuación mineral del ganado bovino de la zona en estudio, b) Determinar el efecto de la estación climática, invierno y verano, sobre dicho estado nutricional y c) Proporcionar las bases científicas para una adecuada y sistemática suplementación mineral acorde a la situación existente en la zona.

Para el efecto en las tres fincas se tomaron un total de 81 muestras de sangre, 14 de hígado y 20 de leche de un mínimo representativo de los animales existentes en cada una de ellas en función de la edad y fase productiva. También se colectó 22 muestras de pasto y 11 de suelo de los potreros utilizados en la alimentación de los mismos. En las muestras de sangre se está determinando su contenido de Ca, P y Mg; en hígado Cu, Co, Mo, Fe, Zn y Mn; en leche, I y en pastos Ca, P, Mg, Na, K, Fe, Mn, Cu, Zn, Co y Mo. En las muestras de suelo se está determinando pH, las características granulométricas y el contenido de materia orgánica, Co y Mo. El P y I se analizan los métodos colorimétricos y el resto de elementos por espectrofotometría de absorción atómica.

La información presentada en esta oportunidad pertenece al muestreo de la época de invierno llevado a cabo en el mes de agosto de 1977, la misma que será complementada con un segundo muestreo durante la época de verano (febrero de 1978). Hasta el momento se han completado los análisis de P en suero y de la concentración de Ca, P, Mg, Na, K, Fe, Mn, Cu y Zn en la

materia seca de los pastos.

Los contenidos promedio de P sérico fueron de 60.6, 60.2 y 63.3 µg/ml. Para F1, F2 y F3, respectivamente. Se encontró que F3 fue diferente (P<.05) de F1 y F2 y que éstas dos últimas fueron similares entre sí. Se detectó también, que existía un efecto de edad independiente del factor finca, encontrándose que el promedio para los animales jóvenes (70.5 µg/ml) fue estadísticamente mayor (P<.05) que el encontrado en animales adultos (57.5 µg/ml).

Con respecto al contenido de Ca, P, Mg, Na, K, Fe y Cu en la materia seca de los pastos, no se encontraron diferencias estadísticas entre fincas, siendo los promedios de 2.82, 3.10 y 3.34g para Ca; 1.55, 1.13 y 1.85 g para P; 1.76, 2.00 y 2.17 g para Mg; 0.10, 0.52 y 0.92 g para Na; 12.96, 13.78 y 16.58 para K; 197.1, 188.4 y 199.4 mg para Fe y 3.3, 4.2 y 6.4 mg para Cu por kg de materia seca en F1, F2 y F3 respectivamente. El contenido de Mn fue estadísticamente mayor (P<.01) en los pastos de F1 (51.4 mg/kg) que en los de F2 (36.9 mg/kg) y F3 (21.7 mg/kg) y éstos dos últimos fueron diferentes a un nivel de significancia de P<.05. Con respecto al Zn, F1 (23.4 mg/kg) y F2 (21.4 mg/kg) fueron similares entre sí pero diferentes de F3 (38.2 mg/kg). Se detectó que en F1 el 100.0% de los pastos tenían contenidos de Mg, Na, Cu, y Zn por debajo de los niveles mínimos requeridos para llenar las necesidades nutricionales de los animales que los consumían y que el 75.0% de los mismos eran insuficientes en Ca y P. En F2 y F3 la totalidad de los pastos eran deficientes en P, Cu y Zn mientras que de los pastos en F1 el 50% presentaba contenidos sub-normales de Ca, Mg y Mn, y el 75.0% de Na.

Actualmente están completando los análisis de las muestras de sangre, hígado, leche y forraje (Mo y Co) a fin de establecer un cuadro completo de la situación en la zona representada por las tres fincas de este estudio.

Flores, J. A., M. T. Cabezas y R. Bressani. 1978. Ensayo Preliminar para la detección de deficiencias minerales en el ganado bovino manejado en forma extensiva en la Costa del Pacífico de Guatemala. INCAP, Guatemala, Guatemala.

Sumario

Con la finalidad de planificar estudios posteriores de tipo crítico en lo referente al estado de adecuación mineral del ganado bovino de la costa del Pacífico de Guatemala, se llevó a cabo el presente ensayo, que consistió en realizar al final de la época lluviosa (noviembre de 1976) un muestreo en 2 fincas de ganado de carne, con características ambientales y de explotación similares, del departamento de Retalhuleu. En cada finca se tomaron muestras de sangre de un número representativo de los animales existentes de acuero a su fase productiva, y de pasto Estrella de los potreros destinados a la alimentación de los mismos. Se separó el suero por centrifugación y se analizó su contenido de P, Mg y Cu. Los pastos por su parte, fueron deshidratados a 60°C, molidos e incinerados a 500°C por 8 horas, determinándose la concentración de Ca, P, Mg, Na, K, Fe, Mn, Cu y Zn de la materia seca.

Los niveles séricos promedio de P, Mg y Cu fueron de 33.8, 28.8, y 0.81 µg/ml, respectivamente, no habiéndose encontrado diferencias entre fincas. Se detectó que los animales provenientes del hato de engorde en cada finca, presentaban las concentraciones séricas más bajas de Cu (0.71 y 0.66 µg/ml). Estos niveles se consideraron como indicativos de la presencia de deficiencias de este elemento. Los análisis de pastos tampoco detectaron diferencias en composición entre fincas, siendo los promedios para ambas de: 2.2 g de P, 2.9 g de Ca, 1.5 g de Mg, 1.4 g de Na y 16.3 g de K por kg de materia seca, así como de 195.6, 44.8, 5.8 y 22.7 mg por kg de materia seca de Fe, Mn, Cu, y Zn, respectivamente.

Fue interesante encontrar que el uso a libertad de una mezcla de 10 partes de harina de hueso y 90 partes de sal común fue suficiente para contrarrestar los bajos niveles de P y Mg en los pastos, en vista de que las concentraciones séricas de estos elementos se mantuvieron dentro de los márgenes considerados como normales. Sin embargo no existieron fuentes suplementarias de Cu, por lo que se encontraron niveles ligeramente bajos de Cu en el suero de todos los animales. Con respecto al Zn y al Mn, se impone la necesidad de estudiar las concentraciones de estos elementos en el tejido hepático, a fin de descartar o certificar la presencia de deficiencias de éstos en el ganado, dado los niveles marginales encontrados en la materia seca de los pastos.

Flores, J. A., G. Cruz-Gomar, M. T. Cabezas y R. Bressani. 1978. Contenido de minerales en pastos naturales de los departamentos de Huehuetenango y San Marcos. I. Calcio, fósforo, magnesio, sodio y potasio. INCAP, Guatemala, Guatemala.

Sumario

En el altiplano occidental de Guatemala los Departamentos de Huehuetanango y San Marcos son los que albergan la mayor parte de la población ovina del país. Las explotaciones son del tipo familiar y la alimentación de los rebaños es casi exclusivamente a base de pastos naturales que crecen en la zona.

El objetivo básico del presente trabajo fue de analizar el contenido de Ca, P, Mg, Na y K de la materia seca de dichos pastos y establecer el grado en el cual ellos cubren los requerimientos de los animales que los consumen. Para el efecto, se seleccionaron dentro de cada departamento 4 localidades y al final de la época seca (abril) se colectaron 5 muestras de pastos representativas de cada una de ellas. Los pastos fueron cortados a una altura de 0.5 cm del suelo, depositados en bolsas de tela y transportados al laboratorio. Se deshidrataron a 60°C, se molieron e incineraron a 500°C por 8 horas. En la solución de cenizas se determinó P por métodos colorimétricos y Ca, Mg, Na y K por espectrofotometría de absorción atómica.

Se encontró que en promedio las 40 muestras analizadas variaron entre 1.08 y 8.96 g de Ca; 0.32 y 4.91 g de P; 0.33 y 0.20 g de Mg; 0.08 y 1.30 g de Na y entre 1.94 y 30.42 g de K por Kg de materia seca. Se detectó que solo el 25.0% de los pastos analizados presentaban concentraciones de Ca en la materia seca, por encima de los niveles mínimos necesarios para llenar los requerimientos diarios de este elemento en los animales; y que, el 12.5, 65.0, 45.0 y 75.0% de los mismos cumplían esta condición en lo referente a P, Mg, Na y K, respectivamente. Asímismo, se estableció que las zonas de

insuficiencia en Ca y P se extendieron en ambos departamentos a excepción de las localidades de San Nicolás en Huehuetenango y Venecia en San Marcos. La falta de Na también estaba generalizada pero en un menor grado; mientras que la insuficiencia de Mg sólo se encontró en los pastos de la localidad de Chichim, Huehuetenango y las de K en Serchil, San Marcos.

Flores, J. A., G. Cruz-Gomar, M. T. Cabezas y R. Bressani. 1978. Contenido de minerales en pastos naturales de los departamentos de Huehuetenango y San Marcos. II Hierro, manganeso, cobre y zinc. INCAP, Guatemala, Guatemala.

Sumario

En las 40 muestras de pasto provenientes de las 8 localidades de los departamentos de Huehetenango y San Marcos se completó el análisis de elementos minerales, determinándose por espectrofotometría de absorción atómica el contenido de Fe, Mn, Cu y Zn de la materia seca de las mismas.

La información resultante permitió establecer que la concentración de Fe varió entre 107.3 y 4703.4 mg por Kg de materia seca y que, como resultado, la totalidad de las muestras cubría suficientemente el requerimeinto diario de este elemento, que en función del total de la ración es del orden de 45.0 mg de Fe/Kg. Por su parte el contenido de Mn tuvo un rango que osciló entre 16.2 y 433.1 mg/kg, habiéndose encontrado que solo los pastos de la localidad de Chiaval en Huehuetenango presentaban concentraciones por debajo del nivel crítico de 30.0 mg de Mn por kg de materia seca. Con respecto al Cu, solo el 30.0% de las muestras analizadas tenían contenidos mayores a los 5.0 mg/kg las mismas que en su mayoría pertenecían a las localidades de San Nicolás y Venecia en Huehuetenango y San Marcos, respectivamente. Las demás zonas presentaron valores promedios que oscilaron entre 3.8 y 2.8 mg de Cu por kg de materia seca, considerados éstos como predisponentes de severas deficiencias de este elemento en los animales que los consumen. Finalmente se detectó que la totalidad de los pastos de las 8 localidades bajo estudio contenían cantidades críticamente insuficientes de Zn, de 2.8 a 28.4 mg por kg de materia seca, en comparación con el mínimo requerido de 45.0 mg de Zn/kg.

Se concluye de los datos presentados que en las zonas en estudio existen severas deficiencias potenciales de Ca, P, Cu y Zn, una generalizada pero menos crítica insuficiencia de Na y problemas carenciales muy localizados de Mg y K.

Nuevos estudios, los mismos que incluyan el análisis de estos elementos en tejidos animales, y las variaciones que en su concentración pueden suceder en función de los cambios estaciones, son necesarios para establecer un diagnóstico completo del problema en dicha zona.

Gil, Arturo, Lucía Pabón y Patricia Jiménez. 1977. Molibdenosis en Colombia. Procedimientos VI Reunión ALPA. Habana, Cuba.

Sumario

Muchos suelos seleníferos contienen altas concentraciones de molibdeno (Mo), el cual interactúa con el cobre (Cu) impidiendo su utilización metabólica. Se detectó en biopsias hepáticas que los animales de una zona selenífera presentan una marcada deficiencia en Cu. Para averiguar si fuera primaria, por carencia de Cu o secundaria por molibdenosis, se analizaron Se y Mo por activación neutrónica en forrajes y se determinaron ceruloplasmina y la cinética de depuración sanguínea del ^{64}Cu inyectado en animales aparentemente sanos y enfermos. El ^{64}Cu se obtuvo por irradiación de $Cu\ So_4$. El valor promedio para tres fincas de la zona y tres tipos de forraje por finca, fue para Mo de 20.5 ppm, lo cual es tóxico y para Se de 5.05 ppm, límite inferior de toxicidad. Los valores de las absorbancias para ceruloplasmina difirieron ($P<,01$) entre los 10 animales enfermos (0.20) y 15 sanos (0.32). Mediante la depuración de ^{64}Cu pudieron distinguirse cuatro estados nutricionales para el Cu: 1) normal, medido en 4 animales saludables suplementados permanentemente con minerales, se caracterizó por un descenso entre 100% de la dosis inyectada (DI) a un nivel de estabilización del 10% DI, en 2 horas. 2) Deficiencia subclínica primaria; medida en 4 animales sin suplementar, descenso entre 100% DI y estabilización en 10% DI, a la hora y media. 3) Deficiencia subclínica secundaria; medida en 11 animales de la zona en estudio, descenso entre 100% DI y estabilización en 15-30% DI, en 3 horas y 4) Deficiencia clínica secundaria; medida en 3 animales de la zona en estudio, descenso entre 100% DI y estabilización en 60-70% DI, después de 3 horas.

Gil, Arturo y Gonzalo Guzmán. 1977. Tratamiento de la selenosis en el bovino. Procedimientos VI Reunión ALPA. Habana, Cuba.

Sumario

En Colombia existen regiones en que el contenido de selenio (Se) en el suelo, agua, y plantas es ta que causa síntomas de intoxicación crónica en los ganados. Se ha reportado que el arsénico (As) puede contrarrestar la intoxicación por Se en ratas y cerdos. Además con base en nuestras observaciones sobre la marcada deficiencia de cobre (Cu), en animales de esta zona, y el hecho también reportado de que el Se reemplaza el azufre (S) de los aminoácidos azufrados, se ensayó una mezcla mineral que contuviera As y exceso de Cu y S. Se suplementaron dos grupos de cuatro animales, el primero con sal mineralizada comercial (50% sal + 50% premezcla mineral). El segundo con la misma sal, adicionada de 0.8 kg de sulfato de Cu, 16 kg de azufre en flor y 130 g de ácido arsenílico, por cada 60 kg de sal. De estas mezclas los animales consumieron en promedio 30 g por día. Los valores de Cu en biopsias hepáticas decrecieron a pesar de la suplementación con sal comercial, lo que permite inferir que ésta contiene Cu en cantidad insuficiente para esta región. Los valores de Cu para los animales suplementados con As, Cu y S, indican una acumulación o recuperación hacia la normalidad. La respuesta promedio en el aumento de peso individual en 7 meses, fue de 36.2 kg para el grupo con sal mineralizada comercial, mientras que para el grupo con As, Cu y S fue de 82.2 kg.

Gil, Arturo, Lee McDowell y Joseph Tritschler. 1977. Minerales para bovinos en Colombia. 1977 ALPA proceedings, R-74. Havana, Cuba.

Sumario

Se realizaron dos tipos de experimentos: 1) Progreso de las insuficiencias o toxidades que experimentan los animales en pastoreo en algunas regiones determinadas. Con este fin se seleccionaron 7 granjas experimentales del ICA y 6 fincas particulares y unos 8 a 10 animales por localidad. Cada tres meses durante un año se tomaron de cada animal biopsias de hígado, sangre y forraje. 2) En 14 mataderos de pueblos, en diferentes zonas, se tomaron cada 2 meses y analizaron; un pedazo de hígado, sangre y un pedazo de hueso de animales sacrificados. Las muestras de los mataderos no revelaron deficiencias marcadas para ningún elemento. Esto puede deberse a que los animales usualmente sacrificados, son adultos o vacas viejas que han superado su período crítico (crecimiento y preñez) y han tenido tiempo para equilibrarse, o han sido suplementados y bien alimentados (cebados) antes del sacrificio. Sin embargo, los experimentos revelaron que la deficiencia de cobre es la más extendida. Los niveles fueron muy bajos en los experimentos de Puerto Boyacá, Motilonia y Obonuco. En Caribia, El Nus, Palmira, Turipaná, Coloso, San José del Nus y Caucaca la deficiencia parece evidente pero es menos grave. En Tibaitatá, Subachoque y en Coyaima la deficiencia de Cu parece presentarse durante el período lluvioso solamente. El zinc parece deficitario en unas pocas regiones. Los macroelementos, contrario a lo aceptado tradicionalmente, parecen estar presentes en forrajes y sangre en cantidades adecuadas para el lento crecimiento propio de las condiciones de las ganaderías estudiadas. Una notable excepción es el P en la región de los Llanos Orientales.

Jiménez C., Carlos, Carlos Campabadal H., Manrique Alonso G., Hernán Fonseca Z., Emilio Vargas G., Ismael Pontigo A. 1978. Composición mineral de los forrajes y su interrelación con los requerimientos del ganado vacuno en los distritos de Cañas Dulces, La Cruz y Filadelfia. Vol. 1:37 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

La presente investigación tuvo por objetivo la evaluación del contenido mineral en pastos (Hyparrhenia rufa, Cynodon nlemfuensis y Panicum maximum) de los distritos de Cañas Dulces, La Cruz y Filadelfia, Guanacaste, durante la época seca de 1977. Se analizaron un total de 60 muestras de forraje provenientes de 12 fincas. Las muestras fueron colectadas al azar en los potreros cortándose alrededor de 500 gm a una altura de 15 cm sobre el suelo.

Los minerales analizados para cada muestra fueron: nitrógeno, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc.

Los valores de nitrógeno observados y expresados como proteína cruda (NX 6.25), fueron bajos, con un promedio para los distritos de 3.76%. Considerando la distribución de las muestras un 95% de ellas no satisfacen el requisito mínimo de 7% establecido como crítico para la flora microbiana en el rumen. Además se puede observar que el valor promedio obtenido en la zona cubre solamente un 54% de las necesidades, lo que implica la necesidad de suplementar este elemento en esta época.

Los valores promedios de P, Ca, Mg, K, Fe, Cu, Mn y Zn encontrados fueron de 0.097%, 0.241%, 0.182%, 1.89%, 194 ppm, 5 ppm, 39 ppm y 31 ppm respectivamente. De estos valores solamente los de fósforo y cobre no cumplen adecuadamente el requerimiento mínimo para estos elementos establecidos por el N.R.C., lo cual establece la necesidad de suplementar fósforo y cobre a los animales en pastoreo de la zona.

Kiatoko, M. L. R. McDowell, K. R. Fick, H. Fonseca, J. Camacho, J. K. Loosli and J. H. Conrad. 1978. Mineral Status of Cattle in the San Carlos region of Costa Rica. J. Dairy Sci. Vol. 61, No. 3:324-330.

Abstract

Two experiments on 12 beef and 9 dairy cattle farms were to determine the mineral status of grazing cattle in the San Carlos region of Costa Rica by evaluating concentrations of minerals in liver, plasma, bone ash, forages, and oxalate contents of forages.

Copper (<75 ppm) and cobalt (<.07 ppm) in liver, and phosphorus (<4.5 mg/100 ml) and magnesium (<1.8 mg/100 ml) of plasma were borderline to deficient on 1, 3, 12 and 5 beef cattle farms, respectively. Of livers, 23% and 27% were borderline to deficient in copper and cobalt. Iron (<180 ppm), zinc (<84 ppm) and manganese (<6 ppm) in liver were lower than normal for 63, 16, and 44%, respectively, of the animals.

In dairy cattle, 10 samples of blood and 1 to 2 of forage were collected on each of 5 farms with and 4 farms without the forage Setaria sphacelata. Calcium (.29%) and phosphorus (.18%) concentrations in forage were low in relation to requirements of lactating diary cows. Phosphorus in plasma was deficient (<4.5 mg/100 ml) on all farms. Oxalate percentages were higher in Setaria pastures (2.30%) than in other pastures (1.24%). Low calcium and phosphorus in forage and high oxalate in Setaria pastures may be responsible for the high incidence of a milk fever-like condition in dairy cattle.

Kiatoko, M., L. R. McDowell, J. E. Bertrand, H. L. Chapman, F. M. Pate and J. H. Conrad. 1979. Co, Mn, Zn, Se, vitamin A and carotene interrelationships between forage and animal tissues. 71st Annual Meeting of the American Society of Animal Science. Tuscon, Arizona.

Abstract

An experiment was conducted to determine the mineral status of grazing beef cattle from 9 ranches within 4 different regions of Florida, on the basis of mineral and vitamin concentrations in animal tissues and forages. From each ranch liver, blood, hair and feces were collected from 14 heifers (18-24 months) and 14 cows (3-8 years) twice during the year. Significant mineral and vitamin concentration differences among ranches, seasons and classes of animals were noted. Plasma Se and vitamin E, liver Mn and vitamin A, forage carotene, hair Zn and Mn, and feces Co and Se were lower ($P < .05$) during the dry season. Feces Co was higher ($P < .05$) in cows than in heifers while liver vitamin A was lower ($P < .05$) in cows. Liver Co (> 0.05 ppm) and vitamin A (> 23 ppm), and plasma Zn (> 0.04 mg%) were normal in all ranches and all animals during both seasons. Mean liver Se was low (< 0.25 ppm) in 4 ranches during the wet season and 2 ranches during the dry season. Of the total animals studied, 32% during the dry season and 51% during the wet season had low liver Se (< 0.25 ppm). Mean forage Se was low in 1 region (< 0.05 ppm) during both the dry and wet season, while 6 and 4 ranches had low forage Se during the wet and dry seasons, respectively. Mean liver Mn was adequate in all ranches (> 6.0 ppm) during the two seasons while mean forage Mn was low (< 20 ppm) in 2 ranches and 1 region during the wet season. Of the total animals studied, only 3% during the dry season and 9% during the wet season had low liver Mn (< 6.0 ppm) concentrations.

Kiatoko, M., L. R. McDowell, J. E. Bertrand, H. L. Chapman, F. M. Pate and J. H. Conrad. 1979. Ca. P, Mg, Na and K interrelationships among soil, forage, and animal tissues. J. Anim. Sci. (abstract).

Abstract

An experiment was conducted to determine the mineral status of grazing beef cattle from 9 ranches within 4 different regions of Florida, on the basis of mineral concentrations in animal tissues, forages and soils. From each ranch liver, blood, hair and feces were collected from 14 heifers (18-24 months) and 14 cows (3-8 years) twice during the year. Significant mineral concentration differences among farms, seasons, and classes of animal were noted. During the dry season, mean plasma Ca (< 8 mg%) and P (< 4.5 mg%) were low on 1 and 4 farms, respectively, while forage Ca (< .3%), P (<.25%), Mg (<.20%) and K (<.60%) were low from 2, 8, 7 and 4 farms, respectively. Mean plasma Mg (<1.8 mg%) and forage Na (<.06%) were adequate for all farms during the dry season. In the wet season mean plasma Ca (<8 mg%) and P (<4.5 mg%) were low in 2 and 1 farms, respectively. Forage P (<.25% and soil K (<60 ppm), P (<10 ppm) and Mg (<9 ppm) were low on 7, 7, 2 and 1 farms, respectively. Mean forage Ca, Mg, Na and K and soil Ca and Na were normal for all farms during the wet season. Phosphorus concentrations in hair were higher during the dry season and a positive relationship between plasma and feces P was noted. Magnesium concentrations in liver and forages were lower during the dry season, while no difference (P<.05) appeared in plasma Mg between seasons. Liver Mg may be a good indicator of Mg status.

Marcilese, Néstor A., Jorge Sánchez G., Ramón Corella V., Renata M. Valsecchi y Hernán Fonseca Z. 1978. Anemia hipoplásica en ganado lechero de San Isidro de Coronado, Vol. 1:3 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

Muestreos de sangre en lecherías situadas en San Isidro de Coronado, evidenciaron valores de hematocrito (Ht) llamativamente bajos. Los valores promedio registrados en una población de ganado lechero en producción de casi 300 animales, oscilaron entre el 27 y 35 por ciento. Cifras de 40 y 42 por ciento fueron obtenidas en un hato de unas 100 vacas de otra lechería de Coronado y también en un número similar de animales en Orosi.

Dada la elevada incidencia de la alteración hematológica observada y la dispersión relativamente amplia de las fincas involucradas, se efectuó un estudio con ^{59}Fe con el objeto de aclarar la patogenia de esa anemia del ganado. Se estudiaron seis bovinos, la mitad de ellos como controles y el resto anémicos.

El isótopo (cloruro férrico, actividad específica 100 mCi/mg), se incubó "in vitro" con plasma y 100 uCi se inyectaron endovenosamente a cada animal. Seguidamente se obtuvieron muestras de sangre durante un lapso de tres horas, para determinar la depuración plasmática del trazador. Durante las dos semanas subsiguientes también se tomaron muestras de sangre para establecer la incorporación del isótopo al volumen globular circulante y cuantificar la actividad eritropoyética.

Los valores promedio de los parámetros estudiados fueron Ht: 28.3 y 39.8%; Ferremia: 186.6 y 172.0 ucg/100 ml Fe Plasmático Total: 35.0 y 31.2 mg; T 1/2 ^{59}Fe en Plasma: 106 y 86 minutos; Transporte Plasmático Diario de Fe: 17.9 y 20.1 mg/l; tasa de renovación diaria de Fe: 9.5 y 11.7 veces; utilización de ^{59}Fe por la Médula Osea: 58.2 y 75.1%, para los animales anémicos y controles respectivamente.

La menor utilización del trazador, sin mayores alteraciones en el resto de los parámetros de la cinética del ^{59}Fe, indica una función eritropoyética disminuída en el ganado anémico. Esto, unido también a los trastornos observados en el tiempo de coagulación de la sangre, sugiere una hipoplasia del tejido mieloide.

El ganado estudiado tenía acceso a plantas de helecho, entre las cuales se identificó al Pteridium aquilinum, agente etiológico de las hematuria vesical crónica, la cual se presenta acompañada de anemia. Se desconoce si las otras especies presentes poseen toxicidad y si la misma podría inducir el cuadro hematológico descrito, sin hematuria vesical.

Se requieren estudios adicionales para evaluar la importancia del helecho, planta tan común en el país, sobre la salud del ganado.

Marcilese, Néstor, Renata M. Valsecchi, Manuel Pontigo A., Ramón Corella V., Hernán Fonseca Z., Leonel Calvo G., Gilberto Mejía P. 1978. Valores séricos de hormonas tiróideas en ganado lechero del valle de Orosí mantenido en pasturas con altos niveles de manganeso. Vol. 1:26 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

Estudios en desarrollo en estos laboratorios mostraron que en ratas alimentadas con dietas de alto contenido de Mn, la función tiroidea es afectada. En los mismos animales también se observó un significativo descenso en la aptitud reproductora.

Trabajos previos realizados en el ganado lechero del valle de Orosi, correlacionan la baja fertilidad de dicho ganado con el alto contenido de Mn en las pasturas; las cuales de acuerdo con la época del año y la especie vegetal, poseen valores que oscilan entre 230 y 670 ppm en materia seca.

Dados los resultados obtenidos en los estudios con ratas, se procedió a efectuar un muestreo de sangre en 155 vacas en producción, para determinar los niveles plasmáticos de triiodotironina (T-3) y tiroxina (T-4), como indicadores de la función tiroidea. El muestreo se efectuó en dos lecherías en las cuales se habían realizado los trabajos previos sobre fertilidad. Durante el muestreo en la finca (A) se observó en la mayoría de los animales exoftalmia de grado moderado a severo. En la finca (B) se observó solamente una ligera exoftalmia.

En una tercera finca (C), situada en San Isidro de Coronado, con pasturas conteniendo niveles de Mn de unas 70 ppm, se muestrearon unos 100 animales en producción y secos, para obtener valores de T-3 y T-4 que sirvieron como referencia.

Las determinaciones se efectuaron por duplicado utilizando un kit comercial para radioinmunoensayo marcado con ^{125}I, en base al método de doble anticuerpo.

Los valores medios para T-3 en las fincas A, B y C fueron de: 0.89, 0.88 y 1.12 ng/ml y los valores de T-4 de 60.1, 57.6 y 50.1 ng/ml, respectivamente. Estos valores difieren estadísticamente entre las poblaciones de Orosi y Coronado. A su vez el tipo de curva de distribución de los datos entre ambas poblaciones resultó distinto.

Las observaciones clínicas y la cuantificación de las hormonas tiroideas indican que en el ganado de Orosi existe una significativa incidencia de una tiroideopatía, cuya patogenia no se puede explicar en el estado actual de las investigaciones.

McDowell, Lee R. and Joe H. Conrad. 1978. Trace mineral nutrition in Latin America. World Animal Review, No. 24, 24-33.

Abstract

Inadequate trace mineral nutrition is limiting livestock production in Latin America. The incidence, significance, detection techniques and preventive methods for livestock trace mineral deficiencies and toxicities in Latin America is described briefly. Provision of mineral supplements to grazing ruminants is more complicated than for monogastric livestock. Mineral supplementation represents low input/high output nutrients for greatly increasing livestock production.

McDowell, L. R., C. E. Lang, J. H. Conrad, F. G. Martin and H. Fonseca. 1978. Mineral status of beef cattle in Guanacaste, Costa Rica. Tropical Agriculture. Vol. 55, No. 4:343.

Abstract

Liver and blood samples of three- to four-year old steers were obtained from 15 farms located in five counties to obtain information on the mineral status of grazing cattle in the Guanacaste region of Costa Rica. Of the livers analyzed, approximately 36.0, 30.7, 37.3 and 34.7 per cent were borderline to deficient in copper, iron, manganese, selenium and zinc, respectively. Forty-nine percent of the blood samples were considered borderline to deficient in phosphorus. There was no significant difference ($P<0.05$) in tissue mineral concentration due to county location, with the exception of selenium. Differences ($P<0.01$) in tissue concentrations among farms were found for all six tissue minerals. In general, tissue minerals could be directly related to use or absence of mineral supplements.

McDowell, Lee R., Joe H. Conrad, Jenny E. Thomas, Lorin E. Harris and Karl R. Fick. 1977. Nutritional composition of Latin American forages. Trop. Anim. Prod. 2:273-279.

Abstract

The Latin American Tables of Feed Composition published in 1974 contained data on 3,390 feeds. Of this total, 85% were different from those of the US and Canada. Approximately 77% (2615) of the entries were forages. Of the forage entries, 74% included values for the complete proximate analysis and approximately 43% included both calcium and phosphorus mineral concentrations and forage evaluation methods. Approximately 25% of both the Latin American and US-Canadian forages contained 7% crude protein or less. Latin American forages tended to have higher ash and crude fiber but lower nitrogen-free extract than US-Canadian forages. Of the forages, almost 75% of the phosphorus and 31% of the calcium entries were 0.3% or less, which may be borderline to deficient in these elements. Borderline or deficient levels of certain elements were reported for many entries: Co 43%, Cu 47%, Mg 35%, Na 60% and Zn 75%. Widescale deficiencies of iron, manganese and potassium or toxicities of molybdenum are not to be expected.

McDowell, Lee R. 1979. Geographical distribution of nutritional diseases in animals. Chapter in "CRC 1978 Handbook of Nutrition and Food." 94 pp. CRC Press, Inc. Cleveland, Ohio (In Press).

Abstract

Numerous nutrient deficiencies, imbalances and toxicities severely inhibit animal production in many countries of the world. Nutrient deficiencies or toxicities can be region specific or can in no way be related to geographical locations. For all nutrients, the determining factor as to the incidence of a deficiency or toxicity is often influenced by management capabilities or cultural and religious practices of a particular region. Profound differences in nutrient requirements exist between species, between breeds or types, within a species and individual animals and thus their adaptability to extreme geographical climatic conditions. In general protein, energy and vitamin deficiencies are less accurately ascribed to geographical locations and can be deficient in all world regions and under all climatic and environmental conditions. Mineral and water deficiencies, unlike other classes of nutrients are often dependent and influenced to a large extent on world geographical locations.

Inadequate supplies of energy and/or protein are usually the major nutritional limitations to livestock production in many countries of the world. Specific soils of the world are deficient or in toxic concentrations for certain minerals. Livestock receiving all of their feed from a small defined area have an increased likelihood of developing mineral deficiencies or toxicities.

Often grazing livestock do not receive mineral supplementation and must depend largely upon forages to supply their requirements. Only rarely, however, can forages completely satisfy all of the mineral requirements. Borderline or deficient levels of certain elements were noted for many forages in the 1974 Latin American Tables of Feed Composition: cobalt, 43%,

copper, 47%; magnesium, 35%; phosphorus, 73%; sodium, 60% and zinc, 75%. Calcium deficiency has been reported in 15 developing tropical countries, magnesium in 16, phosphorus in 38, sodium in 14, cobalt in 21, and copper in 20 countries. A systematic mapping technique, based on animal tissues and forage concentrations can be employed to predict where mineral deficiencies or toxicities will occur. Atempts to raise livestock productivity in the diverse geographical locations of the world will be unsucessful unless the nutritional environment is likewise elevated.

McDowell, L. R., J. H. Conrad, J. K. Loosli and David Morillo. 1979. Results of mineral research in Latin America. 1979 Latin American Short Course. Department of Animal Science, University of Florida, Gainesville, Florida.

Abstract

In Latin America, mineral imbalances are a major limitation to ruminant livestock production. Often grazing livestock do not receive mineral supplementation and must depend largely upon forages to supply their requirements. Only rarely, however, can forages completely satisfy all of the mineral requirements. Borderline or deficient levels of certain elements were noted for many forages in the 1974 Latin American Tables of Feed Composition: Co, 43%; Cu, 47%; Mg, 35%; P, 73%; Na, 60% and Zn, 75%. Calcium deficiency is suspected or confirmed in 11 Latin American countries, Mg in 14, P in 23, Na in 7, Co in 13 and Cu in 13 countries. The most widespread mineral deficiency for livestock is that of P. Ten reports from Latin America illustrate the dramatic increase in calving percentage when breeding cattle are supplemented with P. Copper and Co deficient areas are widespread in Latin America. Mineral deficiencies are often more prevalent during the wet season.

The University of Florida, with assistance of a grant from the United States Agency for International Development, is cooperating with Latin American institutions to initiate and establish mineral research. At the present time cooperative research is underway in Bolivia, Brazil, Colombia, Costa Rica, Guatemala, Ecuador, El Salvador, Peru, Uruguay and Venezuela. A systematic mapping technique, based on animal tissues and forage concentrations can be employed to predict where mineral deficiencies or toxicities will occur. Data from Brazil research indicates that positive correlations among soil and forage mineral concentrations for Mg, Cu, Fe,

Mn, Na, Mo and Zn were low or nonexistant. Attempts to raise livestock productivity in tropical countries will be unsuccessful unless the nutritional environment, including adequate mineral nutrition, is likewise elevated. Mineral supplementation is a least cost input to improvement of livestock production.

McDowell, L. R., M. Kiatoko, C. E. Lang, H. Fonseca, E. Vargas, J. K. Loosli and J. H. Conrad. 1978. Latin American mineral research - Costa Rica. IV World Conference on Animal Production. Buenos Aires, Argentina (In Press).

Abstract

Three experiments were conducted to determine the mineral status of grazing cattle in the San Carlos and Guanacaste regions of Costa Rica by evaluating liver, plasma and forage mineral concentrations; bone ash and forage oxalate contents. In each experiment tissue mineral concentrations differed ($P < .05$) among farms for almost all minerals. In 12 San Carlos beef cattle ranches, mean liver Cu (< 75 ppm) and Co (< .07 ppm), and mean plasma P (< 4.5 mg/100 ml) and Mg (< 1.8 mg/100 ml) were borderline to deficient on 1, 3, 12 and 5 farms, respectively. Of the total livers analyzed, 23 and 27% were borderline to deficient in Cu and Co, respectively. Liver Fe (< 180 ppm), Zn (< 84 ppm) and Mn (< 6 ppm) were lower than the reported normal levels for 63, 16 and 44% of the total samples, respectively. Of the total cattle livers analyzed from Guanacaste, approximately 20, 37 and 33% were borderline to deficient in Cu, Mn and Se, respectively. Liver Fe (< 180 ppm) and Zn (< 84 ppm) concentrations were lower than reported levels for 31 and 35% of all animals, respectively. Forty-nine percent of the total blood samples were considered borderline to deficient in P. In general, tissue minerals could be directly related to use or absence of mineral supplements. Of the dairy animals from San Carlos, plasma Ca levels were in the normal range in all samples while 98 and 31% of the plasma samples were borderline to deficient in P (< 4.5 mg/100 ml) and Mg (< 1.8 mg/100 ml), respectively. Low forage Ca and P and high oxalate levels in Setaria ancepselata pastures may be responsible for the high incidence of a milk fever-like condition in dairy cattle. The results from three experiments indicate that mineral

deficiencies are a major limitation to cattle production in Guanacaste, and San Carlos regions of Costa Rica. On the basis of blood, forage and bone analyses, and in agreement with other studies from tropical regions, lack of P is the most prevalent mineral deficiency for grazing livestock.

Mendes, M. O., J. H. Conrad, C. B. Ammerman, L. R. McDowell and R. C. Littell. 1978. Mineral liver concentrations in cattle as affected by age, physiological state, and season. XI International Congress of Nutrition. Rio de Janeiro, Brazil.

Abstract

Co, Cu, Fe, Mn, Mo and Zn were determined on liver samples obtained by biopsy from 420 cattle grouped in five classes from six ranches during two seasons in northern Mato Grosso, Brazil. Rapidly growing animals (class 1) and lactating animals (class 3) during the rainy season tended to have lower liver Co, Cu, Mn, Mo, and Zn levels. Cu, Mn, and Zn were found to be deficient and Co was deficient prior to supplementation. Fe and Mo liver levels were normal. All minerals in the liver were lower ($P < .01$) in the rainy season than in the dry season. It was concluded that the liver mineral levels in grazing cattle in a wet-dry tropical environment are lowest in rapidly growing and lactating animals toward the end of the rainy season. Representative liver samples obtained by biopsy from these most physiologically active animals during only one period of the year can be expected to indicate Co, Cu, Fe, Mn, Mo and Zn levels which may be limiting production functions.

Mendes, M. O., J. H. Conrad, R. H. Houser and L. R. McDowell. 1978. Liver biopsy and season as factors in determining Co, Cu, Fe, Mn, Mo and Zn status of grazing cattle. Abstracts, 70th Annual Meeting American Society of Animal Science. East Lansing, Michigan. p. 430.

Abstract

Liver samples from the same animals were obtained by aspiration liver biopsy (liver I) and by removing 50 g of liver from the lobus dexter at slaughter liver II). A total of 72 cattle, six each from six ranches in northern Mato Grosso, were sampled once during the dry season and once during the rainy season. Significant differences between sampling techniques during the two season were as follows: Co ($P < .02$), Mn ($P < .01$) and Zn ($P < .01$) during the rainy season; Fe ($P < .02$) and Zn ($P < .01$) during the dry season. Significant differences between sampling techniques from combined seasons were as follows: Fe ($P < .05$), Mn ($P < .01$) and Zn ($P < .01$). Liver I means for Fe were higher and Mn and Zn were lower than liver II means. Co, Cu and Mo liver mean values were not significantly effected by sampling technique. These data indicate that the status of Co, Cu, Fe, Mn, Mo and Zn in grazing cattle can be determined satisfactorily from liver samples obtained late in the rainy season either by biopsy or by slaughter, although some significant differences were found between sampling techniques.

Montoya M., Víctor, Carlos Campabadal H., Emilio Vargas G., Hernán Fonseca Z., Ismael Pontigo. 1978. Composición mineral de forrajes y su interrelación con los requerimientos de bovinos en Santa Cruz, Guanacaste durante la época seca. Vol. 1:41 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

En el Cantón de Santa Cruz, Provincia de Guanacaste se realizó un muestreo de las especies forrajeras predominantes en la zona durante la época seca. El objetivo fundamental fue establecer la composición química de los forrajes y establecer interrelación con los requerimientos normales de bovinos en pastoreo.

Se utilizó la técnica de absorción atómica para la determinación en el pasto de: calcio, magnesio, potasio, hierro, cobre, manganeso y zinc.

El fósforo fue determinado por un procedimiento colorimétrico. Se obtuvieron niveles de calcio comprendidos entre 0.17 - 0.23%. El 49% de la muestra presentó niveles superiores a los requerimientos del ganado y el 51% presentó niveles que llenan dicho requerimiento.

Los niveles de fósforo variarion entre 0.065 y 0.085%. Los tres distritos presentaron una marcada deficiencia de fósforo en los pastos.

Los niveles de magnesio variaron entre 0.0130 y 0.174%. Un 54% de la muestra presentó niveles superiores al requerimiento, mientras de que un 42% presentó niveles normales y solo un 4% valores inferiores a los requeridos.

El contenido de potasio en forrajes varió entre 0.80 y 1.60%. Un 59% de la muestra presentó valores inferiores al requerimiento, mientras que un 27% presentó niveles adecuados y el 14% restante valores superiores al requerido.

Los niveles de cobre variaron entre 2-3 ppm. Un 85% de la muestra presentó valores inferiores al requisito mínimo. Un 12% resultó normal y el 3% restante superior a los requerimientos.

En los pastos los niveles de zinc variaron entre 23 y 25 ppm. Un 16% de la muestra presentó niveles inferiores al requerimiento, mientras de que un 82% presentó niveles, dentro del ámbito requerido y el 2% restante presentó niveles superiores.

Se determinaron en los forrajes niveles de manganeso que variaron entre 25 y 60 ppm. El 19% de la muestra presentó niveles comprendidos dentro del requerimiento mínimo y el 81% niveles superiores al requerimiento.

Montoya Segura, Victor Manuel. 1978. Evaluación del nivel de minerales en tejidos animales (sangre e hígado) y forrajes del cantón de Santa Cruz, Provincia de Guanacaste, durante la época seca. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia, San José, Costa Rica.

Sumario

La presente investigación se realizó en el Cantón de Santa Cruz (Distritos de Santa Cruz, Bolsón y 27 de Abril), Provincia de Guanacaste, en la época seca. En este estudio se evaluó el contenido mineral en los pastos y tejidos animales (sangre e hígado), de bovinos en pastoreo.

Se analizaron en el suero sanguíneo los minerales calcio, fósforo y magnesio; en el hígado, hierro, cobre, manganeso y zinc, en los pastos, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc.

El nivel promedio del calcio en el suero sanguíneo de los animales fue de 9.15 mg/100 ml, no presentándose variación ($P< 0.05$), entre los 3 distritos evaluados. Tampoco se encontró variación estadística en el nivel de fósforo sanguíneo, cuyo promedio fue de 5.73 mg/100 ml de suero. El nivel de Mg en el suero fue de 2.86 mg/100 ml de suero.

Los niveles promedio de elementos minerales en el tejido hepático fueron los siguientes: para el hierro de 214 ppm, para el cobre de 96 ppm, para el manganeso de 4 ppm, y para el zinc de 101 ppm.

En los pastos se obtuvieron promedios de 0.21% y de 0.076% para el calcio y el fósforo, no hubo diferencia significativa para los diferentes distritos. El promedio para el magnesio fue de 0.157%, encontrándose diferencias significativas entre especies. El potasio presentó un promedio de 1.16% y se encontró diferencia significativa entre especies. El promedio para el hierro fue de 175 ppm, presentándose diferencias significativa entre especies forrajeras. El promedio para el cobre fue de 3 ppm y para el zinc de 24 ppm, no obteniéndose ninguna variación ($P< 0.05$) para ninguno de los dos.

El promedio para el manganeso fue de 43 ppm y se encontró diferencia ($P < 0.05$) entre especies.

El promedio de proteína fue de 2.40%, existiendo diferencias significativas con respecto a las especies forrajeras.

Montoya S., Víctor M., Carlos Campabadal H., Emilio Vargas G., Jorge Sánchez, Hernán Fonseca Z., Ismael Pontigo. 1978. Niveles sanguíneos de calcio, fósforo y magnesio de bovinos en pastoreo en Santa Cruz, Guanacaste, durante la época seca. Vol. 1:21 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

En el cantón de Santa Cruz, provincia de Guanacaste se evaluaron los niveles de calcio, fósforo y magnesio en el suero sanguíneo de bovinos en pastoreo durante la época seca. El objetivo fundamental fue establecer los factores que afectan dichos niveles.

El calcio y el magnesio sanguíneos fueron determinados por absorción atómica. El fósforo fue determinado por un procedimiento colorimétrico. El nivel promedio del calcio sanguíneo fue de 9.15 mg/100 ml, no presentándose variación significativa, entre los tres distritos evaluados (Santa Cruz, Bolsón y 27 de Abril). Tampoco se encontró variación estadística entre distritos para los niveles de fósforo y magnesio sanguíneos, cuyos promedios fueron de 5.73 y de 2.86 mg/100 ml de suero, respectivamente.

El 43% de la población bovina muestreada presentó niveles de calcio sérico inferiores al normal El 57% restante presentó valores normales. No existieron diferencias significativas entre las variables estudiadas: distrito, finca, sexo y edad. Los factores que en conjunto afectaron el nivel de calcio sanguíneo fueron: finca, distrito y los niveles de proteína, cobre, manganeso y magnesio de pastos.

El 52% de las muestras presentó valores de fósforo sérico inferiores al normal; un 47% presentaron valores superiores al normal. El distrito fue la única variable que afectó significativamente el nivel de fósforo sérico. Los factores que en conjunto afectaron el nivel de fósforo en la sangre fueron: finca, distrito y niveles de hierro y potasio en pastos.

El 23% de la muestra presentó niveles de magnesio sérico inferiores al normal; un 75% valores normales y el 2% restante valores superiores al

normal. Los factores que en conjunto afectaron el nivel de magnesio en sangre fueron: finca, distrito y el nivel de manganeso en los pastos.

Murillo Bravo, Olger. 1977. Evaluación del estado de nutrición mineral del ganado bovino en pastoreo en el cantón de Cañas, Guanacaste. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia. San José, Costa Rica.

Sumario

La presente investigación se realizó en el Cantón de Cañas, Provincia de Guanacaste, para llevar a cabo una evaluación del estado de nutrición mineral de bovinos en pastoreo en dicha zona; se incluyeron 19 fincas con diferentes tipos de manejo, distribuidas en el cantón, a las cuales se les tomaron muestras de sangre, forrajes e hígado entre los meses de diciembre de 1976 a marzo de 1977. En la sangre se analizaron los elementos calcio, fósforo y magnesio, en forrajes calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc; también se analizó la proteína cruda. Por último en el hígado se hicieron análisis para el hierro, cobre, manganeso y zinc.

Los datos obtenidos se analizaron estadísticamente mediante Andeva, Stepwise, $MAXR^2$, así como correlaciones entre los elementos estudiados.

Se encontraron concentraciones promedios en la sangre de bovinos de 10.84, 4.27 y 2.67 mg/100 ml de suero para los elementos calcio, fósforo y magnesio respectivamente; además se encontró una marcada deficiencia de fósforo en la sangre de bovinos en pastoreo.

En los forrajes estudiados se obtuvieron concentraciones promedios de 3.86, 0.25, 0.09, 0.12 y 1.15 por ciento en base seca para la proteína cruda, calcio, fósforo, magnesio y potasio respectivamente; para los elementos hierro, cobre, manganeso y zinc las concentraciones promedios encontradas fueron de 148, 2.81, 27 y 20.05 ppm en base seca respectivamente. En todas las fincas estudiadas los forrajes no mostraron concentraciones que suplieran los requerimientos mínimos de fósforo para ganado bovino.

Además un alto porcentaje de las muestras de forrajes estudiadas en las

fincas no dieron concentraciones satisfactorias para llenar los requerimientos de cobre, el cual parece ser un grave problema en la zona de estudio. También en algunas fincas estudiadas se encontraron concentraciones inferiores a los requerimientos para el manganeso y zinc.

De las muestras de hígado analizadas, solamente el manganeso mostró concentraciones por debajo de lo normal en el tejido hepático, encontrándose un promedio de 208.5, 157.8, 4.75 y 117 ppm en base seca para los elementos hierro, cobre, manganese y zinc respectivamente.

En base a los resultados obtenidos se recomienda suplementar en la zona con fuentes altas en fósforo, cobre y posiblemente manganeso y zinc para llenar los requerimientos que no llegan a suplir los forrajes.

Murillo B., Olger, Emilio Vargas G., Carlos Campabadal H., Carlos Jiménez C., Ismael Pontigo A., Hernán Fonseca Z. 1978. Composición mineral de los forrajes y su interrelación con los requerimientos del ganado en el cantón de Cañas, Guanacaste. Vol 1:36. III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

La presente investigación se realizó en el cantón de Cañas, provincia de Guanacaste, para determinar el contenido mineral de las especies forrajeras predominantes en la zona (Hyparrhenia ruffa, Cynodon nlemfuensis, Digitaria decumbens, Panicum maximum, Brachiaria mutica, Echinochloa polystachia, Paspalum conjugatum, Paspalum fasciculatum, Centrocema Sp), así como relacionar estos contenidos con los requerimientos minerales del ganado en pastoreo.

Se tomaron 90 muestras de forrajes, durante los meses de diciembre de 1976 a abril de 1977; las muestras fueron recolectadas a 10 cm de la superficie del suelo en los potreros donde pastaban los animales. Se determinó el contenido de proteína cruda, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc. De los análisis se obtuvieron promedios generales para los forrajes de 3.86, 0.25, 0.09, 0.12 y 1.15 por ciento en base seca para la proteína, calcio, fósforo, magnesio y potasio respectivamente y concentraciones promedio de 148, 3, 27, y 20 ppm en base seca para los elementos hierro, cobre, manganeso y zinc respectivamente.

Se encontraron diferencias significativas ($P<0.05$) entre las especies forrajeras para la proteína cruda, fósforo, magnesio, potasio y hierro, así como diferencias significativas entre fincas para fósforo y manganeso.

De las especies forrajeras estudiadas el pasto Jaragua fue el predominante (70% de las muestras), no cumpliendo esta especie forrajera con los requerimientos mínimos de proteína cruda. Los requerimientos para bovinos de fósforo, cobre y zinc fueron cubiertos por los forrajes en un

Murillo B., Olger, Emilio Vargas G., Carlos Campabadal H., Hernán Fonseca Z., Ismael Pontigo A., Carlos Jiménez C. 1978. Contenido de calcio, fósforo y magnesio en el suero sanguíneo y factores que afectan estos minerales en los bovinos del Cantón de Cañas, Guanacaste. Vol. 1:6 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

El objetivo del presente estudio fue el de evaluar el estado de nutrición mineral del ganado bovino en pastoreo en el cantón de Cañas, Guanacaste. Se tomaron por punción yugular 106 muestras de sangre en 19 fincas distribuídas en el cantón. El muestreo se llevó a cabo durante los meses de diciembre de 1976 a abril de 1977. Se analizó el contenido de calcio, fósforo y magnesio en el suero. Los datos fueron analizados estadísticamente por medio de los procesos de Stepwise y máxima R^2. Los resultados indican un promedio para la zona de 10.84, 4.27 y 2.67 mg/100 ml de suero para el calcio, fósforo y magnesio respectivamente. Se encontró los siguientes modelos para los factores que afectan el contenido de estos elementos en el suero. El modelo para el calcio fue: Ca S = 14.40 - 1.64 (edad del pasto) - 0.0005 (fósforo en el pasto). El modelo para el fósforo fue PS = 4.25 + 0.008 (magnesio en pasto) - 0.06 (finca) - 0.032 (zinc en pasto) + 0.005 (fósforo en pastos). El modelo para magnesio fue: Mg S = 1.73 + 0.028 (finca) + 0.006 (calcio en pasto) en 0.257 (edad del pasto) + 0.005 (manganeso en el pasto).

Palmer Francis, Luis Fdo. 1977. Evaluación del estado de nutrición mineral del ganado bovino de la provincia de Cartago. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia. San José, Costa Rica.

Sumario

El presente estudio se llevó a cabo con el fin de evaluar el estado de nutrición mineral en el ganado bovino de la provincia de Cartago, involucrando 34 fincas de manejo diferente situadas en los cantones Central, Paraíso, Turrialba, Alvardo y Oreamuno.

Se recolectaron muestras de hígado, sangre y forrajes entre los meses de diciembre de 1976 y abril de 1977. Analizándose en sangre calcio, fósforo y magnesio; en hígado, hierro, cobre, manganeso y zinc finalmente en forrajes proteína, calcio, fósforo, magnesio, potasio, hierro, cobre manganeso y zinc.

Con los resultados obtenidos se hicieron análisis estadísticos de Andeva, Stepwise, MaxR^2 e interrelaciones entre los elementos estudiados. Encontrándose que en la zona de estudio en general se presentan problemas de calcio, fósforo, cobre, además niveles elevados de manganeso en los distritos Orosi de Paraíso, Central y Santa Cruz de Turrialba y San Rafael de Oreamuno.

Los demás elementos en suero sanguíneo y forrajes obtenidos fueron normales según la literatura. Para el hígado de animales se encontró que todos los minerales evaluados mostraron niveles inferiores a lo normal en dicho tejido.

Se recomienda, basado en lo anterior, suplementar con fuentes altas en calcio y fósforo como harina de hueso, fosfato dicálcico, además óxido de cobre, sulfato de cobre o carbonato de cobre para aumentar los bajos niveles de esos minerales encontrados.

Peducasse C., Armando. 1978. Mineral evaluation on the milk valley of Santa Cruz Central (Andrés Ibañez, Warnes and Santistevan provinces, Bolivia. Thesis. University Gabriel Rene Moreno, Department of Health Sciences.

Abstract

In 1977 a study in the milk valley of Santa Cruz Central (Andrés Ibañez, Warnes and Santistevan Provinces) was conducted in order to investigate mineral levels in animal nutrition (bovine ruminants) establishing the soil-plant-animal relations during the dry season (April-May). Eight farms were studied for possible deficiencies and/or toxicities of Ca, P, Mn, Cu, Mo, Zn, Fe, Mn and Co.

The total soil (22), forage (22), blood serum (120) and liver biopsy (32) samples (blood serum and liver biopsy samples collected from cows of 1-2 years of age) were analyzed by personnel of the laboratories of the University of Florida, Gainesville. The pH analyses were made by CIAT Laboratories in Santa Cruz de la Sierra, Bolivia. The results have shown that:

1) The majority of soil samples had from a slightly acid pH (5.8) to a neutral pH (6.7).

2) Soil samples showed low Ca contents on 2 farms, with averages of 54.85 and 55.31 ppm; while the other 6 farms showed normal to high levels (95.69 to 174.15 ppm). However, low concentrations were not found in forage samples, averaging from 0.36% to 0.81% on dry matter on all farms. Based on the Ca values found in soils and forages, these values are consicered adequate for bovine livestock.

3) Soil samples showed normal P values from 24.20 to 56.40 ppm, which are considered normal to high; although individual samples of different portions of the farms showed levels of 3.4 ppm. Forage content was low in P on only one farm (0.23%) which does not agree with the levels of available P in soils (31.21 ppm) from the same farm. The remainder of the farms studied presented averages of 0.32-0.49%. Generally, with the exception of farm 6, P concentrations were found adequate for grazing bovines.

4) Magnesium concentrations in soil were between 18.82-32.34 ppm, which met the requirements, while forage Mg values were from 0.19% to 0.20% in 4 farms and 0.14 to 0.16% for the others. Therefore, hypomagnesemia is suspected in 6 farms (1.04-1.65 mg/100 ml), while the other 2 showed levels of 1.93-2.23 mg/100 ml.

5) Cu concentrations in soils showed from low to marginal to deficient values (1.508-0.832 ppm), while forage levels varied among the 8 farms studied. Two farms were slightly deficient, lower than 4 ppm and the other six were from normal to slightly high (4.02-11.65 ppm). However, Cu concentrations in liver showed low levels from marginal to deficient in 5 farms while, in the other 3, normal values were found. The conclusion was drawn that the existence of nutritional problems due to copper will require future experiments to evaluate the effects of Cu supplementation (i.e., injections).

6) Zn concentrations in soil showed average levels from 0.857 ppm (deficient) to 3.880 ppm (high). Zn content in forage showed average levels of 12.65 ppm to 22.23 ppm (deficient) in 7 farms, while the other showed adequate levels (34.13 ppm) for bovine nutrition. Zn concentrations in blood serum were considered normal in all farms studied, while Zn content in liver was normal on 6 farms (higher than 125 ppm) and slightly low on the other 2 (108.80 to 113.93 ppm).

7) Fe concentrations in soils were considered normal for all farms, and also the levels of Fe in the forages analyzed were adequate which is reflected in normal levels of Fe in the liver samples.

8) Forage samples showed Mn concentrations from 14.06 ppm (low) to 71.67 ppm (high) for bovine nutrition while liver samples showed deficient Mn values on 3 farms (less than 9 ppm) and normal levels for the others.

9) Soil samples showed Co values from 0.551 to 1.061 ppm on all farms, which is considered adequate. Forage analysis showed Co concentrations ranging from 0.140 to 0.376 ppm, quantities that are sufficient for the requirements of bovines.

10) Mo concentrations in soils were average for all farms (0.05-0.998 ppm). Mo content in forage showed adequate levels (1.158-2.720 ppm).

Pérez, R., J. A. Flores, M. T. Cabezas y R. Bressani. 1978. Estado de nutrición mineral del ganado de carne en tres fincas del departamento de Santa Rosa de la costa del Pacífico de Guatemala. Facultad de Medicina Veterinaria y Zootecnia. Universidad de San Carlos de Guatemala.

Sumario

Bajo los mismos objetivos de pasados experimentos se planteó el presente estudio para tres fincas de carne (F4, F5 y F6) de la costa del departamento de Santa Rosa. En total se tomaron 94 muestras de sangre, 22 de hígado, 10 de leche, 23 de pasto y 11 de suelo. El estado actual de la investigación nos permite presentar en esta oportunidad parte de los resultados obtenidos en el muestreo de invierno (agosto de 1977) los que serán igualmente completados y complementados con un próximo muestreo en febrero de 1978.

El contenido sérico de P fue estadísticamente diferente ($P<.01$) entre fincas, habiéndose encontrado un promedio de 74.7, 54.9 y 89.7 µg/ml para F4, F5 y F6, respectivamente. En F5 los 3 grupos de animales muestreados presentaron valores similares de P sérico, mientras que en F4 y F6 se detectó que tanto las novillas (92.4 µg/ml) como los animales de engorde (87.7 µg/ml) presentaban niveles séricos mayores que los encontrados en las vacas adultas (66.4 µg/ml), sin existir diferencias entre los dos primeros grupos de animales.

En los pastos se encontró contenidos de 3.45, 3.86 y 3.13 g de Ca; 0.29 0.11 y 0.19 g de Na; 6.5, 5.1 y 5.0 mg de Cu y 29.0, 32.0 y 40.1 mg de Zn por kg de materia seca en F4, F5 y F6, respectivamente, no habiéndose detectado diferencias entre las tres fincas. La cantidad de P fue estadísticamente mayor ($P<.01$) en los pastos de F4 (3.35 g/kg) que en los de F5 (1.28 g/kg) y los de F6 (1.61 g/kg) siendo éstos dos últimos similares entre sí. Se encontraron diferencias significativas ($P<.01$) entre los pastos de las tres fincas en lo referente a Mg, K, Fe y Mn, siendo los promedios de 2.14,

2.67 y 3.08 g para Mg; 23.81, 67.99, y 14.81 g para K; 165.3, 208.0 y 406.6 mg para Fe y 91.2, 84.7 y 232.8 mg para Mn por kg de materia seca en F4, F5 y F6 en el mismo orden. La totalidad de los pastos de F4 eran insuficientes en Na, Cu y Zn; los de F5 en P y Na y los de F6 en P, Na y Cu. El 33.3 y el 50.0% de F4 y F6 lo eran en Ca; el 66.7% de F4 en Mg y el 50.0 y 75.0% de F5 y F6 en Cu, respectivamente. El resto de elementos (K, Fe y Mn) se encontraban en los pastos en cantidades suficientes como para garantizar un aporte capaz de llenar los requerimientos diarios de los animales que los consumen.

Perla, F., L. A. Silva, G. Acosta M., F. de Moreno, L. R. McDowell, J. K. Loosli and J. H. Conrad. 1978. Mineral status of cattle in El Salvador. Abstracts, 70th Annual Meeting American Society of Animal Science. East Lansing, Michigan. p. 433.

Abstract

An experiment was conducted to determine the mineral status of dual-purpose cattle from 3 regions (North-Central, Western and Eastern) in El Salvador. Tissue samples were collected from 8 locations (slaughterhouses) within the 3 regions and analyzed for the following minerals: liver (Ca, P, Mg, Co, Cu, Fe, Mn, Mo and Zn) and blood (P and Mg). A total of 119 (67 male and 52 female) Criollo, Criollo x Brahman and Criollo x Holstein cattle, separated into age groups of 2-4, 4.5-6 and 6.5 to 10 years, were sampled during the wet season. For the Western region, liver Mg and plasma P were higher (P< .01) while liver Mn was lower (P< .01). Location differences were found for liver Ca (P< .05), Cu (P< .10) and Mn (P< .01) and plasma P (P< .10). No difference (P> .10) between age groups was found with only an age group x sex interaction for liver Zn (P< .10). The only sex difference was higher (P< .10) liver Cu for females. Mean liver Cu (< 75 ppm), Fe (< 180 ppm) and Mn (< 6 ppm), and plasma Mg (< 2.0 mg%) were low or borderline to deficient at 1, 1, 1, and 4 of 8 locations, respectively. Of the total livers analyzed 37.8, 54.0, 14.3 and 10.0% were low or borderline to deficient in Cu (< 75 ppm), Fe (< 180 ppm), Mn (< 6 ppm) and Zn (< 84 ppm), respectively. Liver Co (< .07 ppm) and Mo (1-5 ppm) were normal for all cattle. Plasma P (< 4.5 mg%) and Mg (< 2.0 mg%) were borderline to deficient for 17.6 and 50.4% of the cattle, respectively.

de Sousa, Julio Cesar. 1978. Interrelationships among mineral levels in soil, forage, and animal tissues on ranches in northern Mato Grosso, Brazil. Thesis. University of Florida, Gainesville, Florida.

Abstract

An experiment was conducted with samples from six farms in northern Mato Grosso, Brazil, to study the interrelationships among level of minerals in soil, forage, and animal tissues during the wet and dry season of the year. Soil characteristics and eleven minerals were studied.

The most acid soils had pH average values ranging from 4.7 to 5.8. Higher pH values were found for 3 farms ranging from 6.0 to 6.5. Percentages of soil organic carbon ranged from 1.2 to 2.6. Soil exchangeable calcium and exchangeable magnesium (1 N KCl extracts) were sufficient to meet the requirements of forage plants. Soil exchangeable hydrogen was in a range of 0.21 to 0.34 meq./100 g of soil. Soil exchangeable aluminum was low and ranged from zero to 0.42 meq./100 g. Soil effective cation exchange capacity (ECEC) ranged from 1.4 to 12.1 meq./100 g. Soil pH was positively correlated with soil organic carbon, soil exchangeable calcium, magnesium, and ECEC but negatively correlated with woil exchangeable hydrogen and aluminum.

Soil extractable calcium (double acid extracts), forage calcium and rib bone ash calcium were normal during both dry and wet seasons. Rib bone ash calcium was positively correlated with forage calcium and soil extractable calcium.

Soil extractable phosphorus ranged from 2.5 to 27.6 ppm which is considered low to average. Forage phosphorus was deficient for grazing cattle and ranged from 0.07 to 0.18 percent. Rib bone ash phosphorus levels ranged from 15.5 to 15.1 percent and they are considered borderline to deficient. Rib bone ash phosphorus was positively correlated with soil

extractable calcium, forage calcium, rib bone asch calcium, and soil extractable phosphorus.

Soil extractable magnesium (double acid extracts) and forage magnesium levels were normal. Rib bone ash magnesium levels were slightly below normal but magnesium deficiency is not likely to occur on these six farms.

Soil extractable potassium levels ranged from low to adequate, 48 to 124 ppm, but forage potassium was sufficient to meet the requirements of beef cattle. Soil salinity was considered negligible and forage sodium was highly deficient.

Soil extractable iron ranged from 16 to 42 ppm which was associated with forage iron levels ranging from 104 to 405 ppm. Forage iron levels were high for grazing cattle and liver iron levels were normal.

Soil extractable manganese ranged from 6 to 48 ppm which were associated with adequate forage levels ranging from 83 to 233 ppm. However, liver manganese levels were deficient on five farms which appeared to be due to high levels of iron in the forage and high levels of cobalt in the mineral mixture.

Zinc was deficient in the soils, forages, and livers. Liver zinc levels during the dry and wet season were 113 and 68 ppm, respectively. Soil extractable molybdenum means which included both seasons ranged from 16 to 24 ppm and they are sufficiently high to cause concern. Forage molybdenum was 9.2 ppm on one farm and this level is considered sufficiently high to produce toxicity problems or problems interrelated with copper and sulfur. All farms with the exception of one had normal forage molybdenum levels. The liver molybdenum mean of 3.8 ppm from this farm was higher than those other from other farms but was considered normal. Liver molybdenum was positively correlated with soil pH and soil phosphorus but negatively correlated with soil exchangeable aluminum, soil extractable iron, and liver manganese.

Soil extractable copper was low on five farms. Forage copper was normal in two farms and deficient in the other four farms. Liver copper levels were normal on all six farms due to mineral supplementation.

Soil extractable cobalt was adequate in three farms and inadequate in the other three. Forage cobalt was adequate on four farms and deficient on two farms. However, liver cobalt was normal due to the high levels of supplementation in the mineral mixture.

Sousa, J. C., J. H. Conrad, M. O. Mendes, W. G. Blue and L. R. McDowell. 1978. Ca, P, Mg and K interrelationships among soil, forage and animal tissues. Abstracts, 70th Annual Meeting American Society of Animal Science. East Lansing, Michigan. p. 342.

Abstract

Soil, forage and cattle rib bone samples were obtained from six ranches during two seasons in northern Mato Grosso, Brazil. Samples were analyzed for Ca, P, Mg and K. Soil extractable Ca levels ranged from medium to high. Forage Ca levels were adequate and rib bone ash (RBA) Ca levels were normal. Forage Ca was positively correlated with soil Ca .15, RBA Ca .59, soil P .14, RBA P .66, soil Mg .28 and forage Mg .33 but it was negatively correlated with forage P -.24 and forage K -.41. RBA Ca was positively correlated with soil Ca .86, forage Ca .59, soil P .63, RBA P .99 and soil Mg .98. Soil extractable P was low to average and ranged from 2.5 to 27.6 ppm. Forage P was deficient for grazing cattle and ranged from 0.07 to 0.18%. RBA P was borderline to deficient and ranged from 15.5 to 15.1%. Forage P was positively correlated with soil P .42, soil Ca .31, soil Mg .17, forage Mg .26, soil K .21, and forage K .72. RBA P was positively correlated with soil Ca .86, forage Ca .66, RBA Ca .99, soil P .66 and soil Mg .97. Forage Mg was adequate. Forage K levels were adequate and ranged from 0.82% during the dry season to 1.93% during the rainy season. Forage K was positively correlated with soil K .19, soil Ca .13, soil P .13, forage P .72 and forage Mg .23. Rib bone ash calcium, phosphorus and magnesium levels were highly correlated with these elements in the soil and forage.

de Sousa, J. C., J. H. Conrad, W. G. Blue and L. R. McDowell. 1979. Interrelações entre minerais no solo, forrageiras e tecido animal em fazendas do norte de Mato Grosso. 1. Cálcio e fósforo. Pesquisa Agropecuária Brasileira (Accepted for Publication).

Sumário

Foi feito un estudo de levantamento das deficiências minerais em seis fazendas do norte de Mato Grosso, baseado em amostras de solo, forrageiras e tecido animal, coletadas durante as épocas seca e chuvosa.

As análises de Ca do solo mostraram que, cinco das seis fazendas tinham níveis considerados altos de Ca no solo e apenas uma apresentava valores considerados médios. Os níveis de Ca nas forrageiras, de um modo geral eram suficientes para atender os requerimentos nutricionais dos bovinos nas duas épocas estudadas. Os níveis de Ca no ossos dos animais (costela) foram considerados normais em todas as fazendas.

Os teores de P nos solos das fazendas estudadas foram considerados entre médio e baixo, respectivamente, variando entre 27.6 à 2.9 ppm. As análises de P das forrageiras indicaram que nenhuma delas, exceto leguminosas, forneciam, níveis adequados de P, para um mínimo de produção animal, sendo as seis fazendas deficientes deste mineral. Houve grande variação dos teores de P nas forrageiras entre as duas épocas estudadas, sendo que nas épocas chuvosa e seca as médias gerais de P foram 0.20 e 0.08 por cento, respectivamente. As médias de P nos ossos dos animais amostrados variaram entre 15.5 a 15.1 por cento, por conseguinte, a deficiência de P foi evidente nas fazendas estudadas. Os animais apresentaram níveis mais altos de P (15.5 por cento) durante a época seca e níveis mais baixo (15.0 por cento) durante a época chuvosa. O que sugere uma maior necessidade de P durante o período chuvoso. Os níveis de P nos ossos foram positivamente correlacionados com o teor de Ca no solo, Ca nos forrageiras, Ca nos ossos, e P no solo.

Valdivia, Ricardo and C. B. Ammerman. 1977. Effect of dietary aluminum on growing cattle. Abstracts. Southern Section, American Society of Animal Science, p. 76.

Abstract

Aluminum cloride at a rate of 0, 300, 600 and 1200 ppm Al was fed to 24 growing beef steers (initial weight 225 kg) for 90 days using a completely randomized design experiment. Major dietary ingredients in percent were: corn meal 59.4, soybean meal 12, cottonseed hulls 20, alfalfa meal 3, molasses 3, plus minerals and vitamins. Average daily gain and average daily feed intake were .916, .916, .753, .912 and 6.6, 6.49, 5.98, 7.08 kg for the treatments as listed above, respectively. There was no differences due to treatment (P>.05). Average P, Ca, Mg, and Al levels in blood serum at the end of the experiment were 7.7, 9.78, 2.54 and .0112 mg/100 ml, respectively, with no influence of treatment. After slaughter average Al concentrations in liver and kidney were 9.73 and 6.94 ppm in fresh tissue with no differences (P>.05) among treatments.

Valdivia, R., C. B. Ammerman, J. P. Feaster, P. E. Loggins and P. R. Henry. 1977. Effect of aluminum on phosphorus utilization by lambs. J. Anim. Sci. Vol. 45, Supp. 1 p 265.

Abstract

Twenty wether lambs (36.7 kg) were randomly assigned to 4 treatment groups in a 2 x 2 factorial arrangement with 2 levels of dietary Al (28 and 2200 ppm) and 2 levels of P (.15 and .29%) for a feeding trial followed by a P-balance study. The basal diet contained 10.4% protein and, expressed in %, corn meal 44.0, cottonseed hulls 26.0, corn starch 20.2, molasses 3.0, soybean meal 2.0, alfalfa meal 2.0, urea 1.5 and 1.3, vitamins and minerals. The Ca:P ratio was between 1.4 to .15 for all diets. In treatments designated as low P, low Al; high P, low Al; low P, high Al and high P, high Al; the average daily gains (ADG) were 109, 116, -39 and 15 g; average daily intakes (ADI) were 647, 668, 394 and 545 g; average feed conversions (AFC) were 5.37, 5.39, -- and 18.86. At the end of the feeding trial, serum levels of inorganic P were 6.90, 7.83, 3.62 and 7.73 mg/100 ml, respectively. Differences ($P<.05$) among treatments for ADG, ADI, AFC and serum P were found. In the P balance study ^{32}P was injected daily for 10 days to measure endogenous fecal P which averaged 77, 131, 41 and 86 mg/kg live weight, respectively. True absorption of P was 28.7, 32.8, -9.2 and 8.5% ($P<.05$). Concentrations of Al in fresh liver were 2.6, 2.9, 6.7 and 6.3 ppm ($P<.01$). Similar values for muscle were 2.3, 2.8, 4.1 and 3.9 ($P>.05$).

Valdivia, R., C. B. Ammerman, C. J. Wilcox and P. R. Henry. 1978. Effect of dietary aluminum on animal performance and tissue mineral levels in growing steers. J. Anim. Sci., Vol. 47, 6:1351.

Abstract

Twenty-four beef-type steers with an average body weight of 226 kg were allocated to four treatments and fed for 84 days to study effects of dietary aluminum on performance and mineral composition of selected tissues. Treatments included 0, 300, 600 and 1,200 ppm supplemental aluminum as aluminum chloride. Increased dietary aluminum did not affect feed consumption, body weights, or feed conversion ratios nor plasma concentrations of phosphorus, calcium, magnesium and aluminum. Hemoglobin and hematocrit were not affected by increasing dietary aluminum; likewise concentrations of aluminum, iron, manganese, phosphorus and calcium concentrations in liver, kidney, longissimus muscle and brain were not influenced by treatment. Zinc concentrations were increased in liver ($P<.05$) and kidney ($P<.01$), by added levels of dietary aluminum. Dietary aluminum at levels up to 1,200 ppm did not influence animal performance and caused only minor changes in tissue mineral composition.

Vallejo, Miguel, Juan Kalinowski, Victor Talabera y Francisco Quintana. 1977. Suplementación con minerales y NNP de ovinos al pastoreo en pastizales naturales altoandinos. 1977 ALPA proceedings, R-82. Havana, Cuba.

Sumario

El la Sierra Central del Perú, en pastizales ubicados a 4,000 m de altitud, clasificados como páramo muy húmedos sub-alpino, se estudio la respuesta a la suplementación mineral y nitrogenada no proteica de ovinos al pastoreo. El ensayo se inició en Febrero de 1976, habiendo durado un año. Doscientos ovinos castrados tipo Junín, de 16 meses de edad, con un peso promedio de 31 kg fueron distribuídos al azar en 5 campos contiguos de 8 has cada uno, de condición entre regular y bueno en los que predominaban gramíneas nativas de bajo valor nutritivo. Los tratamientos fueron: (A) sin suplementación; (B) sal; (C) B más cobre, cobalto, hierro y zinc; (D) C más fósforo y (E) más urea. La mitad de los animales de cada tratamiento fueron beneficiados a los seis meses, continuándose con el resto por seis meses adicionales. Fueron evaluados cambio de peso vivo, peso de vellón y peso de carcasa. Al finalizar el período de un año, no se hallaron diferencias estadísticas entre tratamientos en los parámetros estudiados, habiendo sido los resultados: para ganancia de peso (kg), 14.9 (A), 16.5 (B), 15.1 (C), 15.6 (D) y 17.5 (E); para peso de carcasa (kg), 20.0 (A), 19.3 (B), 19.3 (C), 19.2 (D) y 20.9 (E); para peso de vellón (kg), 3.4 (A), 3.45 (B), 3.22 (C), 3.17 (D) y 3.3 (E). Los resultados indicarían que para el nivel de consumo de energía por los animales, ni los elementos mineral ni el nitrógeno fueron limitantes.

Vargas G., Emilio, Carlos Campabadal H., Hernán Gómez R., Juan Coward L., Carlos Jiménez C. e Ismael Pontigo A. 1978. Contenido de calcio, fósforo y magnesio en el suero sanguíneo y factores que afectan estos minerales en bovinos en pastoreo en San Carlos, Alajuela. Vol. 1:8 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

Este trabajo se llevó a cabo con el objetivo de evaluar el estado de la nutrición mineral del ganado bovino en pastoreo en los Distritos de Cutris y Florencia de San Carlos. Se recolectaron 75 muestras de sangre en 15 fincas de la zona, además de 22 muestras de hígado en los mataderos locales. El muestreo se llevó a cabo durante los meses de enero a abril de 1977. Se analizó el contenido de calcio, fósforo y magnesio en el suero y de hierro, cobre, manganeso y zinc en el hígado. Los datos fueron analizados estadísticamente por medio de un diseño anidado, obteniéndose además modelos de predicción por medio de los procesos de Stepwise y Máxima R^2. Los resultados indicaron un promedio para la zona de 8.07, 4.65 y 2.66 mg/100 ml de suero para calcio, fósforo y magnesio respectivamente. Se encontraron ecuaciones de predicción para las concentraciones de estos elementos en el suero con R^2 de 27.87, 74.81 y 64.78 para el Ca, P y Mg respectivamente. Los resultados señalan concentraciones en el hígado de hierro, cobre, manganeso y zinc de 206, 85, 5 y 90 ppm en base seca respectivamente. En base a los datos del suero, 72 y 30.7 por ciento de la población está deficiente en Ca y P respectivamente.

En base a los análisis en el hígado, se podría afirmar que existe una deficiencia de Fe, Cu, Mn y Zn en la zona.

Vargas G., Emilio, Carlos Campabadal H., Luis F. Palmer, Carlos Jiménez C., Ismael Pontigo A., Hernán Fonseca. 1978. Contenido de calcio, fósforo y magnesio en el suero sanguíneo y factores que afectan estos minerales en bovinos en pastoreo en Cartago. Vol. 1:7 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

La presente investigación se llevó a cabo con el objeto de evaluar el estado de la nutrición mineral del ganado bovino en pastoreo en la Provincia de Cartago. Se recolectaron 68 muestras de sangre en 34 fincas de la Provincia, y 10 muestras de hígado en mataderos locales. El muestreo se llevó a cabo durante los meses de enero a abril de 1977. Se analizó el contenido de calcio, fósforo y magnesio en el suero y de hierro, cobre, manganeso y zinc en el hígado. Los datos fueron analizados estadísticamente por medio de los procesos de Stepwise y máxima R^2. Los resultados indicaron un promedio para la zona de 7.94, 4.17 y 2.41 mg/100 ml de suero para el calcio, fósforo y magnesio respectivamente. Además se encontró los siguientes modelos para los factores que afectan el contenido de estos elementos en el suero. El modelo para el calcio fue: Ca S = 9.95 - 0.01 (calcio en pasto) + 1.12 (muestra de pasto) - 0.30 (cantón). El modelo para el fósforo fue: PS = 4.66 - 0.006 (magnesio en pastos) + 0.0009 (hierro en pastos) + 0.015 (zinc en pastos). El modelo para el magnesio fue: Mg S = 3.31 - 0.017 (zinc en pastos) - 0.21 (distrito) - 0.27 (muestra en pasto).

Los resultados señalan asímismo, concentraciones en el hígado de hierro, cobre, manganeso y zinc de 124, 51, 4 y 58 ppm en base seca respectivamente, lo que indica una posible deficiencia de estos elementos.

Vargas G., Emilio, Carlos Campabadal H., Hernán Gómez R., Juan Coward L., Ismael Pontigo A., Carlos Jiménez C. 1978. Composición mineral de forrajes y su interrelación con los requerimientos del ganado vacuno en los distritos de Florencia y Cutris, San Carlos. Vol. 1:39 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

La presente investigación se llevó a cabo con el fin de evaluar el contenido mineral de las diferentes especies forrajeras presentes en los distritos de Florencia y Cutris del Cantón de San Carlos, y relacionarlos con los requerimientos de bovinos de razas de carne. Se recolectaron 57 muestras de 10 especies de pasto, (Axonophus scoparius, Paspalum conjugatum, Panicum maximum, Brachiaria mutica, Brachiaria ruzziensis, Setaria phaseolata, Pennisetum purpureum, Cynodon nlemfluensis, Hyparrhenia rufa, Echinochloa polystachia), cultivados en 15 fincas de la zona, durante los meses de enero a abril de 1977. Las muestras fueron colectadas a 10 cm del suelo, en los potreros próximos a pastar por los animales. Se determinó el contenido de proteína, calcio, fósforo, magnesio, potasio, hierro, manganeso y zinc. Los resultados señalan un promedio para la zona de 10.62, 0.22, 0.10, 0.23 y 2.4 por ciento para proteína, Ca, P, Mg y K respectivamente, así como 213, 7, 117 y 28 ppm en la materia seca para Fe, Cu, Mn y Zn respectivamente. Se encontraron diferencias estadísticas ($P<0.05$) en proteína por distrito y por especie y de cobre por especie. Todas las especies estudiadas mostraron valores de proteína adecuados, con excepción del pasto Jaragua. Asímismo, todos los forrajes fueron deficientes en fósforo, siendo el pasto Alemán el más crítico en este elemento, además este pasto mostró deficiencias en cobre y zinc. Como promedio los forrajes de la zona llenan perfectamente los requerimientos de los animales de la zona, con excepción de fósforo, el cual es cubierto solamente en un 56 por ciento de las necesidades.

Los pastos Estrella Africana y Pangola no llenaron los requerimientos de fósforo, pero sí para demás elementos. El contenido de hierro estuvo muy por encima de los requerimientos en todas las especies estudiadas.

Vargas G., Emilio, Carlos Campabadal H., Luis Palmer F., Manuel Pontigo A., Carlos Jiménez C., Hernán Fonseca. 1978. Composición mineral de forrajes de la Provincia de Cartago y su relación con los requerimientos de bovinos de leche. Vol. 1:35 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

Sumario

Con el objeto de evaluar el contenido mineral de las diferentes especies forrajeras (Pennisetum clandestinum, Cynodon nlemfuensis, Lolium perenne, Pennisetum purpureum, Axonophus scoparius) existentes en la provincia de Cartago, y relacionarlos con los requerimientos de bovinos de leche, se recolectaron 63 muestras de forrajes en 34 fincas distribuídas en cinco cantones de la zona, durante los meses de enero a abril de 1977. Se determinó el contenido de proteína, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc. Los resultados indican un promedio para la pronvincia de 13.76, 0.19, 0.15, 0.22 y 3.44 por ciento de proteína, calcio, fósforo, magnesio y potasio respectivamente; así como 297, 8, 11 y 33 ppm en la materia seca de hierro, cobre, manganeso y zinc respectivamente. El contenido de manganeso de los forrajes del cantón de Paraíso (Valle de Orosi) fue estadísticamente ($P<0.05$) superior al de los demás cantones estudiados.

De los forrajes analizados solamente el Kikuyo y Raigrás mostraron contenidos de proteínas adecuados para la ganadería de la zona. Asímismo, todos los forrajes fueron deficientes en calcio y fósforo, con excepción del Imperial que mostró valores de calcio adecuados. El manganeso y potasio fue adecuado en todos los forrajes. Todas las especies fueron deficientes en cobre y zinc y adecuadas en hierro y manganeso, sin embargo la Estrella Africana y el Elefante mostraron valores de manganeso relativamente altos. Como promedio, los forrajes de la zona no llenan los requerimientos de calcio, fósforo, cobre y zinc, para el ganado de leche.

Velásquez, José A. 1978. Situación de la nutrición mineral del ganado bovino en el estado Monagas. Universidad de Oriente, Escuela de Zootecnia, Nucleo Monagas, Jusepin, Venezuela.

Sumario

El objetivo del presente trabajo fue estudiar la situación de la nutrición mineral del ganado bovino en el Estado Monagas mediante el análisis de muestras de suelo, forrajes y sangre de bovinos en siete fincas del Estado Monagas, durante las épocas secas y lluviosas de 1977.

En las fincas seleccionadas se muestrearon cuatro potreros, tomándose una muestra de suelo de los primeros 20 cm de cada potrero.

Las muestras de forrajes se tomaron a una altura mínima de 5 cm, tomándose 10 muestras por potrero compuesta de 4 sub-muestras y se tomaron muestras de sangre de la vena yugular a 5 vacas y a 5 novillos por finca.

A las muestras de suelo se les determinó textura, pH, capacidad de intercambio catiónico, materia orgánica, bases cambiables y fósforo. A las muestras de forrajes se les determinó nitrógeno, calcio, fósforo, magnesio, manganeso, zinc, hierro, cobre y zinc y en plasma sanguíneo fósforo, calcio y magnesio.

Los valores promedios obtenidos para pH, materia orgánica, calcio, magnesio, potasio, aluminio, fósforo y capacidad de intercambio catiónico durante la época seca y lluviosa fueron los siguientes: 5.06 y 4.82; 1.39 y 1.18%; 0.68 y 0.88; 0.37 y 0.33; 0.13 y 0.09; 0.51 y 0.30 meg/100 g; 3.52 y 4.10 ppm y 4.48 y 3.83 me/100 g, respectivamente. Los contenidos promedios de nitrógeno, calcio, fósforo, magnesio, hierro, manganeso, zinc y cobre para las dos épocas fueron 0.62 y 1.18%; 0.16 y 0.19%; 0.08 y 0.09%; 0.08 y 0.14%; 176.21 y 567.54 ppm; 105.97 y 143.43 ppm; 22.91 y 40.43 ppm y 2.89 y 6.53 ppm respectivamente. La concentración promedio de calcio, fósforo y magnesio en el plasma sanguíneo para las dos épocas fueron de 10.47 y 10.36; 3.15 y 4.10; 3.05 y 2.87 mg/100 ml, respectivamente.

Vidal, H., C. Aguilar, F. Villena y L. R. McDowell. 1979. Deficiencias y toxicidad de minerales en el ganado en el norte del Perú: I. Estado nutricional de minerales en vacunos del departamento de Lambayeque. Presented 1979 ALPA Meetings. Lima, Perú.

Sumario

En 170 muestras de suero sanguíneo y 92 de hígado se han determinado las concentraciones de P, Ca, Mg, Cu, Fe y Mn, con la finalidad de evaluar el estado nutricional mineral del ganado vacuno en el departamento de Lambayeque, norte del Perú.

Las concentraciones promedios de P, Ca y Mg en el suero sanguíneo fueron 6.1, 8.8 y 2.6 mg/100 ml, respectivamente y el contenido de Cu, 0.6 ppm. En el hígado se encontraron valores de 1.3% de P y de 331.2, 31.2 y 9.4 µg/g de Fe, Cu y Mn, respectivamente. Se observó un alto grado de deficiencia de P (16.8%), Ca (38.2%) y Cu (38.7%) en suero sanguíneo; así mismo, en el hígado la deficiencia fue alta para Cu (58.1%) y Mn (62.0%). En la cuenca lechera de Chacupe la más importante de la zona, se detectaron los siguientes grados de deficiencia: P, 37.9%; Ca, 31.0%; Cu, 53.5% y Mn, 61.8% (hígado). Mayor grado de deficiencia de P se encontró en los animales bajo pastoreo, aunque en el caso de Cu la deficiencia fue mayor en ganado estabulado. Los grados de deficiencia de Ca y Mn fueron similares en ambos sistemas.

Los machos presentaron significativamente más altos concentraciones de P, Ca y Cu, asistiendo mucha similitud de concentración de minerales entre animales jóvenes y adultos. La concentración de todos los minerales tendió a ser ligeramente menor en animales Holstein-Brown Swiss en comparación con los Criollos-Cruces.

Villalobos Morales, Jose Leonidas. 1975. Contenido mineral de cinco forrajes tropicales y su relación con la edad y el valor nutritivo. Tesis. Universidad de Costa Rica, Facultad de Agronomía, San José, Costa Rica.

Sumario

La presente investigación fue realizada con el fin de determinar el contenido de elementos minerales y la relación de éstos con la edad y el valor nutritivo en 5 forrajes de la zona de La Fortuna de San Carlos.

Los forrajes analizados fueron: Guinea (Panicum maximum), Pará (Brachiaria mutica), Gigante (Pennisetum purpureum), San Juan (Setaria sphacelata) y Estrella (Cynodon nlemfluensis).

Se utilizaron parcelas de 4 m^2 de área con 0.5 m de borde por cada lado. Los tratamientos (7 edades de corte) se distribuyeron en un diseño de block al azar con 3 repeticiones en el espacio y 3 en el tiempo (3 rebrotes). Las edades de corte variaron de 1 a 7 semanas con intervalo de 7 días.

Los valores de proteína y DIVMS corresponden a análisis previos de las mismas muestras utilizadas en esta investigación.

Los elementos minerales analizados fueron calcio, fósforo, magnesio, potasio, relación Ca:P, cobre hierro, manganeso y relación Fe:Mn.

Se establecieron coeficientes de correlación entre los elementos minerales entre sí y entre éstos y la edad, la proteína cruda y la DIVMS. Se establecieron además ecuaciones lineales de regresión con el fin de predecir el contenido de algunos minerales en función de la Edad, la P.C., la DIVMS y el Rebrote.

El contenido promedio de Ca varió de 0.41% en el pasto Estrella a 0.88 en el Guinea; el Ca se correlacionó con Mg, Ca:P, P, K y Cu en forma significativa ($P<0.01$).

En promedio el contenido de P osciló de 0.28% en el pasto Guinea, a 0.36% en el Gigante.

El P se correlacionó en forma significativa ($P<0.01$) con la edad, P. C., Fe, DIVMS, Ca:P, Fa, K y Cu. Las ecuaciones que mejor predicen el contenido de P ya sea en base a la edad, la P.C. o la DIVMS corresponden al pasto Estrella.

La relación Ca:P varió de 1.20 en el pasto Gigante a 3.16 en el Guinea.

El contenido de Mg va desde 0.17% en el pasto Gigante a 0.29% en el Guinea. El Mg se correlacionó significativamente ($P<0.01$) con edad, Ca, Ca:P, Fe y P.C. Las ecuaciones de regresión de los pastos Guinea y Pará son las que mejor predicen el contenido de Mg en función del rebrote. La ecuación correspondiente al pasto Estrella es la más adecuada para predecir el contenido de Mg en función de la P.C.

El contenido promedio de K varió de 1.32% en el pasto Gigante a 2.02% en el San Juan. El K se correlacionó significativamente ($P<0.01$) con Ca, P, Ca:P, Cu, y con Mn ($P<0.05$).

El Cu osciló de 27 ppm en el Guinea a 51 ppm en el San Juan. El Cu se correlacionó significativamente ($P<.01$) con Ca, P, K y Ca:P.

El Fe muestra valores que van de 107 ppm en el pasto San Juan a 113 ppm en el Gigante. El Fe se correlacionó significativamente ($P<0.01$) con Edad, P.C., DIVMS, P, Mg y Mn. Las ecuaciones correspondientes a los pastos San Juan, Estrella y Pará, son las que mejor predicen el contenido de Fe en función de la edad, P.C. y DIVMS respectivamente.

Los valores de Mn variaron de 47 ppm en el pasto Gigante a 88 ppm en el Estrella. El Mn presenta correlaciones significativas con Fe, P.C. ($P<0.01$) y con edad y K ($P<0.05$).

La relación Fe:Mn osciló desde 1.27 en el Estrella a 2.40 en el Gigante.

Wong Reyes, Luis Eduardo. 1978. Contenido de minerales de los pastos y del suero sanguíneo de los bovinos en el Cantón de Nicoya, Guanacaste durante la época seca. Thesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia, San José, Costa Rica.

Sumario

El presente estudio tuvo como objetivo evaluar el contenido de minerales en los pastos y en el ganado del Cantón de Nicoya.

Para tal efecto se recolectó al azar 81 muestras de sangre y 68 muestras de pastos en 16 fincas pertenecientes a los distritos de Nicoya y de Mansión. La época de recolección fue desde diciembre de 1976 a abril de 1977.

Los promedios de calcio, fósforo y magnesio en el suero sanguíneo de los bovinos de la zona fue de 9.73, 4.97, y 2.45 mg/100 ml respectivamente. Los resultados indicaron un promedio para los pastos de la zona de 3.71, 0.24, 0.08, 0.13 y 0.99% de proteína, calcio, fósforo, magnesio y potasio respectivamente. Mientras que para el hierro, cobre, manganeso y zinc se obtuvo promedios de 175, 2.4, 49 y 26 ppm, respectivamente.

En base a la información obtenida se recomienda la siguiente suplementación para la zona:

1. Uso de un suplemento líquido que contenga urea.
2. Suplementación directa de fósforo (harina de hueso), mediante una sal mineral, o un suplemento líquido.
3. Suplementación directa de cobre (sulfato, carbonato u óxido) mediante una sal mineralizada.

Yew, Hew Peng and R. I. Hutagalung. 1979. The mineral status of cattle, forages and soils at the farm of the University of Agriculture of Malaysia. Department of Animal Sciences, Universiti Pertanian Malaysia. Serdang, Selangor, Malaysia.

Abstract

Blood, liver and bone samples from 51 cattle were collected at slaughter. These were culled animals comprising of 30 males and 21 females of various breeds including Local Indian Dairy (LID), Santa Gertrudis, Jersey Hereford and Crossbreds. Their weights and ages ranged from 325 to 1573 lbs and 3 to 9 years, respectively. Blood samples were analyzed for Ca, P, Mg, K and Cu; liver samples for Ca, P, Mg, K, Cu, Fe, Zn and Mn; bone samples for Ca, P and Zn, using atomic absorption spectrophotometer.

Forage samples were collected from five pasture plots comprising of Napier (Pennisetum purpureum) and guinea grass (Panicum maximum Jaq.). They were analyzed for Ca, K, Cu, Fe and Zn. Soil samples were also collected from similar pasture plots and were analyzed for Ca, P, Mg, K, Na and pH.

The number of samples collected were 51, 11, 11, 5 and 5 for blood, liver, bone, forage and soil, respectively. The Methods of Mineral Analysis for Plant and Animal Tissues (Fick et al., 1976) were used with some modifications, to adjust with the existing laboratory facilities, for collection, preparation and analysis.

Mean plasma P concentrations 61.72 ppm (6.17 mg% plasma), ranging from 36 to 78.5 ppm. This is slightly higher than the values reported (4.5-6 mg%, Underwood, 1966). Similarly with plasma Ca levels (16.1 mg%) which was higher than that reported (9-12 mg% plasma). Mg levels (2.7 mg%) appear to fall within the normal range (2-3.5 mg%). K and Cu plasma levels (170 and 5.6 ppm, respectively) appear to be borderline values (200 and 0.7-1.4 ppm, respectively). Liver P level (17,390 ppm) is above the normal values

(10,000-14,000 ppm). Liver Ca (718 ppm) level is higher than the accepted values (200-460 ppm). Liver Mg (228 ppm) is lower than the normal Mg values (400-600 ppm). Mean liver K (41,187) is markedly higher than the normal value (10,000 ppm).

Copper concentration in liver (104 ppm) tends to be on the low side when compared to reported value (200 ppm). Liver Fe (362 ppm) is within the range values. Zn liver (194 ppm) was rather excessive (normal liver Zn levels: 84-132 ppm). Average liver Mn (12 ppm) content is sufficient (normal liver Mn: 8-10 ppm). Bone P levels of 33.3% was found to be higher than that reported (17%). Mean Ca level, 64.95% is higher when compared to that of 36%. Zn concentration (85.4 ppm) in bone is at the borderline when compared to 100 ppm. Mean forage Ca level is 245 ppm as compared to normal concentration (2,400-8,500 ppm). K level in forage (24,810 ppm) is slightly higher than those reported (10,000-31,300 ppm). Forage Cu value (14 ppm) is within the normal range (1-40 ppm). Fe level in forage (144 ppm) is within the normal range (10-1,000 ppm). Zn level (24 ppm) is within the range (4-500 ppm).

The results show that Ca and P were higher than those reported values, possibly due to low productivity of these animals whereby they did not efficiently utilize their mineral stores, undetected moisture loss from samples and inaccuracy in the preparation and analysis of samples. Higher Zn and lower Cu appears to be due to mutual antagonistic effect at absorption, whereby high Fe concentration depresses Cu levels in steers.

Higher or lower values of some elements than those reported could possibly be due to contamination during collection-phase and analysis. We could not give an explanation on the low Ca level in the forage. Another possibility is that all of the samples were stored in glass containers rather than plastics

and the values particularly for potassium tend to be high.

It appears that a more accurate and simpler method of sample collection, preparation and analysis should be used in this region.

Annual Estimated Cost of Mineral Research in Latin American Countries

Country	Country Cost*	Direct Florida-AID Contract Cost**
Brazil	$224,000	------
Colombia	62,000	$4,000
Costa Rica	76,773	7,000[a]
Ecuador	36,000	------
El Salvador	57,611	4,000
Guatemala	31,000	6,000[a]
Malaysia	29,000	------
Philippines	71,000	5,000
Venezuela	104,500	------
Total	$691,884	$26,000

* Figures do not include previously purchased equipment or overhead.

** Each country receives in addition $200-900 in consumable supplies.

[a] Costa Rica and Guatemala are no longer receiving direct funds.

COSTA RICA

a.	Estimated total cost per year (CONICET)	$ 20,773
b.	Eight equivalent Peace Corps Volunteers (for Costa Rica Agriculturist to carry out these duties, the estimated cost would be at $6,000 each)	48,000
c.	Fulltime M. S. degree staff member	8,000
	Total	$ 76,773

ECUADOR

a.	Two equivalent laboratory and/or field technicians at $6,000	$ 12,000
b.	One equivalent supervisory staff at $15,000	15,000
c.	Chemical analyses	4,000
d.	Logistical support for travel and supervising experiments	3,000
e.	Supplies other than chemicals	2,000
	Total	$ 36,000

EL SALVADOR

a.	Estimated budget for 1 year	$ 17,611
b.	Five equivalent Veterinary, Field and Laboratory technicians at $8,000	40,000
	Total	$ 57,611

GUATEMALA

a.	Estimated budget for 1 year	$ 18,500
b.	Half Laboratory technician at $7,000	3,500
c.	Half Supervisory Staff at $18,000	9,000
		$ 31,000

VENEZUELA

1. Maracaibo

a.	Equivalent of 3/4 full time supervisory staff at $18,000	$ 13,500
b.	One equivalent laboratory technician at $9,000	9,000
c.	Chemical analyses	4,000
d.	Logistical support for travel and supervising experiments	3,000
e.	Supplies other than chemicals	2,000
	Total	31,500

2. Maracay

a.	Support of research assistants, M. S. program	$ 10,000
b.	One-fourth equivalent supervisory staff at $20,000	5,000
c.	One laboratory and/or field technician	8,000
d.	Chemicals, supplies, and logistical support	6,000
	Total	$ 29,000

3. Jusepin

a.	Research support from CONICET	$ 40,000
b.	One-fourth equivalent supervisory staff at $16,000	4,000
	Total	$ 44,000
	Total Venezuela	$104,500

Philippines

a.	Support of 5.7 graduate student programs	$ 30,000
b.	One and one-half equivalent supervisory staff at $14,000	21,000
c.	One laboratory technician	5,000
d.	Chemicals, supplies, and logistical support	15,000
	Total	$ 71,000

MALAYSIA

a.	One-half support of supervisory staff at $16,000	$ 8,000
b.	One laboratory technician	6,000
c.	Chemicals, supplies, and logistical support	15,000
	Total	$ 29,000