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AID MINERAL RESEARCH PROJECT

Contract Number AID/ta-c-1155

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

PROGRESS REPORT
June 1, 1979 - June 30, 1982

Prepared by: L. R. McDowell
J. H. Conrad
G. L. Ellis

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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:

Contractor's Project Officer: Dr. Hugh L. Popenoe
Tel. (904) 392-1965

Principal Investigators: Dr. Joe H. Conrad
Tel. (904) 392-2185

Dr. Lee R. McDowell
Tel. (904) 392-2185

Dr. George L. Ellis
Tel. (904) 392-2185

Mailing Address: International Programs in Agriculture
3029 McCarty Hall
University of Florida
Gainesville, Florida 32611

Cooperative Animal Nutritionists at the University of Florida:

H. D. Wallace, Chairman
C. B. Ammerman
J. F. Easley
J. K. Loosli
J. E. Moore
R. L. Shirley
Nancy Wilkinson, Technician

Cooperating Graduate Students at the University of Florida:

Joshua Mtimuni: Malawi; Oswaldo R. Rosero, Esvan Paz, David Morillo: Venezuela; Armando Peducassé, Edmundo Espinoza: Bolivia; Rodrigo Tejada: Guatemala; Máximo Jerez: Dominican Republic; Roberto Vargas: Colombia; Yousif M. Salih: Sudan; Ana María Rocha: México.

Cooperating Animal Nutritionists from Latin American countries: Listed at the end of country reports.

3. Contract Period (as amended): From November 1, 1974 to October 31, 1983.

4. Period covered by report: From June 1, 1979 to June 30, 1982.

5. Total AID funding of contract to date: $1,288,108.22.

6. Total expenditures and obligations through previous years: $1,288,108.22.

7. Total expenditures and obligations for period 4/1/82 - 6/30/82: $96,347.46.

8. Estimated expenditures for next contract year: $400,000.

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 and other tropical regions has been extensively reviewed. A summary of this information is found in a number of published articles. Three major reviews were 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 research has established sporadic mineral deficiencies or toxicities on the basis of mineral response, levels of minerals in animal tissues, or forage mineral concentrations. A brief review is as follows: Numerous mineral deficiencies, imbalances and toxicities are severely inhibiting the ruminant livestock industry in Latin America and in other developing tropical 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 appear to be rare except in dairy cattle during peak lactation periods. 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 and other tropical countries, but all have been infrequently studied.

B. Personal contacts have been made through visits and correspondence with interested personnel in fourteen Latin American, 4 Southeast Asian and 4 African countries. The countries involved in the mineral research program are as follows:

Latin America -	Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Peru, Uruguay, and Venezuela.
Southeast Asia-	Indonesia, Malaysia, Philippines, and Thailand.
Africa-	Kenya, Malawi, Sudan and Zaire.

Visits to cooperating institutions 1 or 2 times annually are necessary for stimulating mineral research. The program in Latin America initially started with 5 countries and continually expanded to 14. Programs in the Dominican Republic, Honduras, Panama and Mexico have been initiated during the last two years. In late 1977, visits were made to interested researchers in Indonesia, Malaysia and the Philippines Thailand was

first visited in November of 1978. Since late 1978, contacts were established in Malawi, with Sudan, Senegal, Kenya and Zaire becoming active in the program in early 1981.

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 have also been made.

The most important institutions for mineral research by country are as follows:

Bolivia - Ministry of Agriculture, IBTA and CIAT
Brazil - EMBRAPA, Biological Institute, UMG
Colombia - ICA and CIAT
Costa Rica - Universidad de Costa Rica
Dominican Republic - Ganaderia and CESDA
Ecuador - INIAP
El Salvador - INCAP
Honduras - Panamerican School (El Zamorano) and the Centro de Investigacion y Desarrollo
Indonesia - Gadjah Mada University and Bogor Agriculture University
Kenya - Ministry of Livestock Development, WINROCK International
Malawi - Ministry of Agriculture, Bunda College of Agriculture
Mexico - University of Chapingo and University of Monterrey
Panama - Ministry of Agriculture and IDIAP
Peru - University of San Marcos (IVITA), University in Chiclayo and Agrarian National University
Philippines - University of the Philippines and PCARR
Senegal - Ministry of Agriculture
Sudan - Ministry of Agriculture, Central Veterinary Research Laboratory
Thailand - Kasetsart University and Chiang Mai University
Uruguay - Ministry of Agriculture, Rubino Research Laboratory, Shell Uruguay Ltd.
Venezuela - Universidad de Zulia (Maracaibo), Universidad Central de Venezuela (Maracay) and Universidad del Oriente (Jusepin)
Zaire - Agronomy Faculty, National University of Zaire

Work assignments from June, 1979 to March 1982 are listed below. This is a collaborative research project and as a result, it is necessary to visit with collaborating research personnel in the various countries once or twice a year, depending on the individual situation. Dr. McDowell has been the only full-time professional on the project, with other faculty contributing as needed. More recently, in January, 1982, Dr. G. L. Ellis joined the program as a full time professional. Dr. Ellis will be stationed in Ecuador until June, 1982 and then will be stationed in Gainesville.

Name	Dates of Assignement	Location of Assignment
Dr. L. R. McDowell	9/9 - 9/26/79	Colombia, Ecuador, Panama
	11/9 - 11/14/79	Venezuela
	1/22 - 2/8/80	Philippines, Indonesia, Malaysia, Thailand

Name	Dates of Assignement	Location of Assignment
Dr. L. R. McDowell	5/12 - 5/16/80	Honduras, Costa Rica
	6/15 - 7/2/80	Guatemala, Dominican Republic, Venezuela Bolivia
	/6 - 9/27/80	Surinam, Venezuela, Peru, Colombia, Ecuador
	4/19 - 5/15/81	Philippines, Thailand, Malaysia, Indonesia
	6/28 - 7/11/81	Venezuela, Colombia Ecuador, Panama, Costa Rica, Honduras Guatemala, Mexico
	9/30 - 10/17/81	Dominican Republic, Bolivia
	2/15 - 2/28/82	Mexico
Dr. J. H. Conrad	7/7 - 7/21/79	Brazil
	7/22 - 7/24/79	Uruguay
	7/25 - 7/31/79	Swaziland, South Africa
	8/1 - 8/31/79	Malawi, Nigeria, Togo Senegal
	9/3 - 10/3/80	Brazil (cara inchada not AID fundeu)
	1/21 - 3/13/81	Kenya, Malawi, Sudan, Zaire, Senegal
	9/30 - 10/8/81	Colombia, Dominican Republic
Dr. C. B. Ammerman	9/20 - 9/27/79	Panama
	4/12 - 5/17/81	Taiwan, Philippines, Thailand, Malaysia Indonesia
	9/30 - 10/9/81	Dominican Republic
Dr. H. D. Wallace	9/16 - 9/26/79	Ecuador, Panama
Dr. M. Koger	10/10 - 10/17/81	Bolivia
Dr. G. L. Ellis	1/1 - 1/16/81	Peru
	2/15 - 2/28/82	Mexico

.D.. Specific contributions of participating country institutions compared to AID/Florida inputs are estimated to be a 15 to 20:1 ratio. 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 analyses of samples. Florida has provided laboratory training in mineral research techniques. During the past 2 and 1/2 years, eight technicians have participated in this program representing the countries of Brazil, Dominican Republic, El Salvador, Mexico, Panama, Philippines, Uruguay and Venezuela. The Florida program has provided a great deal of literature to all personnel, including the use of computer facilities for personnel of certain countries.

2. Experimentation Phase

Experiments designed to pinpoint mineral deficiencies and toxicities for specific farms and regions and in progress in all participating countries. Research data from participating countries is further confirming the incidence of phosphous deficiencies. As an example, 29 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 samples contained less than 4 mg% phosphorus. Similar conclusions were found in all of the other theses. During the past several years, mineral research data from Bolivia, Brazil, Colombia Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Malaysia, 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. Incidences of sodium, cobalt, zinc, manganese, magnesium and other mineral deficiencies are highly variable and are noted in individual country discussions. Iodine deficiency is a problem in many countries, with research on injectable iodine being carried out in Malaysia and Peru. 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.

The supplementation of phosphorus has been shown todramatically improve low reproductive performance (i.e., Bolivia, Brazil, Colombia, Malaysia, Panama, Peru, Philippines and Uruguay). A study in Brazil resulted in a 77% calf crop when bonemeal was fed compared to 55% for the controls. 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 a number of tropical countries to verify the effect of phosphorus on reproduction under conditions existing in these countries. Mineral supplementation trials are now underway in Bolivia, Brazil, Colombia, Ecuador, Peru, Uruguay, Malaysia, the Philippines, Indonesia and Venezuela.

The largest mineral supplementation trial to-date involved 1870 cattle in the Beni region of Bolivia. For the first year end results, phosphorus-supplemented weaned animals gained 97 kg versus 77 kg for controls. For the recently completed third year results, cattle receiving a phosphorus source had a 12.5% higher calving percentage and gained 21 kg more than controls. From Goiás, Brazil, cattle receiving common salt gained only 53 g/animal/day versus 90, 137 and 112 g for animals receiving phosphorus, phosphorus + cobalt + copper + iodine, and phosphorus + cobalt + copper + iodine + zinc + iron + manganese, respectively.

In Colombia, research has been designed to lower the costs of mineral supplements. Results from 10 mineral supplementation trials were reported in the 1979 Instituto Colombiano Agropecuario (ICA) Annual Report. The majority of the experiments compared commercial mineral supplements versus supplements containing a minimum number of minerals which previously had been established. This research promoted the concept of specifically tailored mineral supplements for distinct regions at a lower cost. The overall conclusion is that the special mixtures do equally as well as the commercial mixtures which contain more minerals and cost twice as much.

The two-year results of a Colombian experiment to determine the seasonal need for minerals was completed. No benefit was derived by feeding minerals all year long versus during the 5-month rainy season only. A similar mineral supplementation experiment is now underway in the Dominican Republic where breeding cattle are fed no minerals, minerals all year long, dry season only and wet season only.

The etiology of two devastating cattle diseases in Brazil-Bolivia ("cara inchada") and Colombia ("secadera") has been made clearer this year. For over two years, secadera on one ranch has been entirely eliminated through the use of a highly fortified mineral supplement. The response of cara inchada-prone cattle to minerals has resulted in a dramatic reduction of incidence of the condition. For both disease conditions, the exact mineral or minerals responsible have yet to be determined.

Graduate student programs are an important aspect to the mineral research program. Often students do the coursework at Florida and return to their native country for the purpose of organizing research and collecting data. When these students leave Florida, they are well prepared to continue in the mineral research area in their own countries. Currently there are eleven graduate student programs, 5 Ph.D. and 6 M. S., in the mineral research area. These are as follows:

1. Evaluation of Mineral Status of Specific Regions in Malawi (Ph.D.) - Joshua Mtimuni.

2. Mineral Carryover and Storage of Minerals with Sheep (Ph.D.) - Oswaldo R. Rosero.

3. Evaluation of Basic Slag as a Mineral Supplement (M.S.) - Esvan Paz.

4. Evaluation of Mineral Status of Specific Regions in Bolivia (M.S.) - Armando Peducassé.

5. Evaluation of Mineral Status of Specific Regions in Guatemala (Ph.D.) - Rodrigo Tejada.

6. Evaluation of Mineral Status of Specific Regions in the Dominican Republic (M.S.) - Máximo Jerez.

7. Evaluation of Mineral Status of Specific Regions in Venezuela (M.S.) - David Morillo.

8. Mineral Status Comparison and Supplementation of Llamas in Bolivia (Ph.D.) - Edmundo Espinoza.

9. Mineral Status and Factors Affecting Wasting Disease in Colombia (M.S.) - Roberto Vargas.

10. Mineral Status of Brahman Cattle in Florida (Ph.D.) - Yousif M. Salih.

11. Mineral status in a specific region of Mexico or Work with basic slag as a mineral supplement (M.S.) - Ana María Rocha.

In addition to the current students listed above, Ph.D. mineral research programs have been organized for three additional students. Part of the research will be undertaken prior to attending Florida. The three programs are as follows:

1) Evaluation of Mineral Status of Cattle in the Various Regions of Mexico (Ph.D.) - Ricardo Barcena Gama.

2) Mineral Supplementation Trials in the Llanos of Venezuela (Ph.D.) - Alexis Moya.

3) Mineral Status of Grazing Livestock in the Lowlands of Venezuela José Velásquez.

3. Distribution and Application of Results Phase

In 1976, 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 1979 in English and Spanish, with a Portuguese revised edition becoming available in 1980.

The "Latin American Symposium on Mineral Research with Grazing Ruminants" was held in Belo Horizonte, Brazil in 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 during the conference. Brazilians presented 11 papers, University of Florida personnel 12 papers, and invited speakers, 4 papers. The symposium was a major effort to stimulate research and update the available information on mineral deficiencies and toxicities in Latin America. At the University of Florida, these proceedings were translated into both English and Spanish and an extensive photographic section was added to these editions. A total of 3500 copies of the proceedings were printed in Spanish and English and were available for distribution in 1979.

A large quantity of material related to mineral research has been sent to collaborating institutions and other interested groups. This has included reviews related to mineral research as well as theses on mineral research carried out in Latin America. Copies of 3 Ph.D. theses, 2 of which were from Brazil and 1 which was from Colombia, in addition to M.S. theses from Costa Rica and Bolivia, have also been widely distributed.

Many seminars have been presented in the countries visited and articles on mineral deficiencies and toxicities have been presented at national and international scientific meetings. From June, 1979 until the end of 1981, the following presentations had been made in relation to mineral research:

1. Latin American Ruminant Mineral Research (in Spanish). Seminar. Chiclayo, Peru. 6/79.
2. Cattle Mineral Research in Latin America (in Spanish). Guatemala Cattleman's Association. Retalhuleu, Guatemala. 6/79.
3. Co, Mn, Zn, Se, Vitamin E, Vitamin A and Carotene Interrelationships among Soil, Forage and Animal Tissues. American Society of Animal Science. Tucson, Arizona. 7/79.
4. The Importance of Mineral Supplementation to Cattle (in Spanish, keynote speaker). Colombian Animal Production Association (ACOPA). Bogotá, Colombia. 9/79.
5. Mineral Supplementation for Beef Cattle in Beni, Bolivia (in Spanish). Latin American Animal Production Society (ALPA). Panama City, Panama. 9/79.
6. Mineral Status of Beef Cattle in Beni, Bolivia (in Spanish). Latin American Animal Production Society (ALPA). Panama City, Panama. 9/79.
7. Results of Mineral Research for Grazing Cattle in the Americas. Fifteenth Inter-American Cattlemen's Confederation Conference. Ocho Rios, Jamaica. 11/79.
8. Mineral Research in Tropical Countries. Workshop of U.S./Mexico Commission on Agriculture Cooperation. Las Cruces, New Mexico. 11/79.
9. Mineral Deficiencies and Toxicities for Grazing Ruminants in the Tropics. International Workshop on Studies on Feeds and Feeding of Livestock and Poultry and Feed Composition, Data Documentation and Feeding Systems in the APHCA Region. Manila, Philippines. 1/80.
10. Mineral Research in Tropical Countries. Seminar. Universiti Pertanian Malaysia, Kuala Lumpur, Malaysia. 1/80.
11. Recent Findings in Mineral Research and Their Benefits towards Livestock Production in the Tropics (Keynote speaker). The First Seminar on Mineral Nutrition in Thailand. Bangkok, Thailand. 2/80.
12. The Importance of Mineral Nutrition for Tropical Livestock (Keynote speaker). First National Seminar on Dairy Cattle Production. Santo Domingo, Dominican Republic. 2/80.
13. Tropical Programs in Animal Nutrition. Meeting of Advisory Group to University of Florida Center for Tropical Veterinary Medicine. Gainesville, Florida. 3/80.
14. Mineral Deficiencies for Grazing Cattle. Compañia de Desarrollo Bananero de Guatemala, Ltda. Bananera, Guatemala. 6/80.
15. Mineral Status of Beef Cattle Herds from Four Soil Type Regions in Florida. 29th Annual Beef Cattle Short Course. Gainesville, Florida. 5/80.
16. The Importance of Minerals for Cattle Production (in Spanish). Modern Techniques of Animal Production in the Tropics (CENTA) Symposium. Tegucigalpa, Honduras. 5/80.
17. Nutrient Requirements of Various Classes of Cattle. Workshop: Beef and Forage Production in a Low Energy System. Gainesville, Florida. 7/80.
18. Mineral Status of Beef Cattle in the Beni Region of Bolivia. American Society of Animal Science. Cornell, New York. 7/80.

19. Mineral Research with Ruminants in Tropical Countries (in Spanish). Seminar. Lambayeque, Peru. 9/80.
20. Mineral deficiencies and toxicities for grazing ruminants in the tropics. International Symposium Animal Production in the tropics, University of Genira, Wad Medani, Sudan, 2/81.
21. Recent Research Findings with Grazing Livestock in the Tropics. Seminar. University of the Philippines, Los Banos, Philippines. 4/81.
22. Mineral Deficiency Research for Grazing Livestock in Tropical Countries. Seminar. Kasetsart University, Bangkok, Thailand. 4/81.
23. Recent Mineral Status of Grazing Livestock in Tropical Regions. Seminar. Universiti Pertanian Malaysia, Kuala Lumpur, Malaysia. 5/81.
24. Cu, Mo, S, Zn and Periodontitis in Brazilian Cattle. TEMA-4. Fourth International Symposium on Trace Elements. Perth, Australia. 5/81.
25. Mineral Status of Cattle in Tropical Lowlands of Bolivia. TEMA-4 Fourth International Symposium on Trace Elements. Perth, Australia. 5/81.
26. Mineral Nutrition of Ruminants (in Spanish). Lecture and Demonstration. University of Zulia, Maracaibo, Venezuela. 6/81.
27. Tecnica modificada de biopsia costela em bovinos, Sociedade Brasileira de Zootecnia. Goiania, Brazil 7/81.
28. International Programs at Florida with Emphasis on Mineral Nutrition (in Spanish). Seminar. Instituto Universitario de Tecnologia de El Tigre, El Tigre, Venezuela. 7/81.
29.. Mineral Deficiencies in Animals Grazing Pasture. Seminar. CIAT, Cali, Colombia. 7/81.
30. Mineral Status of Grazing Florida Brahman Beef Cattle. American Society of Animal Science. Raleigh, North Carolina. 7/81.
31. Beef Cattle Mineral Status in the Tropics of Bolivia. American Society of Animal Science. Raleigh, North Carolina. 7/81.
32. Mineral Status of Sheep and Llamas of Bolivia. American Society of Animal Science. Raleigh, North Carolina. 7/81.
33. Nutritional Deficiencies for Grazing Livestock in the Tropics (in Spanish). Seminar. IDIAP, Santiago, Panama. 8/81.
34. Latin American Mineral Deficiencies for Cattle (in Spanish). Seminar. University of Monterrey. Monterrey, Mexico. 9/81.
35. Mineral Deficiencies of Cattle Grazing Tropical Forages. Conference of Production and Utilization of Tropical Forages. Chapingo University, Chapingo, Mexico. 9/81.
36. Resultados de investigaciones minerales en Latinoamerica, Third International Nutrition Conference, Cartagena, Colombia 10/81.

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

4. Termination Phase

Since the program was initiated in late 1974, the mineral status of some of the major ruminant livestock producing regions of Latin America have been established. Also, the limitation of minerals for grazing livestock in Africa and Southeast Asia has become apparent. With approximately one and one-half years remaining, there is insufficient time to accomplish all of the desired goals for mineral research

in many of the participating countries. Nevertheless, efforts will be made to gradually reduce support for participating countries and to summarize research results to date. One trip per year should be sufficient for most countries. Some countries (i.e., Costa Rica, Guatemala, Peru, Brazil, Venezuela, Malaysia, Philippines) have developed a higher technological level and visits are only desired 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. Countries which only recently have become involved in the program, including Mexico Panama, Dominican Republic, Honduras and the African countries, would be expected to require more support.

The emphasis for the mineral research program for the remaining year will be as follows:

a) To continue to determine the location of mineral deficiencies, adequacies and excesses in selected areas of Latin America, Africa and Asia where grazing ruminants predominate. The mineral status of numerous regions in many tropical countries where grazing livestock are extremely important is still unknown.
b) To define deficiencies of energy, protein and vitamin A in addition to minerals which may be limiting animal production. Some research has been broadened to evaluate these nutrients through both chemical analysis and supplementation trials.
c) To emphasize the solving of small holder animal production problems that appear to be caused by nutritional deficiencies or excesses. For example, research is underway to study the etiology of "swollen face" in Brazil and "wasting away" disease in Colombia. Both syndromes have recently been attributed to minerals but the exact mineral involvement is unknown.
d) To continue research on soil-plant-animal mineral relationships for diagnosis of mineral status of grazing ruminants.

e) To continue experiments to determine the cost/benefit ratio from the effect of supplemental phosphorus and other minerals on reproduction and weight gains of ruminant animals.
f) To continue 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 and cameloids (llamas and alpacas) in Bolivia and Peru.
g) To continue research to determine the validity of different methodologies for establishing mineral status of grazing ruminant animals. This would include use of a bone biopsy technique to evaluate phosphorus status.
h) To continue to improve developing institutions' capacities to carry out mineral research. This would include laboratory training at the University of Florida.
i) To continue to locate regions for well-controlled mineral supplementation studies even though these experiments will continue after the present project has terminated.
j) To determine the effect of phosphorus supplementation during the rainy season and the carryover effect from periodic mineral supplementation,

especially phosphorus.

k) To continue investigating the possibilities of using more economical phosphorus supplements (i.e., basic slag - from steel).

l) To attempt to establish more graduate student programs where degree candidates would conduct research in their home country.

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

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

o) To more critically evaluate mineral supplements and to encourage mineral supplement companies, researchers and ranchers to formulate, produce and use high quality and nutritionally adequate mineral supplements. The evaluation would include analysis of mineral supplements available in the marketplace.

p) To publish a producer-oriented extension bulletin on mineral deficiencies and toxicities for grazing ruminants (in Spanish, Portuguese and English). This would be patterned after a Florida extension bulletin to be published in 1983.

5. Research Methodology

Research methodology which will permit rapid determination of the mineral status of ruminant livestock populations is under study. An accurate review of the mineral status in a specific region will permit the recommendation of the mineral supplements for correcting deficiencies and toxicities. Mineral status varies with soil type, forage species, age and physiological function of the animal. On the following page is a listing of critical levels indicating low or deficient concentrations in soils, plants and animal tissues.

CRITICAL LEVELS OF MINERALS

MINERAL PROJECT - UNIVERSITY OF FLORIDA, 1982

J.H. Conrad, L.R. McDowell, and G.L. Ellis

	Ca	Mg	P	K	Na	Co	Cu	Fe	Mn	Mo	Se	Zn	Protein
Soil mg/100 g or ppm	<.35	<.07	<10	<.15	----	<.10	<.6	<19	<19	----	----	<2	---
Forage % or ppm	<.30	<.20	<.25	<.60	<.06	<.10	<10	<30	<20	>4	<.10	<30	<7
Liver ppm	----	----	----	----	----	<.05	<75	<180	<6	>4	<.25	<84	---
Serum mg or mg/100 ml	<8	<2	<4.5	----	----	----	<.65	----	----	----	----	<.8	---
Bone % fat free	<24.5	<.45	<11.5	----	----	----	----	----	----	----	----	----	---
Ash (66.8) %	<37.6	<.67	<17.6	----	----	----	----	----	----	----	----	----	---

a) Tissue collection and analysis. Kinds of material: soil, plant and animal tissues. Physiological state of plants and animals. Kinds of animal tissue: blood, liver, bone, milk, saliva and feces. Sampling technique: liver biopsy of live animals or slaughter animals for liver samples. Locations: farms and centralized commercial slaughterhouses. Season of year: wet, dry.
In addition to the liver biopsy procedure, a new procedure for bone biopsy is being implemented. This procedure is being demonstrated in participating countries.

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. Some supplementation trials are determining the seasonal effect of mineral supplements.

6. Contribution to Institution Building

One of the principal goals of the program is to stimulate mineral research within the participating countries. To accomplish this objective, laboratories have been assisted by purchase of chemicals, consumable supplies and occasionally, small equipment. This project has made and is continuing to make excellent progress towards increasing cooperating laboratories' capability to carry out mineral analyses. In 1976, a manual on "Methods of Mineral Analysis for Plant and Animal Tissues" was distributed to all cooperating laboratories in one of three languages - English, Spanish or Portuguese. This publication standardized procedures for sample collection, identification and analysis. The second edition of this publication was published in English and Spanish in 1979 and a revised Portuguese edition became available in 1980. The Florida Nutrition Laboratory has aided some laboratories by doing some of the more difficult analyses, including cobalt, selenium, molybdenum and sulfur.

During the past 2 and 1/2 years, as part of building up laboratory capabilities, three-month laboratory training programs have been provided at Florida to 8 laboratory technicians from Uruguay, Brazil, Dominican Republic, El Salvador, Mexico, Panama, Philippines and Venezuela. To further assist laboratories and standardize procedures, project personnel have visited all cooperating laboratories to discuss and demonstrate laboratory techniques. One or more laboratories in each country are currently conducting the majority of mineral analyses, except cobalt, molybdenum, selenium and sulfur. 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 are listed in the appendix.

7. Utilization Plans

The ultimate objective of the project 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 Workshop on Feeding Systems (APHCA), CENTA Symposium, Thailand Mineral Conference, Fourth International Symposium on Trace Elements, Chapingo Nutrition Conference, Colombian Animal Production Association, International Congress of Nutrition, World Conference on Animal Production, Symposium on Feed Composition, Animal Nutrient Requirements, World Conference on Animal Feeding, Brazilian Society of Animal Production and International Minerals Conferences as well as at 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 four mineral elements most likely deficient for grazing livestock are phosphorus, cobalt, zinc and copper. Phosphorus is the most deficient and also the most expensive mineral; 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 zinc usually are generally provided in very suboptimal amounts. Livestock producers are being informed concerning nutritionally adequate mineral supplements and how they should be used.

8. Cost-Benefit Ratios

Major contributions of mineral supplementation are: (1) increase in number of calves born and weaned and (2) improved rate of gain and feed efficiency. There are some locations where mineral deficiencies are sufficiently limiting that animals will not survive without mineral supplementation. A recent experiment conducted in the south of Mato Grosso, Brazil (Sousa, 1982, Pesq. Agropec. Bras., In press) reported that steers gained 40 kg during 336 days when supplemented with only salt compared to 144 kg when fed a complete mineral with phosphorus, copper and zinc. The cost:benefit ratio of this mineral supplementation was shown to be 1:26. Mineral research in the Colombian llanas indicates a number of macro- and micromineral deficiencies which affect reproduction, rate of gain and even death loss. Using research results from a herd, systems approach the cost benefit ratio has been shown to be 1:15 in this region.

Joshua Mtimuni: Malawi; Oswaldo R. Rosero, Esvan Paz, David Morillo: Venezuela; Armando Peducassé, Edmundo Espinoza: Bolivia; Rodrigo Tejada: Guatemala; Máximo Jerez: Dominican Republic; Roberto Vargas: Colombia; Yousif M. Salih: Sudan; Ana María Rocha: México.

Cooperating Animal Nutritionists from Latin American countries: Listed at the end of country reports.

3. Contract Period (as amended): From November 1. 1974 to October 31, 1983.

4. Period covered by report: From June 1, 1979 to June 30, 1982.

5. Total AID funding of contract to date: $1,288,108.22.

6. Total expenditures and obligations through previous years: $1,288,108.22.

ANNUAL RESEARCH REPORT

I. General Background

Mineral deficiencies have been identified as one of the major factors limiting ruminant livestock production in tropical countries. 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 in Latin America are nutritionally related:

1. Reproductive performance of cattle is low and average calving rates are usually between 35 and 50% compared to the 85% average in the U.S. In the last extensive mineral research progress report (June, 1979), ten supplementation trials carried out in 6 Latin American countries were noted. In each instance, mineral supplementation had dramatically increased average calf crops. Since that time, additional supplementation trials in Bolivia, Malaysia, Thailand and the Philippines have shown a dramatic reproductive response to phosphorus supplementation.
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. 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. 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.

Statement of Project Objectives as Stated in the Contract

The objective of this research contract has been 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. Selection of additional countries was made in consultation with the AID/W Project Officer and was not limited to those countries where programs were originally initiated.

This research was carried out with the following objectives: 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 benefits 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

other tropical countries, but all have been infrequently studied.

B. Personal contacts have been made through visits and correspondence with interested personnel in fourteen Latin American, 4 Southeast Asian and 4 African countries. The countries involved in the mineral research program are as follows:

Latin America -	Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Peru, Uruguay, and Venezuela.
Southeast Asia-	Indonesia, Malaysia, Philippines, and Thailand.
Africa-	Kenya, Malawi, Sudan and Zaire.

Visits to cooperating institutions 1 or 2 times annually are necessary for stimulating mineral research. The program in Latin America initially started with 5 countries and continually expanded to 14. Programs in the Dominican Republic, Honduras, Panama and Mexico have been initiated during the last two years. In late 1977, visits were made to interested researchers in Indonesia, Malaysia and the Philippines Thailand was

order to stimulate the widespread use of mineral supplements. Research activities have been divided into the following phases: 1) Reconnaissance and Recruitment Phase; 2) Experimentation Phase; and 3) Distribution and Application of Results Phase. These phases are described in more detail as follows:

1. Reconnaissance and Recruitment Phase

In carrying out this first phase of the mineral research project, literature related to grazing livestock was evaluated and contacts were established in the participating countries through correspondence and personal visits. In each country under consideration, previous research on mineral concentrations in soils, forages and animal tissues, in addition to reports of clinical signs of plant and animal mineral deficiencies at specific locations, were evaluated to determine the highest priorities for cooperative mineral research projects.

Research institutions and personnel with both the ability and desire to carry out the proposed mineral research were located in the participating countries. Laboratory equipment and mineral analysis methods to be used were determined by the contractor. The specific contributions of both the participating institutions and the University of Florida to the mineral research program were clearly established during this initial phase.

2. Experimentation Phase

The experimentation phase consists of two separate phases: the Tissue Collection Phase and the Mineral Supplementation Phase. During the first of these phases, tissue samples (liver, blood and bone) are collected from cattle ranches and slaughterhouses. Analyses of these tissues serve to 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 permit an understanding of the soil-plant-animal relationships with respect to minerals and other nutrients as well as toxic elements. Following the Tissue Collection Phase, a Mineral Supplementation Phase will 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 are investigated also.

3. Distribution and Application of Results Phase

Experimental results have been and will continue to be distributed to farmers, government officials and scientists. Results shall be published in both scientific journals and extension-type publications suitable for distribution to farmers through local livestock organizations in participating countries where possible and through other means considered appropriate by the Contract and/or the AID Research Specialist. Publications reporting this research will establish the mineral status of cattle-producing regions within participating countries. In addition, publications should deal with recommendations for mineral mixtures suitable for specific areas. Results of experimental findings will also be presented at local in-country short courses and conferences

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 for analysis as well as technicians capable of carrying out mineral research programs. In order to improve the institutions' capacity to carry out mineral research, the AID-Florida contract will continue to provide 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 reported data.

The overall objective of the mineral research program has been 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 it is also necessary 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 while in reality the mineral supplements are extremely inadequate. Thus more work is needed in evaluating the local commercial mineral mixtures available to farmers.

In addition to the problem of inferior mineral supplements sold in the marketplace, many farmers have a poor understanding of animal requirements and methods of administration of minerals. 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 during the wrong time of the year (dry versus wet season). Surveys from Colombia and Ecuador indicate that many farmers dilute mineral mixtures with additional salt in proportions anywhere from 10:1 to 100:1.

More emphasis needs to be given to training people to do mineral research. People with nutritional and laboratory experience are often available; however, these people frequently need short-term training in mineral research techniques.

D. Accomplishments To-Date

Findings: The activities comprised by this research project were divided into three phases as mentioned above and the findings will be discussed in terms of these phases as follows:

1. 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 staff was thereafter reduced and 1 full-time and 5 part-time animal nutritionists were retained throughout the majority of

the project. A larger staff was necessary during the initial phase of the project to review literature, establish research procedures and initiate contacts and research programs in the respective countries. In January, 1982, 1 additional full-time animal nutritionist was added to the staff in order to give more emphasis to the research program in Ecuador and to assist in summarizing the final data.

Mineral research information compiled in the initial phase was summarized in three major publications. "Mineral Deficiencies and Toxicities and their Effect of Beef Production in Developing Countries" was presented at a conference in Edinburgh, Scotland and 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", contained 269 references and was presented at the "Latin American Symposium on Mineral Research with Grazing Ruminants" held in Brazil in 1976. The proceedings of this symposium were available in Portuguese and later translated into English and Spanish at the University of Florida. Later in the year, an extensive review entitled "Geographic Distribution of Nutritional Diseases in Animals" was prepared. This review is 94 pages long and contains 451 references, the majority of which deal with the location of mineral deficiencies and toxicities in developing countries.

Project personnel have made frequent trips to visit interested researchers in the Latin American countries. In the early part of the program, active research was in progress in the 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 now initiated mineral research programs. Thailand was first visited in late 1978 for the purpose of determining if mineral research was desired. In April, 1979, the African country of Malawi was visited and a mineral research program was established. Within the past 2 years, the countries of Sudan, Senegal, Kenya, Zaire, Mexico, Dominican Republic, Honduras and Panama have also initiated mineral research programs.

During 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 full-time bilingual secretary
1 part-time bilingual secretary
10 graduate students

2. Experimentation Phase

A discussion of the research program in each individual country follows:

Bolivia

The mineral research program in Bolivia was initiated in late 1976. There are three groups in Bolivia interested in doing 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 3) A private ranch 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 in the Beni. The 3-year experiment was initiated in June, 1977 and has now been completed. For year 1, the experiment consisted of approximately 1,870 steers and heifers 12 to 15 months of age allotted to the following treatments: 1) no mineral supplement, 2) salt only, and 3) salt plus bone meal. Within each treatment, various combinations of injections of selenium-vitamin E, copper and iodine and cobalt bullets were administered. The weight gains for year 1 were as follows:

Average Daily Gain of All Animals (Year 1 Results)

	Control	Salt	Salt + Bone Meal
Males	0.241	0.249	0.294
Females	0.257	0.227	0.285
Both	0.249	0.238	0.289

Mineral consumption for the first year was very low. The salt group consumed 11.5 g/day while the salt plus bone meal group consumed 16 g/day.

The design of the experiment for Year 2 and 3 was changed since the heifers were moved out of the pastures into new areas. The steers remained until October, 1979 and then were sold for slaughter. The breeding season for the heifers was four months, from September 1 to December 31, 1978. The control animals receiving no minerals were eliminated. The format for the second and third year of the experiment was as follows:

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

Results from year 2 were disappointing in that there was no difference in favor of the phosphorus supplemented group. There were basically two reasons for this: 1) An unusual amount of rain during the wet season resulted in very little grazing area for the phosphorus group while the salt only group had a much larger, more elevated pasture area. As a result, the salt group did not

lose much weight while the phosphorus group lost a great deal of weight. 2) Another reason for no difference between treatments was that there was unusually heavy rainfall at a severe point in the dry season. This apparently had a "flushing" effect and both groups had a pregnancy rate of 88 to 89% compared to a 63 to 65% rate for heifers the previous year.

Towards the end of the second year, the loss of weight by the phosphorus group was reversed. For year 3, the phosphorus group had a distinctive advantage over the group receiving only salt. Animals receiving only salt lost 9 kg of weight while those receiving phosphorus gained 12 kg, making a difference between treatments of approximately 21 kg. Also, animals receiving the phosphorus treatment had a pregnancy rate of 12.5% higher than the control. Research data from the 3-year experiment is still being analyzed. Abstracts on the data have been presented at conferences in Panama City, Panama; Santo Domingo, D.R.; Perth, Australia; Cornell University; and North Carolina State University. An article for the Journal of Animal Science has been accepted and a second article is being prepared. From the analysis data, deficiencies of P, Cu, Zn, Na and Se are in evidence or likely.

In October, 1981, a trip was made to the Bauer ranch in order to determine the feasibility of an additional mineral supplementation trial. As a result of the last experiment, all of the breeding animals were now receiving phosphorus supplements. Weaned animals, however, were not being given a phosphorus supplement. A decision was made to carry out an experiment comparing the benefits of a complete mineral supplement for weaned steers in order to determine: 1) the effect of a complete mineral supplement on time required to reach slaughter weight: 2) the effect of supplementation on performance, including weight gains and mortality; 3) the mineral status of weaned steers during both the wet and dry seasons; and 4) to evaluate the economic benefits of mineral supplementation to growing steers. The experiment would last approximately two and a half years, beginning in January, 1982 and ending towards the end of 1984.

The experiment would include two treatments, with approximately 600 animals receiving only salt (control) and the second group of approximately 320 animals receiving a complete mineral supplement. The mineral supplement would contain BioFos, trace minerals and possibly, sulfur. In addition, the mixture would contain 20% cottonseed meal to increase consumption. In the other experiment, mineral consumption for weaned animals only averaged 16 g/day. It is hoped that the trace mineral supplements will be provided by the Pfizer company. Liver biopsy, bone biopsy, forage and soil samples will be collected twice a year during the wet and dry seasons. The research proposal for this experiment is found at the end of this section of the report.

The major part of the mineral research program in the Santa Cruz region involves the M.S. degree program of Armando Peducassé. For his M.S. thesis, Ing. Peducassé has collected samples from the north of Santa Cruz and also from the Beni. For his egresado degree thesis, Ing. Peducassé had likewise collected samples from areas of Santa Cruz to determine the mineral status. These samples were analyzed in Gainesville by Lic. Hugo Pérez who had come to Florida for laboratory training. The Florida mineral project has been assisting the mineral program at CIAT by providing consumable laboratory supplies.

Ing. Peducassé will be finishing up his M.S. degree thesis in June, 1982. He will be writing an abstract to be presented at the 1982 Animal Science meetings.

In the La Paz region, nutritional research has been carried out at the Patacamaya Experiment Station. Ing. Edmundo Espinoza recently completed his M.S. degree at Florida and his thesis dealt with a comparison of the nutritional status of sheep and llamas. Twenty sheep (10 castrated males and 10 females) and 20 llamas (10 castrated males and 10 females) of approximately one year of age were used in this study. Animal tissues, blood, liver and bone samples were collected, along with forages and soils, in order to evaluate the status of minerals, protein and energy. In the particular pastures grazed by these animals, there were 8 to 10 different species of forages growing, depending on the season. The proposal for cameloid research was presented in the June, 1979 trip report and a summary of the results is found in the appendix. Species differences and season differences existed. Nutrients likely to be deficient include P, Zn, Se and protein.

Ing. Espinoza is now planning to go on for his Ph.D. degree. Prior to leaving Gainesville last spring, he completed one quarter of coursework towards the Ph.D. degree. It is not certain exactly when he will return for his studies but in the meantime he will be working on the research component of his Ph.D. program in Bolivia. There are three experiments being planned for this research program. The titles of the proposed experiments are as follows: 1) Effect of Mineral Supplementation on Fertility of Female Llamas; 2) Body Composition of the Llama and Optimum Slaughter Weight; and 3) Nutritional Characteristics of Altiplano Forages from Three Regions. Outlines of the research proposals are found at the end of this section.

The first experiment involving the effects of mineral supplementation on fertility will be carried out at the Patacamaya experiment station. The purpose of this experiment would be as follows: 1) To evaluate the biological response, particularly on fertility and weight gains, of breeding llamas receiving mineral supplements; 2) To study the carryover effects of mineral supplements administered only during the wet or dry season; 3) To determine the economic benefit of mineral supplementation to grazing llamas; and 4) To establish the mineral and vitamin A status of grazing llamas during both the wet and dry seasons. The treatments would be as follows: 1) Control - common salt only; 2) Complete mineral supplement administered all year long; 3) Complete mineral supplement administered during the wet season only (October through March); and 4) Complete mineral supplement administered during the dry season only (April through September). Approximately 30 to 100 animals will be included per treatment.

If the experiment is to begin with bred llamas, then the duration of the experiment will be two years. Another option would be to start with 12 to 16 month old animals and the experiment would then last three years. Animal tissue (blood, liver and bone), forage and soil samples would be collected every six months. It is possible that blood progesterone samples may be taken since fertility and low production is such a problem with llamas.

The research objectives of the second experiment dealing with body composition and optimum slaughter weight of the llama are as follows: 1) To establish what age and/or weight is optimum at slaughter time; 2) To evaluate and compare

the body composition of llamas with that of other herbivores; 3) To investigate the weights of dissectable muscle, bone, fat, viscera and main salivary glands; and 4) To evaluate and compare the mineral status of the llama at different physiological states. This experiment would also be carried out at the Patacamaya experiment station and would involved 30 weaned llamas allotted to the following two treatments: 1) Control animals fed "typical" altiplano diets of pasture only plus salt (NaCl) free choice; and 2) Control plus complete mineral and protein supplement to provide optimum nutrition. The duration of this experiment would be one year (the normal slaughter time) or before, if a treatment group reaches slaughter weight earlier. Slaughtered animals would be weighed precisely for the amounts of dissectable muscle, bone, fat and various organs. In addition, every three months animals would be sampled for liver, blood and bone, in addition to forage and soil samples, for mineral analysis.

The third experiment involves collecting forages during both the wet and dry seasons from three locations on the altiplano: Ulla-ulla (near the border with Peru), Belem (northern part of Lake Titicaca), and Patacamaya. These forages would be analyzed for the typical minerals, in addition to carotene, in vitro digestibility, lignin and cellulose. The duration of the experiment would be either one or two years.

MINERAL RESEARCH PROGRAM FOR PATACAMAYA EXPERIMENT STATION - LA PAZ, BOLIVIA

TITLE: Effect of mineral supplementation on fertility of female llamas.

LOCATION: Experiment Station "Patacamaya", La Paz, Bolivia, 100 km. south of La Paz. Possibility of repeating experiment on nearby farm.

PROJECT LEADERS: Instituto Boliviano de Tecnología Agropecuaria (IBTA) - Edmundo Espinoza, Juan Rodríguez and Zenon Martínes.

INTRODUCTION: The most important limiting factor to cameloid production is the low reproductive rates characterized by low rates of embryonic mortality and often a calf in alternate years. In many cameloid production areas of Latin America, numerous mineral deficiencies, imbalances and toxicities may be limiting production. Most of the time, grazing cameloids do not receive mineral supplementation and most depend largely upon forage to supply their requirements. Borderline to deficient levels of certain elements were noted for many native forages in a previous study (Espinoza, 1981).

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 supplementation include Bolivia (Bauer, 1976), Brazil (Conrad and Mendes, 1965), Colombia (Stonaker, 1975) and Peru (Echevarría et al., 1974).

A study conducted in Brazil resulted in a 77% calf crop when bone meal was fed compared to 55% for the controls (Conrad and Mendes, 1965). Pregnancy rates 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 the highlands will be unsuccessful unless the nutritional environment, including protein, minerals and vitamin A, is adequate. Although mineral supplementation is a least cost input to improvement of livestock production, nevertheless, mineral supplementation in Latin America is 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.

PURPOSE:

1) To evaluate the biological response, particularly on fertility and weight gains of breeding llamas receiving mineral supplementation.

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

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

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

REQUIRED RESOURCES AND FACILITIES: 1) A minimum of 30 and maximum of 100 breeding llamas for each treatment. 2) Pastures with strong fences sufficiently large enough to accomodate all the animals. 3) Weighing and handling facilities. 4) Two persons responsible for daily supervision of llamas

management, sample collection, etc.; 5) Analyses of plant and animal tissues at the University of Florida in Gainesville and some at the Patacamaya laboratory; 6) A supplier of mineral supplements other than salt.

TREATMENTS:
1) Control - common salt only.
2) Complete mineral supplement administered all year long.
3) Complete mineral supplement administered during the wet season only (October through March).
4) Complete mineral supplement administered during the dry season only (April through September).

DURATION OF EXPERIMENT: If the experiment begins with bred llamas, then the duration of the experiment can be two years. Another option is to start the experiment with young animals 12-16 months of age, in which case the duration of the experiment would be three years.

SAMPLES TO BE COLLECTED: Animal and forage tissues could be collected at the initiation of the experiment and every six months thereafter.

a) Animal tissue - Samples of blood, liver (biopsy) and bone (biopsy) will be collected from llamas at each collection period. A total of 12-14 animals would be sampled for liver, bone and blood for each treatment. If possible, the same animals would be sampled during each collection period.
b) Forage - Pasture should be sampled at each collection period. Two samples each of the major forage species should be collected. Each sample should be a composite and will be collected only after careful observation of the llama grazing patterns.
c) Soils - A composite sample, in duplicate, should be taken for each pasture in relation to the sites where forages were collected.
d) Mineral supplements - Mineral supplements used during the experiment should be analyzed.

COLLECTION PERIODS:
a) Initiation of the experiment - January, 1982. Identify all animals, weigh them, categorize by age and weight, and allot to treatment groups. Weigh and record minerals administered and collect samples for analysis.
b) End of six months period - Weigh all animals, weigh and record mineral consumption and collect samples for analysis.
c) End of 12, 18 and 24 months - Same as b.

ANALYSES:
Blood serum - hormones (progesterone), Ca, P, Mg, Cu, Zn and Se.
Liver biopsy - Co, Cu, Fe, Zn, Mo, Se and Vitamin A.
Forage - Protein, carotene, NDF, in vitro dry matter digestibility, Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mo, S and Se.
Soil - Available forms of Ca, P, Mg, Na, K, Co, Cu, Zn, Mn, Fe, Mg, Se, Al, N, organic matter and pH.
Mineral supplements - A complete mineral analysis.

MANAGEMENT: Management of the llamas should remain the same in relation to disease control. However, no substance containing a mineral or vitamin would be administered. Young animals should be uniformly weaned at the same time for each treatment group. The dates that a llamo is kept with the llamas should be recorded.

RECORDS: The following information should be recorded:

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

BODY COMPOSITION OF THE LLAMA AND OPTIMUM SLAUGHTER WEIGHT

INTRODUCTION: Details of the skeletal and muscular structures of the llama were given in a report by Cardozo (1964). Pinto (1974) described the mean percentage of carcass muscle in the liveweight animal. Fernandez-Baca (1978) described the stomach of the alpaca but apart from this, little information on the body composition of the llama is available. Therefore, this investigation is planned to investigate the body composition of growing llamas and to compare it with the literature on the body composition of other domestic herbivores. The weights of dissectable muscle, bone and fat in each animal will be determined and the viscera and the main salivary glands will be examined.

RESEARCH OBJECTIVES:
1) To establish what age and/or weight is the maximum at slaughter time.
2) To evaluate and compare the body composition of llamas with that of other herbivores.
3) To investigate the weights of selected organs, dissectable muscle, bone, fat, viscera and the main salivary glands.
4) To evaluate and compare the mineral status of the llama at different physiological states.

LOCATION OF RESEARCH: Patacamaya Experiment Station, located 100 km south of La Paz, Bolivia.

PROJECT LEADERS: Instituto Boliviano de Techología Agropecuaria (IBTA) - Edmundo Espinoza, Juan Rodríguez, Zenon Martínez; Florida - J. Carpenter and L. R. McDowell.

RESEARCH PROPOSALS: Thirty (30) weaned llamas will be allotted to two treatments of 15 animals each. The treatments will be as follows:

1) Control animals fed "typical" altiplano diets of pasture only plus salt (NaCl) fed free choice only.
2) Control plus complete mineral, energy and protein supplements to provide optimum nutrition.

The duration of the experiment would be one year (the normal slaughter time) or before if a treatment group reaches slaughter weight earlier. At slaughter, organs and other tissues will be collected from all animals and weighed. Pasture samples will be taken every six months for each of the major pasture species. Two composite samples will be taken for each forage species.

Analysis and observations would be as follows:

a) Slaughtered animal description records: weight of dissectable muscle, bone, fat, viscera, other organs and main salivary glands.
b) Forage identification records, analysis for Fe, Mn, Zn, P, Ca, Mg, Cu, Co, K, Mo, Na, N, in vitro dry matter digestibility, acid detergent fiber, cellulose, lignin and carotene.

c) Blood - Ca, P, Mg, Zn, Cu, Fe and Ca.
d) Liver - Zn, Fe, Mn, Se, Cu, Co, Mo and vitamin A.
e) Bone - Ash and specific gravity, Ca, P and Mg.
f) Soil - Complete soil analyses to include soil classification, pH, organic matter and available forms of the following minerals: Al, Fe, Mn, Zn, Co, Cu, P, Ca, Mg, K, Na, N, Se and Mo.
g) Mineral supplements and complete feed - Ca, P, Mg, K, Co, Cu, Zn, Mn, Fe, Mo and Se.
h) Other - Growth rates, feed and/or mineral consumption, amount of wool, length of fiber and carcass comparisons could be made.

COLLECTION PERIODS:
a) Initiation of the experiment - November, 1981. Identify all animals, weigh all animals; after blocking by age or weight groups, allot next to treatment groups. Weigh and record supplements administered and collect samples for analysis.
b) End of three month period - Weigh all animals and collect samples for analysis.
c) End of 6, 9 and 12 month periods - Same as b.

Mineral Supplementation Trial

Location: San Rafael Ranch, Beni, Bolivia.

Title: Effect of Mineral Supplementation on Performance of Weaned Steers

Project Leaders: Bernardo Bauer and Enrique Galdo - Bolivia; L. R. McDowell and Marvin Koger - Florida.

Introduction: Phosphorus supplementation has dramatically increased fertility levels in grazing cattle from many parts of the world. McDowell and Conrad (1978) summarize 10 experiments from Latin America which illustrated dramatic increases in calving percentages with supplemental minerals.

A recent 3-year study at the San Rafael Ranch in Beni, Bolivia indicated the benefits of mineral supplementation. During year 1, young cattle receiving a supplement containing bone phosphate average 17 kg higher gains than controls. During the 3rd year of experimentation, breeding animals lost an average of 9 kg weight while those receiving a source of phosphorus gained 12 kg, making a difference of 21 kg between treatments. One limitation of the experiment was the low consumption of the mineral mixture, usually less than 20 g/day. During the first year for the weaned animals, average consumption was only 16 g/day.

In addition to the benefits of growth rates and reproductive efficiency, it has been suggested by some studies that mineral supplementation decreases death losses of cattle. In a 4-year study by CIAT in Colombia (CIAT, 1977 and Miles, 1981), death losses prior to weaning were 19.2% for controls vs. 10.5 for animals receiving a complete mineral supplement.

Purpose of experiment: (1) To determine the effect of a complete mineral supplement on time required to reach slaughter weight. (2) To establish the effect of supplementation on performance, including weight gains and mortality. (3) To determine the mineral status of weaned steers during both the wet and dry seasons. (4) To evaluate the economic benefit of mineral supplementation to growing steers.

Period of Research: From January-April, 1982 to October-December, 1984.

Proposed Research: Animals are weaned by age from January through April. As animals are weaned, they will be randomly allotted to either 1 of 2 treatments as follows: a) Control - common salt only.
b) Complete mineral supplement containing 20% cottonseed meal.

Approximately 320 animals will recieve the complete mineral supplement and 600 for the control.

The desired formula for the mineral mixture is as follows:

Ingredient	Percentage
Biophos	40.0
Cottonseed meal	20.0

Ingredien	Percentage
Trace Minerals	
a) Cobalt	.002-.004
b) Copper	.20 -.40
c) Iodine	.016-.032
d) Manganese	.5 - 1.0
e) Zinc	1.0 - 2.0
f) Iron	1.0 - 2.0
g) Selenium	.002-.004
Sulfur (Optional)	5.0
Common salt	remainder
	100%

Samples to be collected: Animal, forage and soil samples will be collected in the dry season (June) and wet season (December). a) Animal tissues - 12 to 15 representative samples of blood plasma, liver (biopsy) and bone (biopsy) will be collected during June and December from both treatment groups. Tissue samples (liver, blood and bone) will only be collected from animals weaned in March. The same animals sampled during the first collection do not need to be sampled at later collection dates. For each collection period, representative animals from the March age group can be used. b) Forage - 2 samples of 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. Samples should be taken from both the mineral supplemented group and representative pastures grazed by control animals. c) Soil - A composite sample in duplicate should be taken for each pasture. Soil samples should correspond to location where forages were collected and numbered to correspont to the forage. d) Mineral supplements - Minerals used during the experiment should be used as samples for the analysis.

Schedule: a) January - April, 1982 - As animals are weaned and weighed, allot to either control group or mineral supplement treatments. Take a total of 12-15 blood, liver and bone samples from representative animals (March group) prior to allotting to treatments. This would represent the steer population vs. some from each treatment group. b) June, 1982 - From each treatment group, collect 12-15 plasma, liver (biopsy), and rib (biopsy) samples from the March weaned group. Also collect representative samples of forage and soil. c) December, 1982 - Same as June, 1982. d) May, 1983 - Obtain 24 month weight. e) June, 1983 - Same as June, 1982. f) December, 1983 - Same as June, 1982. g) June, 1984 - Same as June, 1982. h) October - December, 1984 - Determine the final weight and calculate age at slaughter.

Analyses:

Blood serum - Ca, P, Mg, Cu, Zn, K and Se.
Liver biopsy - 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.
Rib biopsy - Ca, P, Mg, specific gravity and ash.
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. The date individual animals are slaughtered should be recorded.

Bolivia Contacts

Mr. Robert Thurston
USAID/Bolivia
Gallareia Luz Building, 5th Floor
La Paz, Bolivia

Ing. Bernardo Bauer (Tel. 63218, Home 20873)
Ing. Enrique Galdo (Tel. 370995)
c/o Estancias Elsner Hermanos
Cajón de correo 6007
La Paz, Bolivia

Ing. Juan Rodríguez
Ing. Tito Rodríguez
Ing. Zenon Martínez
Ing. Francisco Pereira (Director Ejecutivo)
Instituto Boliviano de Tecnología Agropecuaria (IBTA)
Edificio del Ministerio de AA.CC. y Agropecuarios
Avenida Camacho, Casilla 5783
La Paz, Bolivia

Dr. John Wilkins (Tel. 36867, Home 37732)
Dr. Patterson
Lic. Hugo Perez S.
Ing. Rufo Angulo (Jefe,Laboratorio)
Ing. Rolando Paz (Director, CIAT)
Ing. Filemón Vallejos Rodas
CIAT
Casilla 359
Santa Cruz, Bolivia

Dr. Andres Parra L.
Dr. Jaime Parada (Dean)
Dr. Raul Grork T.
Dr. Mario B. Paniagua
Facultad de Veterinaria y Zootecnia
Casilla 702
Santa Cruz, Bolivia

Dr. Winston Suárez A.
AGRIPAC Boliviana Cia. Ltda.
Casilla 3042
Santa Cruz, Bolivia

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.

Trips have been made to Brazil by J.H. Conrad during July 1979, September 1980, July 1981, and July 1982. The itinerary for the July trips has centered primarily around the annual meeting of the Sociedade Brasilera de Zootecnia which are annual meetings attended by many of the people doing mineral research in Brazil.

In July 1979 the SBZ meetings were held at the Federal University of Parana, Curitiba, Parana. A one day meeting was held the day following that meeting to discuss the progress of mineral research in Brazil and the progress on the solution to the problem of "cara inchada". A number of talks were presented but no formal proceedings were published. Dr. Julio Cesar de Sousa presented the results of his Ph.D. dissertation on "Interrelationships among mineral levels in soil, forage, and animal tissues on ranches in Northern Mato Grosso, Brazil" and Dr. João Veiga presented the results of several years of research as a technical consultant to Tortuga Co. Zootecnia Agraria, São Paulo, Brazil indicating that controlled experiments and extensive field trials indicated that low Cu and Zn, in addition to the Cu-Mo-S interrelationship, are involved in periodontitis of Brazilian cattle. Visits and seminars were presented at Campo Grande and São Paulo.

In July 1981 the SBZ meetings were held in Goiana, Goias. A paper was presented on "An improved technique for performing a rib biopsy in cattle." Again many research people from all over Brazil attended these meetings. In a few days time it is possible to consult with many of these research people, otherwise it would take from one month to six weeks to visit them at their respective research laboratories.

After the meetings in Goiana, a visit was made to the National Beef Cattle Research Center, EMBRAPA-CNPGC, Campo Grande, Mato Grosso du Sul, Brazil where Dr. Julio Cesar de Sousa is in charge of mineral research with beef cattle in Brazil.

Some of the projects and experiments are as follows:

Project I

Identification and correction of mineral deficiencies and toxicities caused by mineral imbalances in beef cattle. Beef Cattle Research Center, Campo Grande.

Experiments:

1. Mineral supplementation of Nellore females grazing native pastures; CNPGC; JUN/78.

2. Mineral supplementation of steers grazing fertilized guinea grass pastures (Panicum maximum) in South Mato Grosso; Miranda; Oct/78.

3. Mineral deficiencies in cattle in the territory of Roraima; Roraima; Feb/79.

4. Effect of season of the year on mineral supplementation of beef cattle; Miranda; Nov/79.

5. Response of Nellore steers to mineral supplementation in improved pastures; Rio Brilhante; Jun/80.

6. Levels of serum inorganic phosphorus as an indice of conception in Nellore females supplemented with different levels of phosphorus while grazing native pastures; CNPGC; Oct/80.

7. Effect of levels of phosphorus supplementation on gains of beef steers grazing Brachiaria decumbens; in Bandeirantes; Dec/81.

8. Effect of phosphorus supplementation on the development of two and three year old steers grazing guinea grass pasture; Rio Brilhante; Feb/82.

Project II

Cara Inchada in Bovinos: Morphology, Experimental Reproduction, Georgraphic and Osteodystrophic Classification and other aspects. Cooperative Project: South Mato Grosso, Minas Gerais, Goias, Mato Grosso, Roramia, and Amazonas.

Project III

Mineral Supplementation of Beef Cattle in the Pantanal of Mato Grosso. UEPAE Corumba. Edison Beno Pott.

Project IV

Identification and correction of phosphorus, copper, cobalt, iodine, and zinc deficiencies of cattle in Amazonas. UEPAE, Manaus.

Project V

Research on distribution of mineral deficiencies in cattle grazing pasture. Instituto Biologico, São Paulo, Waldemar Camargo.

Project VI

Identification and correction of mineral deficiencies in cattle UEPAE, Rio Branco, Acre J.F. Valentim.

Project VII

Cara Inchada in cattle. J. Dobereiner. Mato Grosso.

Project VIII

Determination of mineral deficiencies in cattle in southwest Goias. EMGOPA, E. Vilela.

Project IX

Identification and correction of mineral deficiencies in cattle. IAPAR, Parana. S.R. Morales-Vega.

Project X

Study of the causes of mortality in calves. EMPAER, South Mato Grosso. R.F. Correa Gomes.

Project XI

Identification and correction of mineral deficiencies in dairy cattle in the Zona de Mata of Minas Gerais. CNP Dairy Cattle, M. de S. Dayrell.

Project XII

Mineral supplementation of dairy cattle. IAPAR, Parana, S.R.M. Vega.

Project XIII

Effect of feeding silage and minerals on growth and development of Holstein heifers. UEPAE, Aracaju, Sergipe. E.C. de Araujo.

Project XIV

Influence of magnesium deficiency on development of calves. PESAGRO, Cantagalo, Rio de Janeiro.

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 has conducted some excellent mineral research took early retirement and Dr. Jorge Lopes trnasferred 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 forage from Florida. Dr. Julio Cesar de Sousa 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 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.

Erci Moraes, head of the UEPAE of Manaus - EMBRAPA, recently completed a study on the effect of levels of phosphorus on gain and fattening of steers grazing Brachiaria humidicola in the Amazon Region during the rainy season. Treatments were 0, 4.3, 6.7, and 8.4 grams of supplemental phosphorus per head per day for 168 days with daily gains in grams of 216, 379, 465, and 564 respectively. He plans to continue this work in Roraima.

Dr. Milton de Souza Dayrell, National Dairy Cattle Research Center in Coronel Pacheco, Minas Gerais is studying the levels of inorganic phosphorus in the blood of lactating cows in the region of the Zona da Mata of Minas Gerais.

Sra. N.C. das Virgens is studying correlations between levels of phosphorus in soil-forage and goats in the semi-arid tropics, county of Uauá, Bahia.

Dr. Moxon, Ohio State University, is heading up a study on the levels of selenium in the serum of lactating cows in the state of São Paulo.

Economic returns from feeding mineral supplements in Brazil.

This subject has been of major concern to the research group CNPGC/EMBRAPA, Campo Grande.

This study "Economic evaluation of alternatives to mineral supplementation of steers grazing fertilized guinea grass pasture" was recently published (Pesq. Agropec. Bras. Brasilia 17(7):1083-1088, jul. 1982). Treatments were: (1) no minerals, (2) salt only, (3) salt and dicalcium phosphorus, and (4) treatment 3 plus cobalt, copper, and zinc. Returns to salt only were 16.98 to 1, salt and phosphorus 3.27 to 1 and treatment 4, 2.75 to 1.

The abstract of another study follows:

Sousa, J.C. de, 1982. Response of steers to mineral supplementation when grazing guinea grass. (Panicum maximum Jacq.) Pesq. Agropec. Bras. (In press).

Two hundred Nellore steer calves two years of age were assigned to four experimental treatments. This study was conducted on São Domingos Ranch, Rio Brilhante, South Mato Grosso for 336 days beginning June 2, 1980. All animals grazed guinea grass pasture (Panicum maximum). Lots were rotated every 14 days and animals were

weighed and samples of blood, bone, and liver every 60 days.

Treatments	Gain, Kg	Mineral Consumption
A. Salt + P + Micro	144	32/day
B. Commercial	130	21/day
C. Salt + P	68	18/day
D. Salt	40	16/day

Data indicate that phosphorus and zinc, within the treatments, gave the greatest response. An economical analysis indicated that treatments A and B would return 26 cruzeiros per cruzeiro spent for mineral supplement.

Dissemination of Information

Technical circular No. 5 has been written by Dr. Julio Cesar de Sousa, CNPGC-EMBRAPA entitled aspects of Mineral Supplementation for beef cattle. Thousands of copies of this 50 page report is being widely distributed throughout Brazil.

List of Mineral Papers Presented at Brazilian Society of Animal Science Meetings, 15 to 21 of July 1982 at Piracicaba

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Conde, Roseli Gouveia, Alexandre A.M. Sampaio, Pedro de Andrade, Luis Claudio de Andrade Rosa and Antonio Tadeu de Andrade. 1982. Effect of different sources of phosphorus in semi-purified diets of sheep on levels of calcium phosphorus and magnesium in blood and bones of growing sheep. Abstract 260.

Contacts in Brazil

BAHIA

Joao Alberto Paiva
Rua Senador Quintino, 523
44.100 - Feira de Santana
Bahia, BRAZIL

Ms. Nilzete Clarinda das Virgens, Nutritionista
Alfeu Gomes da Silva, Chefe
UEP/Salvador
Av. Ademar de Barros, n. 967
Ondina
Caixa Postal 1222
40.000 Salvador, Bahia
BRAZIL

Dr. Paulo de T. Alvim
Coordenador Tecnico - Cientifico
Dr. Marcos Silva Soares
Centro de Pesquisas do Cacau (CEPLAC)
Km 26, Rodovia Ilheus - Itabuna
Caixa Postal, 7
Itabuna, Bahia, BRAZIL

Eng. Agr. Ayrton Paiva Penna
Eng. Agr. Jose Olino A. Lima
EPABA
Av. Ademar de Barros 967, Ondina
40.000 Salvador, Bahia, BRAZIL

BELEM

Biblioteca

Dr. Adilson Serrão
Dr. Cristo Nazaré Barbosa do Nascimento
Sr. José de Brito Lourenço Junior
CPATU/EMBRAPA
Caixa Postal 48
66.000 Belém - Pará - BRAZIL

BELO HORIZONTE

Biblioteca

Dr. J.A. Carneiro Viana
Prof. Roberto Machado da Silva
Dr. Norberto Mario Rodriguez
Escola de Veterinária de U.F.M.G.
Caixa Postal 567
30.000 - Belo Horizonte - MG
BRAZIL

Mr. Alberto Portugal
EPAMIG
Avenida Amazonas, 115
30.000 Belo Horizonte
BRAZIL

BOA VISTA

Dr. Erci de Moraes, Chefe
UEPAT/Boa Vista
Av. Cap. Julio Bezerra, 415
Boa Vista, Roraima
BRAZIL

BRASILIA

Dr. Vicente P. M. Peloso
Bloco 8, 5a. Andar, Sala 517
DAGE Ministerio de Agricultura
70.000 Brasilia, D.F.
BRAZIL (Home SQS 316H 606)

Dr. Ruy P. Valle, CNPQ
W-3 Norte 509
70.000 - Brasilia - D.F.
BRAZIL (Tel. 272 0035 Ramal. 360)

Dr. Armando Primo
CENARGEN - EMBRAPA
Av. W-5 Norte - Parque Rural
70.000, Brasilia, D.F.
BRAZIL

Biblioteca

Eng. Henrique Otávio Lopes
Gilbero Gonzales Leite
Dr. C. Patrick Moore
EMBRAPA - CPAC
Caixa Postal 07/0084
70.000 - Brasília - D.F.
BRAZIL

Dr. Odon P. Santana
Assessor de DTC
Ed. Venancio 2000-9° Andar
70.000 - Brasília - D.F.
BRAZIL

Dr. Ubaldino Dantas Machado, [redacted]
Departamento de Inf., Doc.
Ed. Venenacio 2000-7° Andar
70.000 Brasília - D.F.
BRAZIL

Contacts in Brazil
(continued)

CAMPO GRANDE

Biblioteca

Dr. Leonidas Valle
Dr. Julio Cesar de Sousa
Dr. Ivan Valadão Rosa
Rodovia BR 262 - KM 4
Caixa Postal 154
79.100 - Campo Grande - MT
BRAZIL

CORONEL PACHECO

Biblioteca

Dr. Geraldo Duzi, Director
Dr. Fermino Deresz
Dr. Milton de Souza Dayrell
CNP - Gado de Leite
Rodovia MG-133, Km 42
36.155 Coronel Pacheco,
Minas Gerais - BRAZIL

FORTALEZA

Prof. José Adalberto Gadelha
Centro de Ciencias Agrárias
Universidade Federal do Ceará
Fortaleza, Ceará
BRAZIL

MANAUS

Zootecnista
UEPAE de Manaus
Caixa Postal 455
Manaus, Amazonas, BRAZIL

PARAIBA

Prof. Amaro Calheiro Pedrosa
Dept. Zootecnia, CCT
Universidade Federal da Paraiba
58.397 Areia, Paraiba
BRAZIL

PORTO ALEGRE

Biblioteca

Dr. Enio Prates
Dr. Jorge Lopes
Avenida Bento Gonçalves, 7712
Faculdade de Agronomia U.F.R.G.S.
Porto Alegre, RS
BRAZIL

RECIFE

Paulo Ponce de Leon Filho
Rua Raimundo Freixeira, 254
Casa Amarela
50.000 - Recife - PE
BRAZIL

RIO DE JANEIRO

Dr. Marcelo de Oliveira Mendes
Instituto de Zootecnia UFRRJ
23.460 Seropedica, Km 47
Rio de Janeiro, BRAZIL

Dr. Carlos Tokarnia
Projecto Patologia Animal
EMBRAPA, Km 47
23460 Seropedica, Rio de Janeiro
BRAZIL

Dr. Jurgen Dobereiner - [redacted]
Patologia Animal
EMBRAPA, Km 47
23.460 Seropedica, Rio de Janeiro
BRAZIL

Dr. José Roberto Teixeira
Av. Visconde de Albuquerque, 1180
Apt. 502
Rio de Janeiro, BRAZIL
(ph. 274-3757)

SANTA MARIA

Biblioteca

Dr. Lauro Muller
Universidade Federal de Santa Maria
Departamento de Zootecnia
Caixa Postal 1274
97.100 Santa Maria, Rio Grande do Sul
BRAZIL

Contacts in Brazil
(continued)

SAO PAULO

Dra. Heid Hatinger
Sr. Marcio Antonio Arbex
Associação dos Empresarios
Agropecuarias da Amazonia
Rua Libero Badaro, 425, 19° Andar
01009 São Paulo - SP
BRAZIL

Dr. Alcimir Santiago
Dr. Walter Nazario
Dr. Waldemar Camargo
Dr. Nelson Fernandes
Doenças Nutricionais e Metabólicas
Instituto Biológico
1252 Conselheiro Rodrigues Alves
C.P. 7119
04.014 São Paulo - SP
BRAZIL

Stephen Bromfield Geld
Sementes Contibrasil Ltda.
Avenida Dr. Vieira de Carvalho, 40
6º Andar
São Paulo - BRAZIL

Dr. Manoel Becker
Rua Piracuama, 52
05017 São Paulo - SP
BRAZIL

Mr. Celso Ribeiro Moreira
Eng. Agrônomo
Alameda Ministro Rocha Azevedo
1274 - 10º Andar
01410 São Paulo - SP BRAZIL
(ph. 881-1761, 64-6790)

Mr. Arnoldo Zancaner
Rua Flavio de Moraes, 10
01249 - São Paulo, SP
BRAZIL
(ph. 65-6746)

Eng. Agr. Edgard L. Caielli, Director
Rua Hector Penteado, 56
Instituto de Zootecnia
Caixa Postal 60
13.460 Nova Odessa - São Paulo
(ph. 0192-85913)

Dr. Antonio Julio J. Franco
C.P. 6
Olimpia, São Paulo

PELOTAS

Run Thormann Alves
Bioloao M.S.C.
UEPAE/EMBRAPA/DELOTAS/UFPEL
Cx. Postal 553
96.100 - Pelotas

VICOSA

Biblioteca

Dr. Joaquim Campos
Dr. Jose Brandão Fonseca
Dr. Jose Alberto Gomide
Dr. Jose Fernando Coelho da Silva
Prof. Dirceu Jorge da Silva
Departamento de Zootecnia
Universidade Federal de Viçosa
36.570 Viçosa, Minas Gerais
BRAZIL
(ph. 011-5531, 891-2921)

Manoel Ricardo Pinto dos Santos
Industria de Alimentação Animal Ltda.
Rua Batista de Carvalho, 4-33
8° Andar, Sala 808
Bauru, São Paulo, BRAZIL

Dr. Licio Velloso
CIZIP
Pirrasununga, São Paulo
BRAZIL

Dr. Julio J.N. Silveira
Nutritionist
Anhanguera
Campinas, São Paulo

Colombia

A research program between the Centro de Agricultura Tropical (CIAT) in Cali, Colombia and the University of Florida had been in progress since March, 1975. Mr. Soekanto Lebdosoekojo carried out a Ph.D. research program at the Caramagua experiment station entitled "Mineral Supplementation of Breeding Cattle in the Colombian Llanos" in which soil, animal tissues and forage samples were collected in herd system programs, analyzed and written up in a dissertation. The dissertation was completed in 1977 and an abstract of the data was presented at the 1977 ALPA meetings in Cuba.

Since Mr. Lebdosoekojo's study, no cooperative programs between the Florida-AID program and CIAT have taken place. However, a trip was made to CIAT in September, 1981 to discuss the possibility of mineral research. Interest in the mineral research area was expressed by Dr. Carlos Lascaño and Dr. G. Gené. Work is now scheduled to begin on evaluating the cost-benefit ratio of minerals and studies to lower the cost of mineral supplements by using less conventional sources of minerals will be carried out. At Florida, a student from Venezuela is currently working on an M.S. degree program to evaluate the value of basic slag as a phosphorus source. The basic slag originated in Colombia.

A cooperative mineral research program between the Instituto Colombiano Agropecuario (ICA) and the Florida-AID contract has been in effect since July, 1975. This is one of the most extensive programs in any of the cooperating countries. The original leader of the program was Dr. Arturo Gil. Dr. Gil resigned in early 1978 but remains active in the program even though his main work is now with industry. Dr. Gil was replaced by Dr. Max Laredo. An additional contact is Dr. Juan Salazar, who was very instrumental in helping to establish the Florida-AID mineral contract. The main contribution of the Florida-AID program has been to provide consumable supplies and to analyze some of the more difficult minerals.

The June 1979 ICA Annual Report illustrates the extensiveness of the Colombian mineral research program. A large number of samples have been collected throughout the country, analyzed and written up in ICA annual reports. General statements of the mineral status of specific regions are as follows: Los llanos - The most severe deficiencies are phosphorus and protein. Caqueta - There appears to be a calcium deficiency. Puerto Boyacá - There are deficiencies of copper, phosphorus, and calcium, and toxicities of molybdenum and selenium. La Sabana region near Bogotá, Tolima and Huila - This area appears deficient in copper, zinc and perhaps cobalt, and toxic in molybdenum. Turipana, Caribia and Montilonia - 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 locations have similar problems: severe copper deficiencies and marginal zinc deficiencies. Antioquia - Phosphorus deficiency is the most noticeable problem. Valle and Nariño - Phosphorus appears adequate but copper is deficient.

Table 1 presents information on a study of the cost of mineral supplements in relation to animal gains. Comparisons were 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 at much lower costs than the commercial supplements that are available and thus can be more economical for beef cattle production. The overall conclusion is that the special mixtures do equally as well as the commercial ones and cost half as much.

Table 1. 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 animals	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 weight $\bar{X}$ (kg)	208	218	159	163	160	157	163	188	189	229	229
Final weight X (kg)	328	348	277	273	269	206	219	243	243	312	315
Total weight gain $\bar{X}$ (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 consumption/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).

The 1980 ICA Annual Report for the nutrition division is 51 pages long, 31 of which deal with mineral nutrition experiments. A list of the experiments included in the publication is as follows:

Project 1. Deficiencies and toxicities of cattle in Colombia.
Exp. 1.1. Effect of urea and phosphoric acid supplementation on annual behavior as compared to commercial salt. Carimagua.
Exp. 1.2. Effect of copper and phosphorus on the reproductive behavior of beef cattle. Turipaná.
Exp. 1.3. Effect of calcium, phosphorus and copper on the reproductive behavior of beef cattle. La Libertad.
Exp. 1.4. Effect of bicalcium phosphate, copper and zinc on the reproductive parameters of female Bon. El Nus.
Exp. 1.5. Effect of calcium and copper on the reproductive parameters of female crossbred cattle. Macagual.
Exp. 1.6. Effect of copper and zinc supplementation on the reproductive behavior of dairy cattle. Obonuco.
Exp. 1.7. Mineral status of forages, blood serum and liver in the savannah of Bogotá.
Exp. 1.8. Mineral status of forages, serum and liver in Boyacá.
Exp. 1.9 Mineral status of forages, blood serum and liver in the Magdalena Medio zone.
Exp. 1.10. Monthly and seasonal mineral fluctuations in tropical pastures.

The publication lists a number of experiments which compare a complete mineral supplement with specially formulated mineral supplements and also notes deficiencies of particular minerals in specific regions.

New research to be carried out will compare the following treatments: 1) Commercial mineral mixtures fed all year long; 2) Special ICA mixtures fed all year long; 3) Special ICA mixtures fed during the wet season only. These experiments will be carried out in three locations, with forages and animal tissues collected for analysis every six months. Samples will also be collected from five or six ranch locations which have recently been designated.

Dr. Laredo has pointed out the severe problem posed to ICA by the increasing costs of mineral supplements. As an example of how prices have increased, various prices at different times have been as follows:

Date	Cost
Jan., 1980	14 pesos/kilo
July, 1980	25 pesos/kilo
July, 1981	40 pesos/kilo

Four recent ICA publications have dealt with mineral research. The authors and titles of these papers are as follows:

1) Huertas, Hugoberto, Max Alberto Laredo C., José E. Manzur and Edgar Ceballos B. 1983. Efecto del cobre, fósforo y calcio en ganancias de peso del ganado en pastoreo. ICA Journal.
2) Laredo C., Max Alberto and Alberto Carillo Matiz. 1983. Estado de nutrición mineral en hatos lecheros de la sabana de Bogotá. ICA Journal.
3) Laredo C., Max Alberto and Juvenal Gomez. 1983. Fluctuaciones minerales en pastos tropicales. 1. Brachiaria en los Llanos Orientales. ICA Journal.

4) Vargas B., Ricaurte, Max Alberto Laredo C. and Carlos Buitrago. 1982. Efecto de la suplementación de Ca, P, Cu and Zn en ganado para carne. ICA Journal.

During a visit last September (1981), Dr. Laredo discussed the forage analysis program for the coming year. They plan to analyze 5000 samples this year. The principal areas to be studied and the forage species to be collected are as follows:

1. Llanos Orientales
   A. Carimagua
      a. Brachiaria
      b. Atropogon
   B. Villavicencio
      a. Brachiaria
      b. Antropogon
      c. Brachiaria and Kudzu
2. Tolima
   A. Arnero
      a. Puntero
      b. Pangola
      c. Angleton
3. Magdalena Medio
   A. Puerto Salgar
      a. Puntero
      b. Angleton
   B. Puerto Boyacá
      a. Angleton
      b. German
   C. La Dorada
      a. Angleton
      b. German
      c. Puntero

Forages will be collected every month from these locations. International Minerals (IMC) and Florida will be assisting with some of the analyses.

A mineral experiment at Carimagua in the llanos was set up by ICA to evaluate the seasonal need for mineral supplements. Some of the treatments were not as we had recommended as we felt that at least one treatment should be control, with salt only and no phosphorus supplement. The treatments were as follows: 1) complete mineral supplement; 2) 70% salt plus 30% dicalcium phosphate; 3) 70% salt plus 30% phosphoric acid; 4) 70% salt plus 20% phosphoric acid plus 10% urea. These treatments were given to weaned heifers and the experiment will have a duration of three years.

The treatments have been further divided so that animals receive the mineral mixtures either all year long or just 5 months of the wet season. It is interesting to note that in each treatment the group receiving minerals just during the wet season performed better than those fed all year long. The reason this experiment was designed was to determine if minerals could be fed during the wet season only, based on the theory that animals were losing weight during the dry season due to lack of energy and protein, not lack of minerals, and that mineral requirements would be greater during the wet season when there was adequate energy and protein available in the forages.

An additional experiment is now underway at Carimagua involving four treatments with 32 animals each. The treatments are as follows: 1) salt + phosphoric acid + 10% urea; 2) control + Cu; 3) control + Zn; and 4) control + Cu + Zn.

Another important contact is Dr. Charles Mullenax, a U.S. veterinarian who lives in Villavicencio (in the llanos). Dr. Mullenax has had tremendous experience with mineral-related diseases in the llanos and has an excellent background in chemistry and pathology. Dr. Mullenax has very good suggestions as to what the possible causes of some of common disease conditions might be and is hopeful that research will continue to more closely identify the etiology of these conditions. Dr. Mullenax's remarks on four of these pathological conditions are as follows:

"The diseases are, in local terminology, 1) Calambre, 2) Vacas Infladas, 3) Secadera and 4) Pathological (Spontaneous) Fractures. The impact of these 4 diseases on productivity in the area of the Llanos in which I have worked most is indicated by the following: Of deaths in cattle over 10 mos. of age, Calambre (which has a 90 to 100% mortality), accounts for 41%; secadera for 11%; and fractures about 22% actual deaths. (Less than 40% make an adequate recovery so that all animals which are in good enough condition, etc., are salvaged for meat). The incidence of Vacas Infladas has a cyclical nature and some years reaches epizootic proportions wherein 25% of pregnant cows abort or produce calves dead at birth or which die shortly thereafter.

Calambre - Although this disease may be seen at any time of year, 80% of all cases occur during the dry season - between December and March - and 45% of the total annual cases occur in February (when forage calcium and magnesium levels are lowest and potassium highest). There is a secondary peak, accounting for approximately 10% of all cases, in September.

The disease is rarely, if ever, seen in calves but can occur in animals of all ages and sexes. The lactating cow appears to be 8 times more susceptible than any other group.

Calambre has features in common with Downer Cowd, Creeper Cowd, and Grass Tetany (but not Milk Fever). It is not identical to any of these nor does it respond to the usual treatments for these diseases (with the exception that large doses of magnesium given intramuscularly have not been tried yet). It also has features both etiologically, clinically and pathologically very similar to Rhabdomyolysis with renal injury in man.

The occurrence of Calambre appears to require a "predisposing" factor (the most appealing possibility at present being an imbalance in the relation K/Mg + Ca), and a "precipitating" factor which is usually some form of stress, usually physical but sometimes nervous. The histamine content of lush green grass during periods when there is no rain (as is the case with subirrigated "bajos" in the dry season) may also play a role in the etiology.

The typical signs of the disease begin with a nervous, hyper-excitable state, aggressiveness and disorientation. The eyes may show a dazed appearance or vacant stare. These signs may be accompanied or followed by muscle fasiculation of the ears, tail and legs. If the animal is standing, it usually shows muscular weakneww of the limbs and incoordination, especially in the rear legs (the major

muscles of which normally have the highest K content of all muscle tissue). The animal may collapse at this point (if not already down), showing a flaccid paralysis of the limbs, the hind limbs usually being more severely affected than the forelimbs (if the forelimbs are affected at all). At this point the hyperexcitability disappears and the eyes return to normal. The animal is able to maintain sternal recumbency until shortly before death, which may occur from 3 to 10 days or more after onset of the paralysis. There are neither tonic nor tonoclonic muscle spasms and certainly not the marked tetany and sudden death seen with grass tetany.

The digestive and urinary tracts function more or less normally and, though the appetite is reduced, total anorexia doesn't occur until 1 or 2 days before death.

At necropsy some muscle groups, especially of the rear limbs, appear more pallid than normal but there are no lesions typical of White Muscle Disease. Myoglobinuria is occasionally encountered. Microscopically, there is found in some but not all cases: 1) necrosis (Zenker's) of various muscles, but little inflammation, and 2) degeneration of renal tubules which may contain hemoglobin and/or myoglobin.

Potassium chloride at the rate of 25-45 mg/kg live weight in a 10% solution given slowly I.V. and repeated at 12 hour intervals for 2 to 3 days as necessary has produced dramatic recoveries in a number of cases, some of which had been down for as long as six days prior to treatment. It is the only treatment we have found that is effective. Unfortunately, it does not work in all cases, its effectiveness appearing to vary with the time of year and mineral status of the animals. Cases treated in any month other than January or February are more apt to respond as are animals receiving mineral supplements.

It is not likely that the response to this treatment implies an absolute potassium deficiency, as forage levels appear to be nearly adequate most of the year and (possibly) excessive in February. Thus we may be dealing with two related but different conditions involving mineral imbalances.

Vacas Infladas (Hydrops allantois; Hydrops anmii?) - This is another disease in which abnormal mineral metabolism is involved. Based on the limited data we have accumulated so far, it appears that the immediate cause of this condition is necrosis and mineralization of the placenta in the pregnant cow. The fetal tissues (trophoblast of the chorion) are more severely affected than the maternal tissues. The deposition of calcium oxalate apparently impedes circulation between fetus and dam, resulting in accumulations of 200 liters or more of fluid in the uterus. (This can reach proportions such that the weight of the fluid makes it impossible for the affected cow to rise). Some of the lab studies indicate abnormal Na and K levels and, as will be explained below, there are indications of adrenocortical deficiencies.

The end result in the majority of cases is abortion at the 8th to 9th month of gestation or stillborn calves or weak calves that die shortly after birth (95%). Placental retention is the rule as is the finding of up to 500 gm of mineral crystals free in the uterus.

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 has conducted some excellent mineral research took early retirement and Dr. Jorge Lopes trnasferred under contract to the UFRGS (Federal University).

Affected cows can often be recognized visually and/or by palpation as early as the 4th or 5th month of gestation. If treated at this time with corticosteroids the condition is usually resolved and a normal calf produced. Spontaneous recoveries occur following stress (such as transport). Cows treated after the 6th month of gestation usually abort but if not, the resulting calf is dead or abnormal at birth.

Calves carried to term are usually markedly cachectic, have various articular malformations, and show a variety of lesions in the internal organs. We have not, so far, been able to demonstrate any infectious agent but in some electron microscope studies, there were indications of viral inclusions.

Secadera - This is a syndrome which CIAT-ICA appear to be labelling simply "Inanition" in their annual reports, and which could, perhaps, be defined as progressive inanition in which there is evidence of failures in intermediary metabolism. The following description is based primarily on detailed observations of 25 cows selected from over 120 cases of which 67 were females. It shows in the course of its development some symptoms in common with both hyper- and hypo-adrenocorticism. It affects cows (both dry and in lactation) with greater frequency than any other group. Forty-five percent of all cases in cows occur in September 40-50 and 20-25 days after the 2 peak periods of biting insect distress and 30 days after peak internal parasite egg production. The insect attacks reduce grazing time by as much as 30 to 50%. The peak incidence also coincides with the lowest annual level of zinc in native grass.

The pathognomonic sign of incipient secadera in light skinned animals is a marked darkening of the skin made more visible by brittle, dry hair which tends to curl up. Later the skin becomes thickened and loses pliability. Beginning at the same time, probably, but certainly evident visually within a week, is a rapid, continuing loss of weight which is not related to appetite as 80% of the cases maintain a good appetite. Approximately 50% of the cases develop muscular weakness with 12% showing incoordination or ataxia involving the rear legs. Some 8 to 10% of affected animals may show tremors in various muscle groups. A small percentage have flaccid paralysis of the tail (Trypanosomiasis?). Only about 30% of the cases show marked depression and there are the ones most likely to die. Ten percent are hyperexcitable and unusually nervous; and another 5% are unusually dull, some to the point of not responding to visual stimuli. In 8-12% of the most advanced cases there is ketosis. An occasional case shows a jugular pulse (related at necropsy to a thinning of the right ventricular wall), and 8% show submandibular or ventral edema. Especially in younger animals, the prefemoral and prescapular lymph nodes may be abnormally large and prominent.

Necropsy findings are variable, ranging from no discernible gross pathology to spongy and/or brittle bones (mainly head and ribs), pallid muscles, hemosiderin deposits in various tissues and organs, thyroid glands either hypertrophied or atrophied, and atrophy of the adrenal cortex. Lymph glands are frequently congested and enlarged.

Microscopically, hemosiderin deposits and chronic microgranulomas have been found in various tissues in the few cases studied so far.

None of the many treatments employed to date have given a definite response. Of the common trace minerals, only Se and Zn remain to be evaluated by injection. Corticosteroids are useful but, so far, haven't seemed to be the key to a rapid

recovery. There is no consistent response (if any) to antibiotics, antihemoparasite drugs or vitamins, including B_{12} which has been claimed in some areas to hasten recovery. The cases in this study received, for the most part, mineral supplementation which happened to include 65 ppm of Co and showed no particular response to the administration of either Co or vitamin B_{12}. Neither was there a response to Cu.

Nevertheless, some 60 to 75% of secadera cases can be saved by removing them from the herd, reducing handling and stress as much as possible, and providing them with the best feed and most complete mineral supplement possible. If an affected cow is lactating she should be dried up. Even for the least severe cases and under the best of conditions, the recovery period may extend from 1 to 2 months. Severely affected animals require up to 6 months to make a full recovery.

Pathological (Spontaneous) Fractures - Forty-five percent of all fractures occur in the period June-August; another 20% occur during January and February. The group most severely affected is 1 to 2-year old males (8.1% of the population); the second highest incidence (5.7%) occurs in males over 2 years of age. Of females, lactating cows are most severely affected (2.0% of the population) - twice as many as in dry cows. Even in herds receiving free choice mineral supplementation, the annual incidence of fractures in the entire herd may vary, year by year, from 1.2 to 3.0%. About half of the fractures occur in the pastures when no handling of stock is involved. Of total fractures about 5% occur in the pelvis, 12% in the vertebral column and most of the remainder (80%) in the limbs usually in the middle or distal third of the long bones.

The June-August peak coincides with the following forage values: highest Ca, near highest Cu, lowest P and lowest N (which is relevant in view of the fact that the carbon atoms used for collagen synthesis are apparently derived primarily from amino acids). The secondary peak in January-February coincides with maximum P, N, Cu and minimum Ca values in forage (the reverse of the situation in June-August). There is some evidence for Fe interference with Ca in April when Fe, always in excess, is at its peak, with the result that (if the Ca/P ratio is important) the incidence of fractures remains unchanged despite an apparent increase in forage Ca which brings the Ca/P ratio closer to normal. Based on Lebdosoekojo's Carimagua forage analyses and NRC recommendations, a lactating cow consuming 7.5 kg of dry matter per day in the Llanos runs an average daily deficit of 13 g of Ca and 10 g of P."

Another main contact in relation to minerals is Mr. Wayne Miles, formerly of AID. Mr. Miles had the condition of secadera on his ranch, "La Plata", in the llanos. This disease condition has been known since the early 1950's and consists of gradual and continual loss of condition ending in death. Both ICA and CIAT veterinary personnel have been out to his ranch to do metabolic profiles; they found nothing but made the suggestion that the disease was related to tick infestation. Thus Mr. Miles spend considerable amounts of money for prevention of ticks. Several years ago, 65 calves out of a lot of 95 died of secadera and those that did not die at that time, died the following year.

In correspondence and personal visits, Drs. McDowell, Loosli and Conrad had suggested to Mr. Miles that minerals should be considered and that the mineral mixture he had been using was inadequate in certain minerals. The mineral mixture was a CIAT mixture that, upon evaluation, was found to be

extremely low in copper and zinc, and devoid of selenium. With suggestions from Florida staff, these minerals were added to the mixture so that at least 50% of all trace mineral needs were met. Since using this mineral mixture, there have been no secadera problems for two years. Last September, however, a few animals from a new herd did develop secadera but careful examination revealed that the mineral box was too high for these animals to reach. Once this was remedied the animals which had exhibited secadera quickly improved. Mr. Miles had also given mineral supplements to his neighbor who also noted excellent results.

Due to the importance of secadera, an M.S. degree research program is now being carried out in the llanos of Colombia by Dr. Roberto Vargas. The title of the program is "The Mineral Status of Cattle in the Eastern Plains of Colombia and Its Possible Relationship with the "Secadera" Problem". A copy of the proposal for this program is found at the end of this section of the report. Dr. Vargas has now collected samples from Colombian ranches during the wet season (July-August, 1981) and the dry season (January-February, 1982) and plans to have the results written up by this coming August.

Mr. Miles is the most adamnant "pusher" of mineral supplements in Latin America. He has written two popular articles on the benefits of minerals as follows: 1) Miles, Wayne. 1980. Mayor producción ganadera. Carta Ganadería, Febrero, pp. 26-30. 2) Miles, W. 1979. Programa para modernización de la ganadería Colombiana. Carta Ganadería, Diciembre, pp. 13-38. A new article on mineral deficiencies in the llanos of Colombia has recently been written by Mr. Miles and L. R. McDowell.

Mr. Miles has closely reviewed the mineral supplementation program and all literature related to minerals in the llanos. From a survey carried out by CIAT, there was an obvious improvement in animals that received minerals versus those receiving only salt. On close scrutiny, Mr. Miles has analyzed the data and concluded that animals receiving mineral supplementation have a 98% higher production rate. This production rate would be measured as 1) calving percentage; 2) death losses of all classes of cattle, particularly calves prior to weaning; 3) daily rates of gain; 4) average weight of breeding cows. During a meeting at CIAT, the statistical evaluation of the economics of mineral supplementation was discussed with CIAT personnel. Their overall conclusion was that minerals were economically beneficial but only when they had been fed for five years. Those of us at the meeting who were not with CIAT disagreed with this conclusion since many of our studies and observations have indicated a dramatic improvement during the first year. There was considerable discussion concerning how their figures were calculated. Mr. Miles pointed out that his calculations give a much better picture for supplementation. Death losses for all classes of cattle, particularly for calves prior to weaning, were not included in CIAT's statistics. It was finally admitted that there are insufficient data from which to make economic assessments.

An additional mineral which deserves consideration is sulfur. Mr. Miles, who is an agronomist, noted that the llanos have been burned for thousands of years, both naturally and artificially, and that this burning has resulted in low sulfur concentrations in forages. On the basis of analyses, Mr. Miles has suggested that 8% sulfur be added to llanos cattle diets. Dr. Laredo of ICA had some analyses which showed that sulfur appeared to be relatively adequate in quite a few areas of Colombia; however, at Villavicencio (the llanos region), sulfur was low, with three samples containing .03, .02 and .02% of this mineral.

Within the past year, Florida has had 10 forage samples analyzed, 8 of which are from the llanos of Colombia (Miles, Soekanto) and 2 of which are from the llanos of Venezuela (Velásquez). The results of these analyses are as follows:

	% sulfur	Season	Av. % sulfur
Sample #1 (Miles)	.049		
#2 (Miles)	.040		
#3 (Miles)	.068		
#4 (Miles)	.049		.0515
#5 (Soekanto)	.076	Early Rainy	
#6 (Soekanto)	.057	Early Rainy	
#7 (Soekanto)	.088	Early Dry	
#8 (Soekanto)	.069	Early Dry	.072
#9 (Velásquez)	.032	Dry	
#10(Velásquez)	.075	Wet	.0535

It is apparent that more research is needed to determine the benefit of sulfur supplementation. On the basis of the analyses, sulfur supplementation is warranted since every forage value from the llanos is less than 1/2 the recommended requirement.

In 1979, an AID contract proposal entitled "Mineral Deficiencies Limiting Cattle Production in the Colombian Llanos" was submitted. Assistance in the preparation of this proposal was provided by Dr. David Schaer (former Rural Development Officer in Colombia), Dr. James Oxley (formerly of the Development Support Bureau of AID in Washington) and Mr. Wayne Miles. This 25-page document pointed out the need for mineral research and the expected returns from proper mineral nutrition. It is hoped that this program will eventually be funded.

Master's Proposal for Roberto Vargas

Title: The Mineral Status of Cattle in the Eastern Plains of Colombia and Its Possible Relation with the "Secadera" Condition

Introduction: The Eastern Plains of Colombia comprises approximately 25% of total land area of the republic and has about 6 million cattle or approximately 25% of the total cattle in the country. Due to poor soil fertility, lack of technology and an insufficient infrastructure, cattle production in this area is low. One of the most important factors of low production is mineral malnutrition; in this regard, reports from ICA and CIAT, as well as those from private veterinarians, have demonstrated excellent responses from mineral supplementation. The few studies carried out in relation to minerals have reported severe deficiencies of Ca, P, Cu, Zn, I and S, as well as an excess of Fe, with mineral concentrations varying from the wet to the dry season.

According to reports from ICA and CIAT, the condition responsible for the highest index of incidence and mortality is the "secadera" condition. Despite the severity of the problem, little research has been done on secadera. The symptomatology and pathology of the condition is not well defined, but it is accepted by most veterinarians that its origin is metabolic rather than infectious or parasitic; however, its etiology is absolutely unknown.

Purpose:
1) To establish the mineral status of the pastures in the Eastern Plains.
2) To establish the mineral status of the cattle in the Eastern Plains.
3) To establish the mineral interrelationships between cattle and pastures.
4) To describe the symptomatology and pathology of the secadera condition.
5) To search for a possible relation between secadera and the mineral status of the cattle in the Eastern Plains.

Date of Research: The month of July, the time of year when secadera is most prevalent.

Location of Research: Six to ten ranches located in the areas where the secadera condition is most prevalent, in the states of Meta, Vichada and Casanare.

Institutions Involved: University of Florida, ICA, Caja de Crédito Agrario, National University of Colombia, Fondo Ganadero de Cundinamarca, Fondo Ganadero del Meta, Comité de Ganaderos del Meta, INPEC Ltda.

Research Proposal: As an introductory explanation, for the purpose of sampling, it is necessary to take into consideration the places where the sampling will be done. Because of the bad conditions or lack of roads, lack of electricity and infrastructure, difficult working conditions and the time of year when the sampling will be done (rainy season), the conservation, delivery and preparation of samples may be complicated. Soil, pasture, liver, bone and necropsy samples will be collected in any case, and fecal, blood serum and blood plasma samples will be collected if conditions permit. From each farm, samples from both healthy and diseased animals (cows 5-10 years old, mainly) will be taken, and a standardized questionnaire for farm description will be completed. Two or three necropsies

will be done on typical secadera cases. The collection and handling of samples would be as follows:

1) Soil - 2 to 5 samples from different regions of the farms. Soil samples would be collected at the same spot where forage samples are taken.

2) Separate samples of each of the major forage species should be taken. This would likely involve 2 to 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 percentage 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 to 5 samples from 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 stell equipment), and the samples should be transported to Florida.

3) Blood plasma - From each farm, 10 samples should be collected from randomly selected healthy cows, and an undetermined amount of samples from diseased animals, depending on their availability. Approximately 30 to 40 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 separate 10 cc. The other 20 cc will be centrifuged within 2 to 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 - Ten samples of liver (biopsy) can be collected from both healthy and diseased animals, if possible, at the same time as blood is collected. Samples would be stored in biopsy bottles under refrigeration (or freezing) or in 10% formaldehyde.

5) Bone - If possible, bone samples (biopsy or slaughterhouse) 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 and the samples stripped of all soft tissue. Four cm of the central part of the right rib is cut and split into halves with the bone marrow removed using a jet of distilled water. Two cm 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.

6) Necropsies - Two or three animals with typical cases of secadera will be selected for the purpose of necropsy studies. Samples of the following organs will be taken: brain, pituitary, spinal cord, skin, muscle, bone, spleen, liver, kidney, pancreas, adrenals, thyroid gland, sections of the gastrointestinal tract, lungs, and all the samples that

at the time will be considered valuable for the purposes of the research. Samples will be placed in buffer formaldehyde prior to shipping to Florida.

7) Fecal samples - Fecal samples will be collected and analyzed for parasites only if conditions permit.

8) Symptomatology - The symptomatology of the sick animals will be carefully observed. A complete examinstion of each sick animal will be carried out and the observations recorded.

9) Blood serum and plasma samples for clinical and pathological studies - (10 cc - see section 3).

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 and N.

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.

6) Necropsy - Histopathological studies of the collected samples will be done at the University of Florida.

7) Feces - Feces will be analyzed for parasites, if possible, on the ranches or shipped to Villavicencio for examination (only if conditions permit).

8) Clinical pathology - Blood counts, hematocrit, hemoglobin, hemoparasites, and plasma metabolic profile.

Colombia Contacts

Ambassador Boyatt
Mr. Lloyd I. Holmes (tel. 2329974)
(agriculture attaché)
Mr. Hector Sarmiento
Mr. Alberto Restrepo
United States Embassy
Bogota, Colombia

Dr. Arturo Gil (Tel. 2326305)
Empaques Impresos en Polietileno
Carretera 44 No. 20-10
Apartado Aéreo 29603
Bogotá, Colombia

Mr. Wayne Miles (tel. 2536241)
Gerente Sociedad Ganadera La Plata, Ltda.
Apartado Aéreo 51612
Bogotá, Colombia

Dr. Alejandro Uribe
Universidad Nacional
Facultad Veterinaria
Bogotá, Colombia

Dr. Juan Salazar (Tel. 236461)
Carretera 13-A
No. 9723
Bogota, Colombia

Ing. Jaime Garcia
Departamento Técnico
Jaramillo, Uribe & Cia
Apartado Aéreo 3823
Medellin, Colombia

Dr. Charles Mullenax
Apartado Aéreo 2118
Villavicencio, Colombia

Dr. Max Laredo
Programa Nacional de Nutrición Animal
Instituto Colombiano Agropecuario (ICA)
Apartado Aéreo 11523 Eldorado
Bogotá, Colombia

Ing. Rodrigo Pastrana B.
Programa Ovino Tibaitatá
A.A. 151123 Eldorado
Bogotá, Colombia

Dr. Carlos Lascano
Dr. J. Toledo
Dr. E. Aycardi
Dr. J. G. Salinas
Dr. C. Seré
Dr. R. D. Estrada
Dr. Jim Spain
Dr. John L. Nickel
Centro Internacional de Agricultura
Tropical (CIAT)
Apartado Aéreo 6713
Cali, Colombia

Ing. Rafael Noriega R.
Apartado Aéreo 2737
Villavicencio, Colombia

Costa Rica

Since 1975 the mineral research effort in Costa Rica has been outstanding. An evaluation has been made of a large part of the country in relation to where mineral nutrition would most likely be limiting. Each individual area was first surveyed as to the number of beef cattle and dairy cattle in order to determine which areas would be most important for the collection of animal tissues and forage samples. A large number of samples have been collected from 371 farms primarily by 11 Peace Corps volunteers who worked in the program from September, 1976 to December, 1978.

For collection purposes, the country was divided into four zones: 1) dry Pacific, 2) southern, 3) Atlantic and 4) central zone. These zones were further subdivided into 7 provinces, counties within the provinces, districts within counties and farms within districts. All of this information was coded for computer analysis, with additional codes given for the type of tissue and individual farm. Also included in the data were the age and sex of animals, pasture species and stage of maturity and date of collection. All of the analyses have now been completed for the wet season and many are now being completed for the dry season.

The data are analyzed by students at the Facultad de Agronomía of the University of Costa Rica and are written up as part of their egresado degree theses. To date, 29 egresado theses have been completed in the mineral area. As data are completed, they are written up and given to the individual participating farmers. For each particular region, 4 to 6 page handouts of the conclusions are distributed to farmers and extension personnel. Individual egresado degree candidates and the University staff are also traveling to specific regions and giving seminars on the results of the studies.

The mineral research program in Costa Rica may be divided into three stages. The first stage involved collection and analysis of samples from various regions throughout the country. The second stage involves reanalysis of samples and regions suspected as problems as well as publication of data in both extension and scientific publications. Papers are generally published by mineral status of each province and include maps of deficient or toxic areas. Much of the data will be published in the local Journal "Agronomía Costaricense". Some papers will be published both in Spanish and English; suggestions for appropriate English journals were provided.

The third stage of the mineral research program involves supplementation trials. The overall design for the mineral supplementation phase is illustrated in Table 1. The supplementation phase will last a minimum of five years and will include supplementation trials with both dairy and beef cattle. Three experimental farms will be chosen from the each of the following zones: 1) central, 2) dry Pacific, 3) wet Pacific and 4) Atlantic. The Florida staff has spent considerable time going over experimental designs that would be appropriate and will provide the Costa Rican program with injections of Se-vitamin E, Cu, and Co bullets.

TABLE 1. THIRD STAGE OF COSTA RICAN MINERAL RESEARCH PROGRAM

Supplementation Phase

Objective: To measure the biological response to mineral supplementation in various problem areas of the country.

Type of Animals: a) Beef cattle
b) Dairy cattle

Experimental Animal:

1 - Weaned heifers (male and female)
a) 150-300 kg
b) 300-450 kg
2 - Breeding herd

Treatments:

1 - With supplementation
2 - Without supplementation (control)

Parameters to be evaluated:

1 - Males

1. Monthly weight gain
2. Mortality rate
3. Clinical symptoms of mineral deficiencies
4. Trimonthly analysis of blood
   a) Hematocrit
   b) Serum minerals
   c) Hemoglobin
   d) Ceruloplasma
5. Biannual liver analysis
   a) Biopsies for mineral analysis
6. Forage analyses
   a) Minerals
7. Soil analyses
   a) Minerals
   b) pH

2 - Females

1. Age at first conception
2. Age at first calving
3. Birthweight of calf
4. Calf mortality rate
5. Weaning weight of calf
6. Conception rate
7. Fertility rate
8. Calving interval
9. Complications at birth
10. Milk production

TABLE 1. (continued)

Location: Three representative farms will be chosen from each of the following zones:

A) Central zone
B) Dry Pacific zone
C) Wet Pacific zone
D) Atlantic zone

Duration: Five years (1980 - 1985)

Personnel: Jorge M. Sanchez
Emilio Vargas
Juan Coward
Carlos Jímenez
María E. Li
Carlos Campabadal

TABLE 2. MINERAL ANALYSES OF FORAGES IN COSTA RICA (WET SEASON)

Province	No. of Samples	Protein	%				ppm			
			Ca	P	Mg	K	Fe	Cu	Mn	Zn
San José	81	18.02	0.214	0.252	0.183	2.61	196.05	12.54	56.93	29.81
Alajuela	367	10.04	0.814	0.139	0.134	1.48	319.29	5.94	58.81	16.44
Cartago	58	16.38	0.244	0.199	0.166	2.60	337.51	11.05	75.76	28.43
Heredía	36	13.71	0.311	0.238	0.214	2.32	224.63	8.01	182.01	31.13
Guanacaste	539	7.61	0.234	0.148	0.114	1.18	175.34	3.11	21.28	9.81
Puntarenas	228	8.23	0.227	0.155	0.107	1.11	168.56	2.81	42.90	11.60
Limón	159	9.81	0.136	0.147	0.137	1.20	1103.14	11.30	220.49	28.67
PROMEDIO	1468	11.97	0.161	0.183	0.155	1.79	360.65	7.82	94.03	22.27

TABLE 3. MINERAL ANALYSIS OF FORAGES IN COSTA RICA (DRY SEASON)

Province	No. of Samples	Protein	%				ppm			
			Ca	P	Mg	K	Fe	Cu	Mn	Zn
San José	81	16.01	0.235	0.099	0.280	4.06	227.99	10.29	73.26	32.86
Alajuela	391	8.96	0.203	0.101	0.180	1.99	313.32	6.55	84.22	20.58
Cartago	65	14.91	0.197	0.126	0.214	3.43	277.80	7.49	142.04	33.27
Heredia	20	7.54	0.196	0.151	0.178	1.35	125.00	5.00	103.50	16.00
Guanacaste	521	4.06	0.271	0.080	0.139	1.08	213.44	3.23	39.71	23.51
Puntarenas	192	4.97	0.247	0.102	0.142	1.42	258.79	3.36	89.21	36.69
Limón	62	8.44	0.205	0.110	0.243	3.10	523.78	7.18	199.10	30.80
PROMEDIO	1335	9.27	0.222	0.109	0.197	2.35	277.16	6.16	104.43	27.67

TABLE 4. MINERAL ANALYSIS OF BOVINE BLOOD SERUM

Province	No. of Samples	mg/100 ml Ca	P	Mg
		(Dry season)		
San José	84	8.46	4.32	2.62
Alajuela	407	9.32	4.72	2.73
Cartago	66	8.47	4.39	2.43
Heredia	12	8.63	5.12	3.44
Guanacaste	648	10.88	5.27	2.74
Puntarenas	214	10.91	4.99	2.99
Limón	123	11.45	6.90	2.89
Promedio	1554	9.73	5.10	2.83
		(Wet season)		
San José	81	10.34	5.02	2.26
Alajuela	369	10.84	4.63	2.42
Cartago	66	10.19	4.99	2.27
Heredia	34	10.59	5.62	2.37
Guanacaste	519	10.37	4.85	2.59
Puntarenas	253	10.34	5.60	2.51
Limón	163	11.29	4.65	2.99
Promedio	1485	10.57	5.05	2.49

TABLE 5. MINERAL ANALYSIS OF LIVER TISSUE

Province	No. of Samples	Fe	Cu	Mn	Zn
			ppm		
		(Dry season)			
San José	136	276.87	121.70	4.17	101.02
Alajuela	166	268.06	96.50	4.72	106.20
Cartago	10	127.88	59.40	4.31	63.64
Heredia	7	175.28	34.66	4.14	79.71
Guanacaste	102	256.17	122.85	4.39	102.15
Puntarenas	20	374.89	59.19	4.16	112.97
Limón	3	199.33	167.00	4.00	162.00
Promedio	441	239.78	94.47	4.27	103.96
		(Wet season)			
San José	62	254.24	225.24	6.69	165.50
Alajuela	42	392.49	72.83	8.22	152.57
Cartago	25	226.67	258.83	7.38	235.98
Heredia	5	419.20	69.00	8.60	89.40
Guanacaste	54	209.91	156.93	7.04	178.03
Puntarenas	18	227.81	331.54	6.85	133.07
(Limón)	--	--	--	--	--
Promedio	206	288.39	185.73	7.46	159.09

Tables 2 and 3 illustrate the results of forage analyses for both the wet and dry seasons. The number of samples for each of the provinces was 250, 600, 150, 100, 800, 700 and 150 for San José, Alajuela, Cartago, Heredía, Guanacaste, Puntarenas and Limón, respectively. The data would indicate that the most deficient mineral is phosphorus, followed by copper. Limón had extremely high forage concentrations of iron which probably interferes with the uptake of other minerals. Manganese is particularly low in Guanacaste, being 39.7 and 21.3 ppm for the dry and wet seasons, respectively. Several individual farms had much lower averages. It is interesting that in Guanacaste, observations have been made of calves with clinical signs suggestive of manganese deficiency. Zinc forage concentrations were low for all regions, particularly Guanacaste and Puntarenas during the wet season (9.8 and 11.6 ppm, respectively).

Table 4 presents blood data averages for calcium, phosphorus and magnesium. A high percentage of animals are deficient in phosphorus as indicated by blood phosphorus values. Table 5 presents liver mineral concentrations. Liver copper and zinc concentrations were low for some regions and farms.

The predominant native forage in Costa Rica and throughout Central America as well is Hyparrhenia rufa. This forage is not only low in minerals but in protein as well. Looking at a monthly report of forage analyses, protein concentrations of Hyparrhenia rufa samples varied from 2.12% to approximately 7%. Seven percent is often considered a critical percentage. From June to November, the forage protein is approximately 7%; however, the rest of the year, forage protein is below this level.

For the next two years, a strong effort will be made to publish the data collected in the 29 theses. The Florida-AID contract has promised to provide funds of $5,000.00/year to assist with computer and publication costs. Since 1977, only a limited number of consumable supplies have been provided to the Costa Rican program. In 1981, the project did provide funds for Ing. Emilio Vargas to attend and present mineral data at the ALPA meetings in the Dominican Republic.

Costa Rica Contacts

Prof. Hernán Fonseca (Home Tel. 25-39-26)
Ing. Carlos Jiménez (Dept. Head) (Tel. 24-55-27, Home 24-28-61)
Dr. Carlos Campabadal (Home - 25-16-75)
Dr. Carlos Chavez
Ing. Jorge Sanchez
Ing. Emilio Vargas (Tel. 25-04-93)
Universidad de Costa Rica
Ciudad Universitaria "Rodrigo Facio"
San José, Costa Rica

Ing. Carlos Lang R. (Tel. 33-31-10)
Presidente Nutec, S. A.
Nutrición Técnica
Apartado Aérep 2000
San José, C. R.

Mr. Larry Laird
AID - Misión de los EE.UU. en Costa Rica
c/o American Embassy
San José, C. R.

Ing. Fernando Calderón L. (Tel. 21-47-78)
Servicios Técnicos
Dawe's Laboratories of Central America
Apartado Postal 2222
San José, C. R.

Ing. Pedro J. de Matheu
Dr. Rolando Quesada B.
Ing. Fernán J. Peralto Volio
Pfizer, S. A.
Apartado Postal 10202
San José, C. R.

Mr. Tim Roberts (Tel. 46-50-50)
Dr. Byron Hopwood (Beef)
Dr. David Black (Head)
Ing. Miguel Grillo
Mr. Bill Hobbs
Escuela C. A. de Ganadería
Atenas, C. R.

Dominican Republic

The first visit to the Dominican Republic took place in February, 1980; since that time, two additional visits have been made. Much of the mineral research program has involved work associated with the M.S. degree program of Ing. Máximo Jerez. The research proposal for Ing. Jerez's program is presented at the end of this section of the report.

The research conducted by Ing. Jerez consisted of collecting samples for mineral analysis from 7 ranches in the eastern region of the Dominican Republic during the summer of 1980 (dry season). The data has now been analyzed and the thesis will be completed in March, 1982. Deficiencies of protein, phosphorus, copper and zinc were found.

Plans for a comprehensive mineral research program in the Dominican Republic are being made by the Ministry of Agriculture. A list of needed equipment and supplies for mineral research has been prepared. As part of the overall plan, a laboratory technician, Gladys de Batista, was trained in mineral research procedures this past fall at Florida.

A mineral supplementation experiment has been set up not too far from Santo Domingo. The Florida mineral project is helping out with mineral analyses of samples related to this experiment. The particular experiment was designed for a duration of two years, one of which has already passed. In this experiment, a total of 300 breeding cows were divided up into the following treatments: 1) Control - no supplementation; 2) Mineral supplementation all year; 3) Wet season supplementation for six months only; and 4) Dry season supplementation for six months only. All animals will receive molasses and urea during the dry season. With this particular design, the animals are divided into two total groups and pasture rotation is used. During the dry season, the control group is pastured together with the wet season supplementation group, while all year supplementation and dry season supplementation groups would be together. During the wet season this combination would change so that the wet season supplementation group is with the all year group and the dry season and the control groups are together. All animals in this experiment receive combinations of molasses and urea during the dry season. There is a four-month breeding season that lasts from May to September.

Dominican Republic Contacts

Mr. Kenneth Ellis
Food and Agriculture Officer
c/o La Embajada de los EE.UU
Santo Domingo, Dominican Republic

Dr. Marcelino Vargas Vargas
(Director General de Ganaderia)
Santo Domingo, Dominican Republic

Dr. Mario J. Fernández
(Encargado de Producción)
Ing. Agr. Yocasta Soto de Rosa
CENIP
Secretaria de Estado de Agricultura
Santo Domingo, Dominican Republic

Ing. Agr. Manuel E. Isidor Sosa
Director de Producción y Fomento
Dirección General de Ganaderia
Santo Domingo, Dominican Republic

Dr. William Hargas
FAO, Naciones Unidas
Apartado Postal 1424
Santo Domingo, Dominican Republic
Tel. 567 6414

Dr. Hans Schaeffler
Director CEAGANA
Consejo Estatal del Azúcar
Santo Domingo, Dominican Republic

Ing. Máximo Jerez
Calle 4° No. 20 SAVICA
Santiago, Dominican Republic

Instituto Superior de Agricultura
Apartado 166
Santiago, Dominican Republic

Dr. Ramón A. Beras Cisneros
Dr. Julio Ponce
CENIP,
Secretaría de Agricultura
Santo Domingo, Dominican Republic

Ing. Gregorio Garcia Lagombra
Estación Experimentál Ganado de Carne
Secretaría de Agricultura
Higuey, Dominican Republic

Dr. Nelson Kingsley
Dirección Genéral de Ganadería
Secretaría de Agricultura
Santo Domingo, Dominican Republic

Sr. y Sra. Pedro Parra
Calle 10 No. 6
Ens. Evaristo Morales
Santo Domingo, Dominican Republic

Ing. Emilio Armando Olivo
Director
Centro de Investigación y Mejoramiento de la Producción Animal (CIMPA)
Calle R. No. 1, Cerros de Gurabo III
Apartado 762
Santiago, Dominican Republic

Ing. Carlos Nuñez Guillen
Instituto Superior de Agricultura (ISA)
Apartado 166
Santiago, Dominican Republic

Ing. Angel Piña
Ing. Rafael Fermín
Dr. Dominguez
Central Romana
Division de Ganaderia
La Romana, Dominican Republic

Dr. Cesar E. López
Director de Investigaciones Agropecuarias
Secretaria de Estado de Agricultura
Santo Domingo, Dominican Republic

Ecuador

Florida personnel are working directly with researchers of the Instituto Nacional de Investigaciones Agropecuarias (INIAP) in Ecuador. The main contacts are Dr. Raúl de la Torre, Ing. Jorge Grijalva, Ing. Fausto Rivera, Ing. Vicente León, Ing. Wilson Coello and Ing. Diego Proaño in the highlands region of Quito and with Ing. Angel Anzúles in the tropical region headquartered at Pichilingue.

Dr. George Ellis, Chief-of-Party of the Florida contract, is stationed in Quito. Dr. Ellis has been working in the dairy section at Santa Catalina. His general responsibilities have been to assist researchers in improving the general reproduction of the dairy herds in the Quito region. In January, 1982, Dr. Ellis joined the Florida-AID mineral research program. He will be stationed in Quito until June, 1982 and then will be located in Gainesville. It is felt that Dr. Ellis, by remaining stationed in Ecuador, will be able to stimulate the mineral research program there before returning to Gainesville.

In the past, unfortunately, the mineral research program has not progressed as well as would be desired due to some unforeseen circumstances. In one case, the head of the mineral research program in the Pichilingue area was killed in an automobile accident. Secondly, an M.S. degree research program planned for Ing. Thelmo Hervas was cancelled. This program was to include collecting forage and tissue samples in different regions where mineral problems were suspected. Unfortunately, Ing. Hervas did not do well on his TOEFL examination and therefore went on for his M.S. degree at Michigan State.

A third unfortunate setback for the mineral research program was the cancellation of thesis research to have been carried out by Ing. Jorge Grijalva. This egresado degree thesis was to be entitled "Estado mineral del ganado en algunas regiones de la provincia del Chimborazo y Tungurahua". The locations of this research in the two provinces were to be as follows: Pillaro, Ambato, Pilahuin, Nrbina, Quimaiag, Tunshi, San Juan, Columbe, Palmira and Chunchi. A copy of this research proposal is included at the end of this portion of the report. The research was to involve comparing the mineral status between growing animals 3 to 9 months of age, bulls 2 to 3 years of age, and lactating cows. Two farms each would be studied in each of the 10 designated locations. This would result in 30 blood samples per farm and a total of 300 for the entire study. Three forage samples per farm would also be collected.

A number of suggestions had been made for improving the experiment. It had been suggested that fewer areas might be sampled and that they be sampled twice during the year - towards the end of the wet and towards the end of the dry seasons. It was also proposed that numbers might be reduced by comparing the status of two classes of animals versus three, e.g., growing animals vs. lactating animals. It was also felt that the ages of the growing animals should be somewhate older and more uniform. The disadvantages of using blood samples to evaluate the status of certain minerals had also been noted. Recommendations were made to collect liver samples from growing animals at slaughterhouses. Also, since feces samples were to be collected to determine parasite counts as part of the experiment, the recommendation was made to look at the feces P levels to help evaluate the P status.

Unfortunately, this proposal by Ing. Grijalva was cancelled due to cost restrictions, and instead, Ing. Grijalva completed work for his thesis in relation to voluntary consumption. Since Dr. Ellis will be working in Ecuador,

it is hoped that the Grijalva experiment will be reactivated. It is interesting that the proposed mineral experiment for Ing. Thelmo Hervas Ordoñes will now be undertaken by Ing. Telmo Oleas as part of his Ph.D. research at Michigan State University. Dr. Ellis will assist Ing. Oleas with this research. A copy of the proposal can be found in the progress report of June, 1979.

The general plan of the proposed research is to collect liver, blood, forage, soil and feces samples from approximately 8 to 10 beef cattle farms in Ecuador. Three regions are being considered: one is El Puyo, which is in the eastern region near Limoncocha. The second possibility is in the state of Manabí on the north coast of Ecuador. There are also possibilities in the eastern and western chain of the Cordillera mountains. In the eastern chain near the city of Pillaro, severe selenium deficiency symptoms have been observed. Calves with white muscle disease which were unable to stand have been reported in the area, located 150 km south of Quito. An additional area in 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. Dr. C. H. Mullenax has found acute clinical white muscle disease in fighting bull calves (ganado de lidia) and Holsteins pastured around the base of Mt. Cayambe. Dr. Mullenax noted that by injecting the cows pre-partum and calves after birth with selenium, the problem was eliminated.

In the Quito region, iodine toxicity is considered a problem. Iodine toxicity resulted from farmers feeding over ten times the recommended iodine requirements in some cases. Another problem related to toxicity was the ill-advised use of the phosphorus supplement, triple superphosphate, as the only source of phosphorus for livestock. This fertilizer phosphorus 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 to become evident. Those animals affected most severely are yearling animals. The most common clinical sign is lameness resulting from fluorosis.

From the deficiency standpoint, forage analyses from the Quito region have, at times, indicated low concentrations of Cu, Zn and Mn. In one of the student theses, data indicated that manganese deficiency could be a problem. Cattle were compared in mineral status between animals with and without reproductive problems. The clearest difference was that animals with reproductive problems had lower blood manganese concentrations.

The Nutrition Laboratory at INIAP has been interested in evaluating mineral supplements as to their stated analysis of mineral contents. On the basis of some of these analyses, a publication was put out entitled "Mezclas minerales para vacas lecheras" (Mineral Mixtures for Dairy Cattle). This was written by Thelmo Hervas and Raúl de la Torre and contained good information on the mineral requirements of dairy cattle producing different levels of milk.

Interesting results were obtained from the mineral supplements analyzed. Fifty products claiming to contain minerals were analyzed for the various minerals in relation to their stated guarantees. The results of the analyses indicated the fraudulent nature of the majority of the products. A great many were adulterated and did not contain the stated level of the more expensive minerals. As an example, one product claimed to contain 20% calcium and 10% phosphorus, but upon analysis, was found to contain 25% calcium and 0% phosphorus. Another mineral product, the most popular one in Ecuador, claims to contain 5% phosphorus while in reality it contains less than 2-3%. It was

estimated that approximately 10% of the mineral supplements on the market are reliable in relation to their stated percentages of each mineral. It was noted in one instance that a certain company purchased minerals from a reliable source and then mixed this supplement with soil and sold this as a new mineral supplement.

The person responsible for mineral research in the Pichilingue area is Ing. Angel Anzúles. Ing. Anzúles has been carrying out an experiment at the Pichilingue Experiment Station entitled "Benefits of Mineral Supplementation to Beef Cattle at Pichilingue" since December, 1977. 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 are being taken three times per year, in December, March and July. The animals have all had one calf and the object is to determine if the complete mineral supplement or the phosphorus mixture will increase the calving percentage over animals receiving salt only. Each treatment group was allotted to a 32-hectare pasture. For each treatment, the pasture is divided into four sections for rotational purposes. In this rotation system, 16-18 heifers precede the 50 cattle into each pasture. This system provides higher nutritive value pastures to the younger animals. The one-year results for the experiment are as follows:

Item	Treatment 1	Treatment 2	Treatment 3
Mineral Consumption (g/day)	25.7	21.8	32.8
Yearly Gain (kg)	175.3	189.3	174.4
Calving Percentage	90	95	92

The results from the first year did not suggest any benefit at that time from mineral supplementation. Blood, liver and forage analyses indicated that concentrations were low for copper and zinc. Calcium, phosphorus, magnesium and iron were adequate. Iron concentrations were very high.

In a different region in Ecuador near Puerto Viejo, liver samples were collected from a farm called Finca de Morchache. Copper analyses taken from Puerto Viejo indicated severely deficient levels, with only four samples out of 27 containing more than 25 ppm. Manganese was relatively low, with about a third of the values being less than 6 ppm. Zinc and iron appeared adequate. Blood copper levels were likewise low while blood calcium, phosphorus, magnesium and iron appeared adequate. About half of the zinc values were likewise low in the blood samples. From the Finca de Morchache, blood calcium, zinc, iron and magnesium were adequate. About half of the blood copper values were low and in this instance, blood phosphorus was low, with 17 of 30 samples containing less than 4.5 mg%.

In addition to the area of Puerto Viejo, Ing. Anzúles has also been responsible for collecting samples in the region of El Oro. It is felt that both Puerto Viejo (Manabí) and El Oro have definite problems in relation to mineral deficiencies.

The main contribution of the Florida-AID program in Ecuador has been to provide consumable supplies for mineral research, analysis of the more difficult-to-determine minerals, and computer assistance for data interpretation.

MINERAL RESEARCH PROGRAM FOR TELMO OLEAS

ESTACION:	Santa Catalina
DEPARTAMENTO:	Nutrición
PROYECTO I:	Rumiantes
SUBPROYECTO I-2:	Minerales
ENSAYO SC-LN-I-2-1-80:	Estado Mineral del Ganado en algunas regiones de la provincia del Chimborazo y Tungurahua.
UBICACION:	Provincia del Chimborazo y Tungurahua Localidades: Pillaro, Ambato, Pilahuin, Urbina, Quimiag, Tunshi, San Juan, Columbe, Palmira, Chunchi.
AUTORES:	Amable Villacrés y Jorge Grijalva.
COLABORADORES:	Programa de Ganadería Dptos. de Economía, Biometría y Suelos, Dueños de ganaderías y Personal del MAG y ESPOCH.
ASESOR:	Dr. Raúl de la Torre.
FECHA DE INICIACION:	
DURACION PROBABLE:	Un año.
COSTO:	Según hoja adjunta.

COSTO APROXIMADO DEL EXPERIMENTO

I. RECURSOS FIJOS

Rubro	Cantidad	Mes/época	Labor
A. Mano de obra	40 jorn.	Oct.-Dic.	Manejo de animales
B. Personal técnico			
- Conductor del ensayo	50%		Todo el ensayo
- Colaborador	50%		Todo el ensayo
- Asesor	10%		Todo el ensayo
C. Servicios de la Estación			
- Análisis de suelo	60	Oct.-Dic.	N-P-K y pH
- Análisis Lab. Nutrición	700	Oct.-Dic.	Determinación de minerales
D. Utensilios			
- Tubos de ensayo	1000		Todo el ensayo
- Agujas hipodérmicas	1000		Todo el ensayo
- Hoces	2		Todo el ensayo
- Palas de desfonde	2		Todo el ensayo

II. RECURSOS VARIABLES

Rubro	Cantidad	Costo
A. Movilización:		
- Viáticos agrónomo	40 días	$22.000
- Viáticos conductor del ensayo	40 días	38.320
- Viáticos colaborador	40 días	16.640
	PASAN	$76.960
B. Gastos en combustible y lubricantes (gasolina)		4.000
C. Utensilios implementos		
- Algodón	10 libras	700
- Sogas	20 libras	300
- Agujas	10	500
- Fundas plásticas	2000	1.000
- Frascos con tapa	100	500
	10% Imprevistos	8.396
	TOTAL:	$92.356

I. REVISION DE LITERATURA

Las deficiencias nutricionales pueden ocurrir en casi cualquier área del mundo y dar como resultado una producción animal deficiente. Fick et al. (1978) dicen que la industria ganadera, en muchas regiones de América Latina, está restringida por deficiencias, desbalances y toxicidades minerales.

Los mismos autores señalan que se han encontrado deficiencias y excesos de minerales en casi todos los países de América, pero no existe suficiente información sobre la extensión de las áreas afectadas. Incluyen al Ecuador entre los países afectados con deficiencia de fósforo, azufre y yodo, y posibles excesos o deficiencias de selenio.

En el país, Hervas (1975), estudió las concentraciones de macro y micro minerales en ganado bovino en el Valle de Machachi. En el cuadro 1, se puede observar que las concentraciones de hierro y zinc en vacas aparentemente normales y con problemas reproductivos son mayores que las consideradas normales por Church (1971), mientras que los valores de manganeso son más bajos en vacas con problemas reproductivos. Esto hace sospechar una posible deficiencia que puede afectar la fertilidad.

Wilson (1975), en estudios realizados en los páramos del Atacazo (3650 y 4200 m.s.n.m.), determinó concentraciones altas de calcio, magnesio, hierro y materia orgánica en el suelo, bajas de fósforo y manganeso y normales de potasio, cobre y zinc.

Al analizar los forrajes, el mismo autor, determinó concentraciones bajas de calcio, fósforo, magnesio, potasio y cobre; altas de manganeso, cobalto y zinc y contenidos normales de sodio. Los análisis del suero sanguíneo indicaron valores más altos que los encontrados a nivel del mar para sodio, potasio y hierro, valores normales para magnesio y niveles más bajos que los determinados a altitudes bajas para calcio (cuadro 1).

II. JUSTIFICACION

La eficiencia de producción de carne y leche en el país es baja. Las tasas de producción están influenciadas en gran manera por la nutrición, especialmente de minerales. La mayor parte del ganado tanto de leche como de carne, no recibe suplementación mineral a excepción de sal común, lo que junto con la parasitosis incide en la producción. Se necesita realizar un diagnóstico del estado mineral y parasitario del ganado para poder emitir las recomendaciones pertinentes de suplementación para un área específico.

III. OBJETIVOS

1). Establecer deficiencias o toxicidades de minerales en algunas áreas de la Provincia del Chimborazo.

2). Evaluar y comparar el estado mineral del ganado en tres diferentes estados fisiológicos: terneros de tres a nueve meses, machos de dos a tres años y vacas en lactación.

Cuadro 1. CONTENIDOS DE MINERALES EN SUERO SANGUINEO DE GANADO BOVINO ADULTO

	Valores Normales				(Machachi)
	Church	Zintzen	Wilson K. (Atacazo)	Hervas T. Vacas normales	Vacas con problemas reproductivas
Concentración	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml	mg/100 ml
CALCIO	9.0-12.0	8.5-12	8.7	10.14	10.40
FOSFORO	4.0-9.0	4.0-7.0	---	6.32	6.40
MAGNESIO	1.8-3.0	1.8-3.2	26.7	2.32	2.21
SODIO	276-322	290-375	374	347.3	344.8
POTASIO	14-18	18-25	381	17.19	18.60
Concentración	µg/100 ml	µg/100 ml	µg/100 ml	µg/100 ml	µg/100 ml
COBRE	100	70-170	----	99.9	95.35
HIERRO	150	200-280	1235	318	331.1
ZINC	80-120	122-284	----	127.45	131.7
MANGANESO	2-3	2.2-2.78	----	2.39	1.17
SELENIO	+20	---	----	------	------

3). Estudiar las relaciones minerales entre el suelo, plantas y animales.

IV. MATERIALES Y METODOS

1. Dos haciendas ganaderas por cada una de las siguientes localidades: Pillaro, Ambato, Pilahuin, Urbina, Guimiag, Tunshi, San Juan, Columbe, Palmira, Chunchi.

2. Sangre. Muestras de alrededor de 20 ml con anticoagulante para extracción de plasma. Análisis de Ca, P, Mg, Mn, Zn, Fe, Se y Cu. 10 animales por grupo en cada hacienda. 30 muestras por hacienda. Total 600 muestras. Métodos del Dpto. de Nutrición.

3. Heces. 10 muestras por cada grupo de animales en cada hacienda. 30 muestras por hacienda. Total 600 muestras para análisis de parasitos. Métodos del Instituto Veterinario I.V.E.

4. Hígado. Cuatro muestras por localidad. Dos de vacas lecheras y dos de machos de dos a tres años. Total 400 muestras. Las muestras se tomarán en los camales. Análisis de Cu, Se, Fe, Mn, Mg. Las muestras se conservarán en botellas con formol. Métodos del Dpto. de Nutrición.

5. Suelo. Tres muestras por hacienda, en los potreros donde están comiendo los animales de cada grupo. Total 60 muestras. Análisis completo. Métodos del Dpto. de Suelos.

6. Forraje. Tres muestras por hacienda de los potreros en los que se hallen los grupos. Total 60 muestras. Composición botánica, humedad, cenizas, proteína, fibra, Ca, P, Na, K, Mg, Fe, Zn, Cu, Mn, Se. Métodos del Dpto. de Nutrición.

7. Registros. Se mantendrán registros individuales por hacienda con información sobre la localidad geográfica y política, propietario, extensión, etc., según formulario adjunto.

   A. Factores en Estudio.

      Localidades
      Haciendas
      Grupos

V. PROCEDIMIENTO

A. Tipo de diseño: jerarquico.

B. Esquema del análisis estadístico.

1. Sangre y heces

F.V.	G.L.	C.M.E.
Localidad	(l-1)	$\sigma^2 + ag\sigma^2_{H(L)} + aghZLi^2/(l-1)$
Hacienda/Loc.	l(h-1)	$\sigma^2 + ag\sigma^2_{H(L)}$

F.V.	G.L.	C.M.E.
Grupos/hda./Loc.	hi(g-1)	$\sigma^2 + a\,\sigma^2_{G(H)(L)}$
Animales/Grupos/ Hda./Loc.	ghi(a-1)	σ^2

2. Hígado

F.V.	G.L.	C.M.E.
Localidad	(i-1)	$\sigma^2 + ag\Sigma Li^2/(i-1)$
Grupo/Loc.	i(h-1)	$\sigma^2 + a\sigma^2_{G(L)}$
Animales/grupo/loc.	gi(a-1)	σ^2

3. Suelos y Forrajes

F.V.	G.L.	C.M.E.
Localidad	(i-1)	$\sigma^2 + m\sigma^2_{H(L)} + mh\Sigma Li^2/(i-1)$
Hda./Loc.	i(h-1)	$\sigma^2 + m\sigma^2_{H(L)}$
Muestra/Hda./Loc.	hi(m-1)	σ^2

4. Se efectuará la prueba de Tuckey para localidades y grupos para sangre, heces, hígado, suelos y forrajes.

C. Métodos de evaluación y datos a tomarse.

1. Concentraciones de minerales en sangre, hígado y forraje. Métodos de análisis adaptados por el Departamento de Nutrición del INIAP.

2. Concentración de minerales en el suelo. Métodos de análisis adaptados por el Departamento de Suelos del INIAP.

3. Parásitos en las heces. Métodos de análisis del I.V.E., Instituto Veterinario del Ecuador.

D. Métodos específicos de manejo del experimento.

Se harán viajes preliminares a las localidades seleccionadas para identificar las haciendas y los camales con los que se trabajará. La selección se realizará con la ayuda de los técnicos del Ministerio de Agricultura y Ganadería y de la Escuela Superior Politécnica del Chimborazo.

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ECUADOR CONTACTS

Dr. Vicente Gusumano
Dr. Fausto Maldonado
c/o U.S. Embassy
USAID/Quito
APO Miami, Fl 34039

Ing. Mario Lalama, Subdirector
Ing. Fernando Torres
INIAP
2955 San Javier
Casilla 2000
Quito, Ecuador

Ing. Angel Anzules
INIAP
Estacion Experimental de Pichilingue
Apartado 24
Quevedo, Ecuador

Ing. Vicente Leon
Ing. Telmo Oleas
Ing. Thelmos Hervas Ordones
Ing. Fausto Rivers (Head, Dept. of Nutrition)
Ing. Patricio Grijalva
Dr. Sam Porch (Soils)
Dr. Raul de la Torre
Estacion Experimental de Santa Catalina
Apartado 340
Quito, Ecuador

Dr. Kamal Dow
c/o U.S. Embassy
AID Program
APO Miami, Fl 34039

El Salvador

The mineral research program in El Salvador was slow in getting started but from 1976 through 1979, considerable progress was made. Dr. Ferdinando Perla of the Ministry of Agriculture (Ganadería) is chairman of the mineral research program. The mineral research program is a cooperative endeavor between Ganadería and the University of El Salvador. The Florida-AID program provided $4,000.00 per year for four years for the purchase of laboratory supplies. Ganadería had the responsibility of collecting 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 (one technician twice) who have come to the University of Florida for training in mineral research techniques.

In 1977 and 1978, the research organizations of Ganadería and the University of El Salvador dedicated a considerable portion of their resources to mineral research. As many as 10-12 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 the data was 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 inadequacy 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.

The last visit to El Salvador was made in June, 1979. Due to severe political upheavals in the country, including closing of the University, no substantial mineral research has been carried out in 1980 and 1981.

El Salvador Contacts

Mr. Robert Moffett (Tel. 25-90-16) (1 block north of Embassy on right)
~~Mr. Charles A. Breitenbach~~ (Tel. 23-11-46)
Food and Agriculture Officer
c/o American Embassy
San Salvador, El Salvador

Dr. Juan Francisco Menéndez (Director de Ganadería, Tel. 27-90-00)
Dr. Luis A. Silva H. (Subdirector de Ganadería)
Dr. Ferdinando Perla E.
Dirección General de Ganadería
Ministerio de Agricultura y Ganadería (Soyapongo)
Apartado Postal No. 554
San Salvador, El Salvador

Dr. Earl Sutherland (Tel. 22-80-44, Home 23-99-72)
Mr. Ivan Behman
Proyecto Desarrollo Ganadero
UNDP/FAO
Apartado Postal (06)1114
San Salvador, El Salvador

Ing. Agr. Roberto Guillermo Acosta M.
(Jefe, Departamento de Zootecnia)
Dr. Coyetano Antonio Mirón
Dra. Francisca Cañas Moreno
Lic. Margoth Oldemia Palma
Ing. María Ursula Bejarano
Facultad de Ciencias Agronómicas
Universidad de El Salvador
Apartados Postales 773 y 743
San Salvador, El Salvador

Ing. Mario Humberto Minervini
Facultad de Suelos
Universidad de El Salvador
San Salvador, El Salvador

Ing. Jorge Alberto Jovel (Statistics)
Departamento de Estadísticos
Universidad de El Salvador
San Salvador, El Salvador

Ing. Agr. Manuel Nilhson Reyes
(Director of Research)
Facultad de Ciencias Agronómicas
Universidad de El Salvador
San Salvador, El Salvador

Dr. Steven Edwards
c/o La Embajada Británica
Apartado Postal 2350
San Salvador, El Salvador

Dr. and Mrs. Carlos Zometa (Tel. 23-1007, Home 28-0323)
(Mailing address)
3a Calle Poniente No. 5-8
Santa Tecla, El Salvador

(Actual address)
11a Avenida Sur No. 4-1
Santa Tecla, El Salvador

Guatemala

The mineral research program in Guatemala started in January, 1975. The organization doing mineral research is INCAP. Dr. Marco Tulio Cabezas was in charge of the mineral research program and Ing. J. Antonio Flores , an M.S. graduate from INCAP, was working full time on the program. The Florida-AID had provided $6,000 per year for 3 years to the program; this money had gone to pay the salary of Ing. Flores. At the end of 1978, INCAP picked up the salary for Ing. Flores. Ing. Flores and Dr. Cabezas, along with Dr. Ricardo Bressani, Ing. Beatríz Murillo and students from the Facultad de Medicina Veterinaria y Zoología of the University of San Carlos, have been active in the mineral research program.

Unfortunately, due to lack of funds, the nutrition program at INCAP has been greatly curtailed, with no active mineral research for the past 1 1/2 years. During the previous three years, INCAP had been responsible for generating quite a bit of research data. Much of the research was carried out at a large dairy and beef cattle ranch near Sonsonate, El Salvador. Pasture data from this ranch indicated that Ca, Cu, Zn and Co were inadequate. Forage Ca concentrations at most samplings were found to be lower than P concentrations. Soils in the area were found to be less acid than in many other areas, having a pH of approximately 6.7. Some P values were low and blood P concentrations were found to be lower in the wet season. On the contrary, Cu concentrations were lower in the dry season. During the dry season, 60% of the dairy cattle and 20% of the beef cattle had low blood Cu concentrations. Blood and other tissue mineral concentrations could be misleading since animals on this ranch were receiving mineral supplements.

In a second experiment at this ranch, a total of 456 samples were collected, including two pastures (Pangola and Stargrass, paddocks and two replicates) and three soils. In addition to mineral analyses, dry matter yields were also determined as well as carotene and blood urea N. Biopsy samples have been taken and animals have been evaluated as to the different stages of their lactation.

In Guatemala, beef cattle and sheep producing regions of the country are slowly beginning to be evaluated. Analyses from pastures on various farms have indicated deficiencies of Na, Ca, P, Cu and Zn. Mineral research data is being collected from four different locations where beef cattle predominate. Samples are being collected twice per year (during both the wet and dry seasons). These regions are all located on the Pacific coast. The main deficiency is P, with Na, Cu and Zn also in low concentrations. Ca is high in forages in this zone which is in contrast to the area near Sonsonate, El Salvador.

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 administering 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 contrast to the ranch in Sonsonate and many other beef cattle ranches.

The main thrust of the Guatemala mineral research program is now the Ph.D. program of Ing. Rodrigo Tejada. Ing. Tejada's overall research goal was originally to determine the mineral status of grazing cattle from three different regions of Guatemala. The research was originally planned for a M.S. program but has now been changed to a Ph.D. program with additional collections required. For the research, soil, forage, blood plasma, liver and bone samples were collected from 8 to 12 ranches in three zones of Guatemala during the wet season (September, 1981). In January, 1982, Ing. Tejada will return to Guatemala to begin collections representing the dry season.

In addition to Ing. Tejada's research program, the Florida-AID mineral project will assist Dr. Marco Tulio Cabezas in publishing journal articles of the previous research. Dr. Cabezas is currently working on several articles and the Florida-AID mineral project will help with the publication costs.

Proposed Mineral Research Program for Rodrigo Tejada in Guatemala

Introduction: In many areas of tropical countries, numerous mineral deficiencies, imbalances and toxicities are severely inhibiting the cattle industry. Grazing livestock often do not receive mineral supplementation and most depend largely upon forages to supply their 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 (A. Bauer, unpublished data, 1979); Brazil (Conrad and Mendes, 1965); Colombia (Stonaker et al., 1975); Panama (Rios Arauz, 1972; R. G. Poultney, personal communication, 1972); Peru Echevarría et al., 1974); and Uruguay (Schmiersmann, 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).

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 the improvement of livestock production. Economical return on mineral investment has been at least two to one in some studies (Conrad, 1976).

Research Objectives: (1) To establish if specific mineral deficiencies or toxicities exist in Guatemala.

(2) To evaluate and compare the mineral status of beef cattle at different physiological states (growing steers or heifers, 1-2 years after weaning and pregnant, lactating cows).

(3) To study mineral soil-plant-animal interrelationships.

Location of Research: Select 2-4 distinct regions throughout Guatemala. Characteristics comprising regions would be, for example, differences in soil types or differences in rainfall. A total of 8-12 ranches should be selected for each individual region. The majority of ranches should probably be beef cattle ranches since they usually do not receive concentrates and better reflect the status of the particular region.

Research Proposal: For each farm, soil, forage, blood, liver and bone samples would be collected. Standardized questionnaires for the farm description, animal identification and forage description will be used. The collection of samples would be as follows:

1. Soil - 2 to 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 5-10 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 specie collected separately. A forage questionnaire should be filled out for each farm to include the % of 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 to hand pluck a sample representative of 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 air-dried at 60 C and ground using stainless steel equipment. If stainless steel equipment is not available, samples can be cut up into smaller pieces with stainless steel scissors, and ground.

3. Blood plasma or serum - At each farm, 10-12 samples from each class of animal should be collected from randomly selected growing steers or heifers (1-2 years after weaning) and pregnant-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 after collection. Pipet off 1 ml of plasma and mix thoroughly with 10% trichloroacetic acid (1 ml plasma and 5 ml trichloracetic acid) and centrifuge. Refrigerate or freeze until needed. A questionnaire describing each animal should be completed.

4. Liver - Liver samples can be taken by either a liver biopsy procedure or from animals at slaughterhouses. The liver biopsy technique is described in the "methods" manual. At slaughterhouses, liver samples should be removed immediately from slaughtered animals as soon as the abdomen is opened, in order to prevent contamination. Every effort should be made to avoid contamination, therefore, plastic gloves should be used. Approximately 100 g of the right lobule (lobus dexter) of the liver is cut out with stainless steel scissors or a stainless steel knife. The samples are refrigerated or frozen until analyses are made. Samples can be put in solution and brought back to Florida. If samples are not in solution, liver samples should be in Nalgene bottles containing 10% formaldehyde before transporting to the U.S. Upon returning to the U.S., a top priority would be to put liver samples in an ash solution so samples do not remain in formaldehyde for extended periods of time.

5. Bone - This will be the most difficult sample to collect. Bone biopsy procedures are available but would not be practical to perform on ranches. Bone sample collections should therefore be limited to slaughterhouses. It would likely be impossible to collect bone samples from each ranch, but hopefully bone samples from some ranches would be possible. One solution may be to collect bone samples from local slaughterhouses that represent specific regions.

One of the best bones to sample would be the rib. A sample of 5-10 cm of rib bone would be sufficient. The bone is stripped of all soft tissue and bone marrow material is removed by working the bone with a jet of distilled water. The sample is blotted dry and weighed in air and water for the calculation of specific gravity. Procedures for bone ashing are outlined in the "methods" manual. Obtain ash weight to calculate percent ash of dry, fat-free bone, mg/cc of fresh bone or a percent fresh bone.

Records - The following records should be kept:

(a) Farm identification and description forms
(b) Individual animal and health observations
(c) Forage identification records
(d) Slaughtered animal description records

Analysis - The following analyses can be undertaken:

(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 - Protein, NDF, in vitro dry matter, Fe, Mn, Cu, Zn, Mo, P, Ca, Mg, K and Na.

(c) Blood - Ca, P, Mg, Zn, Cu, Fe and Se.

(d) Liver - Zn, Cu, Co, Fe, Mn, Mg and vitamin A. (Vitamin A is possible only if analyzed in Guatemala).

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

Equipment and supplies: Soil sampling equipment, portable centrifuge (if available), 20 ml tubes or vacutainers containing lithium citrate (or tube designed for serum samples), pipets, 10% trichloracetic acid, polyethylene test tubes (17 x 100 mm with airtight caps), 50 ml sq. bottles (good for storing ash solutions), air-flow bags for collecting forage samples (burlap bags), plastic gloves, plastic bags for storing dried forage samples, California bleeding needles, stainless steel (or nickel-plated) scissors, 8-16 oz. polyethylene bottles, a saw or knife for collecting vertebrae samples, means of keeping samples cool, 10% formaldehyde and a Wiley mill. The Wiley mill should have stainless steel screens vs brass. If not available, forage samples can be prepared by cutting with stianless steel scissors. Equipment, supplies and procedures for putting samples in solution are described in the "methods" manual.

Procedures for bringing samples to Florida:

(a) Soil - Some analyses could be done in Guatemala or samples could be put in solution.

(b) Forage - Forage samples can be put into solution for analysis, but some of each original sample will be needed back in Florida to determine NDF, in vitro dry matter, Se, etc.

(c) Blood - Bring back serum or plasma. Some analyses such as Ca and P can be completed in Guatemala. Keep samples under refrigeration. Arrange schedule so that samples come from Guatemala to Gainesville as quickly as possible.

(d) Liver - Liver samples should be transported in 10% formaldehyde. Part of the samples can be put in solution. On farms where only biopsy samples are taken, then less total sample (g of liver) is available. Therefore, some samples will need to be designated for Se and some for the remainder of the minerals. Three to four samples per class of animal should be designated for Se and the remainder for other analyses. The samples designated for Se should not be put in solution.

(e) Bone - Bone samples can be transported in 10% formaldehyde. Make sure they are well labelled (in pencil).

Responsibilities:

Dr. Francisco R. Rodas and Cattleman's Association - (1) Locate ranches for sample collections in cooperation with Ing. Rodrigo Tejada and Dr. Marco Tulio Cabezas. Ing. Tejada has 3 ranches already selected that he would like to include in the study. (2) Provide logistical support for sample collections. This would include transportation to farms and assistance in collecting samples.

Dr. Marco Tulio Cabezas and INCAP - (1) Provide laboratory facilities for sample preparation and some analyses. (2) Provide formaldehyde (Florida does not have a license to send this via plane). (3) From the soil science department, assistance with soil classification and soil structure from areas where soil samples are collected. Also, the use of a soil augur for soil sample collections.

Florida - (1) Provide round trip transportation for Rodrigo Tejada from Gainesville, Florida to Guatemala. (2) Provide materials for sample collections and storage.

Guatemala Contacts

Mr. Clemence J. Weber
Rural Development Officer
c/o La Embajada de los EE. UU.
Zona 1
Guatemala, Guatemala

Dr. Marco Tulio Cabezas (Tel. 45-65-8)
FANCAP
P. O. Box 2771
Guatemala, Guatemala

Dr. Ricardo Bressani
Ing. Roberto Jarquín
División de Ciencias Agrícolas
y de Alimentos
INCAP
Apartado Postal 1188
Gautemala, Guatemala

Dr. Francisco R. Rodas C. (Tel. 64623)
11 Calle 6-05, Zona 10
Guatemala, Guatemala

Sr. Carroll T. Bodden (Superintendente de Agricultura)
Ing. Carlos Sett
Ing. Carlos A. Mayen
Bananera, Izabal, Guatemala

Dr. Luis Antonio Mejía
División de Biología y Nutrición Humana
INCAP
Apartado 1188
Guatemala, Guatemala

Ing. Francisco Rosal
3a Av. 16-67, 2.14
Guatemala, Guatemala

Dr. Carlos Tejada (Tel. 68-28-66)
Granjanara
Santa Catarina Pinula.
Guatemala

Honduras

The first visit to Honduras in relation to mineral reserach took place in September, 1981. In the past, the University of Florida has been very supportive of the Panamerican school, "El Zamorano", in Honduras. This school is very much admired for its policies of teaching students practical agriculture - the policy is to learn by doing. El Zamorano is currently planning to expand its programs and facilities and to admit more students.

As a result of the first visit, it was concluded that mineral research at El Zamorano is unlikely in the near future. The restraints to mineral research at El Zamorano include lack of laboratory facilities to analyze minerals, lack of funds to support research in the animal science area and animals being assigned to other areas. Looking at the overall view, it would appear easier to carry out research in the plant-soil area than it would be in the animal science area. In the future, as decisions as to the use of animals are made, mineral research could become an important research component; however, it would be several years before mineral analysis will be likely on the premises. Cooperative mineral research might, however, be established if there were a graduate student from Florida that would be willing to collect samples and supervise mineral research for a period of time at El Zamorano and nearby ranches. The student could return to Florida with samples to be analyzed.

A second possibility for mineral research in Honduras is with the institution called the Centro de Investigación y Desarrollo. This is a government organization which is tied to another organization named Fondo por la Cooperación Nacional de Inversiones (CONADI). One of CONADI's major projects is the development of the plant "calawala". This is a tropical plant, the main extract of which is used to cure various skin diseases and diseases associated with collagen such as arthritis.

The main contact at CONADI is Dr. Antonio Flores. Dr. Flores formerly worked with the mineral project in Guatemala and was responsible for a large collection of samples in different regions of the country. His analyses were very useful in identifying mineral limitations in these regions. Since the animal nutrition program at INCAP in Guatemala ended, Dr. Flores worked for a while with INCAP in El Salvador before going to Honduras.

Dr. Flores has written up a mineral research program for Honduras. This proposal would be a two-year study to determine mineral deficiencies or excesses in the important cattle regions of Honduras. An application has been made for a $1,800,000 loan over a five-year period. Two of the five years would be devoted to collection of animal tissues and forages to determine mineral concentrations. After evaluation of the mineral status of the important cattle producing regions of Honduras, marketing studies will be undertaken and complete mineral supplements appropriate for each specific region will be formulated and sold. Most of the funds for the program are being supplied by various European countries through the Central American Bank at a low rate of interest.

Beef cattle are very important in Honduras, with approximately 2,080,000 head. Approximately 73% of the cattle are of dual purpose but the main use is beef. Seventy-five percent of the cattle are located in five departments of Honduras. The eastern part of the country contains the most cattle.

The design of the experiment is to collect soil, forage, liver, blood and possibly bone samples from 41 representative farms, both large and small. The breakdown in relation to size of farm is that 60% of the farms are between 1 and 10 hectares, 31% between 10 and 50 hectares and 9% are more than 50 hectares. The major forage species to be collected will include African star, Hyparrhenia rufa, guinea and pangola grass.

The schedule for this research program is for the final proposal to be submitted by mid-October. The program would then go ahead and start ordering laboratory equipment and the experiments could begin in March of 1982. Samples would be collected during both the wet and dry seasons. Towards the end of the dry season would be mid-April/May and towards the end of the wet season would be mid-September/October. A copy of the overall proposal (retyped) submitted to the Central American Bank is included at the end of this portion of the report. It is in Spanish and is called "Bases para la elaboración de mezclas minerales suplementarias para la alimentación animal" (Bases for the elaboration of supplementary mineral mixtures for animal feeding).

CORPORACION NACIONAL DE INVERSIONES
CENTRO DE INVESTIGACION Y DESARROLLO
(PERFIL DE ESTUDIO)

"BASES PARA LA ELABORACION DE MEZCLAS MINERALES SUPLEMENTARIAS PARA LA ALIMENTACION ANIMAL"

1º Unidad Ejecutora: Unidad de Nutrición, Programa de Producción Animal.

2º Importancia.

Al igual que en el resto de países del área centroamericana, en Honduras la ganadería bovina constituye uno de los rubros de ingreso más importante. En 1975, de la ganadería y sus productos provino el 18% de los ingresos de la producción agrícola nacional. Existen actualmente aproximadamente 2 millones de cabezas de ganado que descansan en 1.8 millones de Ha. de tierra cubierta de pastos que representan el 16% de la extensión territorial de Honduras. La población ganadera está principalmente concentrada en los Departamentos de Santa Bárbara, Yoro y Cortés en la Zona Norte y El Paraíso, Francisco Morazán, Olancho y Choluteca en la Zona Centro-Sur. De casi una totalidad de 82,610 explotaciones el 82% se manejan bajo el sistema de doble propósito, dependiendo la alimentación del ganado basicamente de los pastos disponibles y de su estacionalidad, lo cual ha dado lugar a que los índices productivos sean bajos (Natalidad, 48%; Mortalidad de Terneros, 12-15%; Extracción, 14.3%; Capacidad de carga, 0.8 UA/Ha; 7 a 8 meses de lactancia por vaca con un promedio de 550 Lt/lactancia y 2.5/vaca/día; Edad de sacrificio de 3 a 3.5 años con 300 a 325 Kg y 48% de rendimiento de canal).

En América Latina los desórderes nutricionales constituyen una gran fracción de los factores que influencian la productividad ganadera, pero aún no se ha podido determinar si es la carencia de proteína o energía el factor más limitante. Sin embargo, se ha observado infinidad de casos en los cuales a pesar de haber un adecuado aporte de estos nutrientes persisten las manifestaciones externas de bajo apetito, infertilidad, baja ganancia de peso y mortalidad los cuales sí han respondido a la suplementación mineral. En Honduras se ha logrado superar en parte este problema mediante el uso de mezclas comerciales disponibles en el mercado, pero al igual como se ha demostrado en otros países del área Centroamericana, existen casos en los cuales la respuesta es mínima o negativa, lo cual puede ser debido a la producción de inbalances provocados por el exceso de algún elemento o la insuficiencia de otros para cubrir los déficit provocados por el pasto.

Estos antecedentes conllevan a la conclusión de que existe un desconocimiento de la situación existente en el país y que la aplicación de medias correctivas no responde a una base sólida de tipo técnico, sino a la transferencia de tecnología desarrollada bajo otras condiciones sin un ajuste adecuado a la realidad local. Asimismo, de ellos se desprende la necesidad de desarrollar un diagnóstico y comprobación de mezclas racionales para que estas contribuyan a solucionar los problemas existentes y por ende al incremento de los índices productivos del sector.

3º Impacto y proyecciones.

Dado que un alto porcentaje de las explotaciones ganaderas del país se encuentran en manos de pequeños productores y que son estos los que contribuyen con el mayor aporte de alimentos de origen animal para la población hondureña, la tecnología que se desarrolle en base a este proyecto contribuiría a establecer sistemas de suplementación de alta efectividad, bajo costo, fácil implementación y amplia cobertura. Esto, traducido en el interés básico de contribuir al desarrollo del sector pecuario y al mejoramiento del estatus nutricional de la población.

4º Objetivos.

El estudio se propone:

a) Objetivo General: Aumentar la disponibilidad de carne y leche en las áreas rurales de Honduras a través de un mejoramiento de la nutrición bovina en el país.

b) Objetivos Específicos: Identificar las localidades en que se presenten concentraciones adecuadas, deficientes o tóxicas de minerales en áreas eminentemente ganaderas del país y determinar el efecto estacional sobre la adecuación nutricional del ganado.

Revisar la información existente y, diseñar y evaluar sistemas racionales de suplementación acordes a la problemática específica de las regiones y a la época del año.

Proponer las bases técnico-prácticas para la implementación de una industria local de elaboración de mezclas minerales que se ajuste a las condiciones existentes en el país y diseñar un sistema de seguimiento y evaluación continuada.

5º Metodología.

En base a la información ya existente en el país con respecto a la distribución del renglón pecuario, se identificarán aquellas áreas o regiones de mayor vocación ganadera y se hará un reconocimiento de la misma a fin de identificar en el terreno aquellas de configuración similar para la regionalización del estudio. Con la ayuda del sector público (Programa de Producción Pecuaria, SRRNN) se identificará dentro de cada región aquellas fincas que presenten características representativas y se levantará un inventario de las mismas para el diseño del sistema de muestreo más adecuado. Se tomará igualmente en cuenta aspectos relacionados con las condiciones climáticas del área.

En una segunda etapa del trabajo se procederá a hacer 2 muestreos en cada localidad (de acuerdo a las estaciones) los cuales consistirán en la obtención de muestras de suelo, forrajes, sangre e hígado y en la medida de lo posible de hueso en los mataderos donde confluye el ganado del área muestreada. Finalmente, las muestras serán debidamente procesadas y analizadas en su contenido de minerales. Dado el número considerable de

resultados analíticos a obtener, se realizará su interpretación bajo un sistema de programación computarizada que permita dilucidar los diferentes efectos y sus interacciones.

Contando con esta información se procederá a seleccionar fincas tipo y a diseñar y comprobar experimentalmente fórmulas o medidas correctivas las cuales serán evaluadas en función de su efecto en la productividad, tomando como referencia la situación encontrada en ellas al inicio del estudio.

Finalmente, en base a la conclusión de estas 2 etapas se diseñarán fórmulas suplementarias acordes a la problemática existente en cada región al mínimo costo que servirán de base para la implantación de una planta productora de premezclas tanto a nivel nacional como regional.

6º <u>Meta</u>.

Establecer las bases técnicas para el desarrollo de un sistema racionalizado de suplementación mineral que se ajuste a la realidad existente en el país, las cuales deberán ser implementadas en una segunda fase a través de la inversión para el montaje de una planta local que elabore las premezclas y las distribuya en el ámbito nacional y regional.

7º <u>Duración y Costos</u>.

El estudio está planificado para realizarse en 2 años a un costo total de L. 400,000.00 (CUATROCIENTOS MIL LEMPIRAS EXACTOS), equivalentes a US$ 200,000.00 (DOSCIENTOS MIL DOLARES).

Honduras Contacts

Mr. Stephen Weinger
Mr. Mike Swartch
Food and Agriculture Officer
Agency for International Development
c/o United States Embassy
Tegucigalpa, Honduras

Dr. Jorge Román (Dean)
Dr. Simón Malo (Director)
Dr. Karl R. Fick (Feed Mill & Swine)
Ing. Candelario Rios (Beef Cattle and Pastures)
Dr. Guillermo Torres Yu Fra (Veterinarian and Meats)
Ing. Aurelio Revilla (Poultry and Dairy Plant)
Ing. Carlos Bascha (Dairy Cattle and Goats)
Escuela Agrícola Panamericana
Apartado 93
Tegucigalpa, Honduras

Dr. Antonio Flores (Tel. 35-1243)
Dr. German Contreras
Unidad de Ciencias de Alimentos y Nutrición
Centro de Investigación y Desarrollo
Apartado Postal 1477
Tegucigalpa, Honduras

Indonesia

Contacts were first made in Indonesia in November, 1977. There are four research groups in Indonesia that have the potential to undertake mineral research with grazing ruminants. These include the Gadjah Mada University at Yogyakarta, Bogor University, the National Atomic Energy Agency (Pasar Jum'at Research Centre) located near Jakarta and the Australian CSIRO program at Bogor. The main contact at Gadjah Mada University is Dr. Soekanto Lebdosoekojo who received his Ph.D. in ruminant nutrition at the University of Florida in 1978.

Mineral nutrition research with ruminants has not yet become a major endeavor in Indonesia. However, there are indications that there are mineral deficiencies in Sulawesi and Sumatera and possibly other places. There have been reports of "unthrifty" cattle on a ranch near Palemband on the island of Sumatera; the quality of feed appeared to be sufficient but the animals were in poor condition. Also, there have been incidences of broken bones in fattened cattle in the eastern islands, especially in Timor. In addition, goiter is an endemic disease among the people of Java.

One of the main mineral research projects was a mineral supplementation trial carried out in Sulawesi. The trial was planned during a visit from Florida staff in October, 1978 and was originally to have involved 200 heifers. The animals were to be divided into two treatments to include 1) a control group (salt only) and 2) complete mineral supplementation. Tissue (liver biopsy), blood and forage samples were to be taken twice during the year for a duration of 2 to 3 years. The experiment did not begin until late 1981, however, due to problems in obtaining the necessary mineral supplements. Attempts had been made to receive minerals from Malaysia through the ICI company. The problem was that the Indonesian government was charging ICI for the privilege of giving minerals as a gift to Gadjah Mada University. Also, much red tape was involved in this transaction. Understandably, ICI withdrew their offer to donate minerals. A mineral mixture was finally obtained but due to the high cost, the size of the experiment was reduced to only 80 animals. The Florida mineral project successfully corresponded with the Pfizer Company in an attempt to obtain the minerals at a greatly reduced cost.

At Gadjah Mada, several trials have been conducted with goats in relation to iodine deficiency which is a problem for both humans and livestock in this area. Previously the mineral project had sent Dr. Lebdosoekojo injections of iodine. These injections proved quite effective since one injection lasts for approximately two years. After the third kidding, however, goiter expressed as an iodine deficiency developed once again. Animals had been fed diets which contained coconut oil meal and rice bran. It is thought that there are some goitrogenic substances in these feeds which worsen iodine deficiency. There have been some problems with iodine analyses in that there is not a good repeatability of results.

In another study, the effect of iodine on increasing milk production was investigated with PHF cattle (local Holstein). There were 10 animals divided into two groups each, with and without iodine injections. There appeared to be no effect on production but significant increases in fat and protein content of iodine-injected animals were reported.

Where cattle are prominent, the general calving percentage in Indonesia is only 43 to 55%. The phosphorus status in certain areas is quite low and the sodium status is also low. In the northern highlands, forage analyses generally are .08 to .14 ppm whereas in the sandy soil lowlands, the phosphorus status is more adequate, ranging from .15 to .31%. In Sulawesi where the experiment is being undertaken, the analyses are around .1% phosphorus. Other analyses show high manganese contents suggestive of toxicity. Sheep wool was very high in manganese, containing over 400 ppm.

The main contact at the National Atomic Energy Agency is Dr. Jenny S. Edwardly. Dr. Edwardly has produced exudative diathesis, a selenium-vitamin E deficiency, in poultry. To produce the deficiency, poultry were fed diets of mostly corn containing less than .05 ppm selenium. The mashed diets are generally made of corn, soybean meal and coconut cake. Dr. Edwardly is now working on her Ph.D. thesis which involves the absorption of selenium as affected by calcium and phosphorus concentrations in the diet. She is presently doing experiments and will be completing these within 1 and 1/2 years. Diets with different levels of calcium and phosphorus are being used and the isotopes calcium-45 and selenium-75 are used. The diets vary from 2.5 to 3.75% calcium.

Dr. Edwardly has done some preliminary analyses of four local grasses as well as banana leaves, wheat and rice straw, and corn stover. The forages were all low in zinc and phosphorus while banana leaves were high in all minerals. From blood analyses, only 10-15% of the samples were found to be low in phosphorus. The limitations of blood phosphorus as an indicator of the phosphorus status of the animal were discussed during a visit and it was suggested that, if at all possible, bone samples should be analyzed for calcium, phosphorus, specific gravity and bone ash.

Dr. Edwardly has noted that there are clinical signs of selenium deficiencies in the area of Palemband, south of Sumatra. Also of interest was a tentative report noting copper and cobalt deficiencies in cattle in the same area. Likewise, mineral deficiencies are also probably involved in the condition of sudden death in cattle. This condition resembles grass tetany, a magnesium deficiency.

The CSIRO program at Bogor Agricultural University (P_3T) is an Australian supported research program. The present staff members most concerned with mineral research include Dr. Wharton, Dr. N. G. Yates and Dr. Coates. Drs. Yates and Coates have replaced Dr. Lynn Cook who passed away unexpectedly in 1979. Dr. Cook had been interested in mineral research and had sent us some of his forage data collected in Sulawesi. Some of the forage phosphorus values were quite low to borderline, with the majority being less than .25%. Likewise, some of the blood phosphorus values were relatively low, less than 5 mg%. From the data, it appeared that potassium, calcium and iron were adequate in all forages. Magnesium was likewise very adequate, with some of the values being extremely high and close to toxic levels. Many of the fotages had low levels of copper, sulfur and zinc.

Dr. Toha Sutardi of the Bogor Agricultural University has been interested in mineral research, particularly in relation to iodine deficiency. There is a very high incidence of iodine deficiency in Indonesia. Dr. Sutardi's previous work had indicated that iodine supplementation was effective in improving animal performance. He had conducted an experiment using thyroprotein as a means to correct thyroid status. Thirty-two rats were used in a randomized complete

block feeding trial involving different levels of thyroprotein. It was found that the highest growth rates were achieved with 0.25 g thyroprotein supplementation and higher levels reduced average daily gain and feed efficiency.

The only contribution of the Florida-AID program to the various Indonesian research programs has been literature and consumable supplies.

Indonesia Contacts

Mr. Walter C. Tappan (Chief Agriculture Development Officer)
Mr. Michael J. Korin (Agricultural Development Office)
Mr. Gordon Fraser (Agricultural Attaché)
Ms. Retinow Sidarta
Agency for International Development
U. S. Embassy
Jakarta, Indonesia
(Medan Merdeka Selatan 3, Jakarta Pusat,
Tel. 340001, Ext. 370/371)

Mr. J. Jan Leswara
Agricultural Marketing Manager
Pfizer Indonesia
Jl. Roya Bogor Km. 28 (Dandaria)
P. O. Box 2706
Jakarta, Indonesia
(tel. 870521)

Dr. Kenneth E. Harshbarger
Director, MUCIA-AID
Indonesia Higher Education Projects
Tromolpos 3285/JKI
Jl. Iman Bronjol 25
Jakarta, Indonesia

Dr. Jenny S. Edwardly (Tel. 760709)
Dr. Mohammed Ridwan, Director
Dr. C. Hendratno
Pasar Jum'at Research Centre
National Atomic Energy Agency
Animal Science Section
P. O. Box 2
Kebayoran Lama
Jakarta, Selatan, Indonesia

Dr. Toha Sutardi (Nutrition)
Dr. Juju Wahya (Animal Nutrition)
Institut Pertanian Bogor
(Bogor Agricultural Univ.)
Fakultas Peternakan
Jalan Gunung Gede
Bogor, West Java, Indonesia

Dr. R. H. Wharton
Dr. J. B. Lowry
Dr. Peter Coates (Laboratory Manager)
Dr. N. G. Yates
Department Pertanian R.
CSIRO Australia
P. O. Box 123
Bogor, West Java, Indonesia

Dr. Soekanto Lebdosoekojo (Animal Nutrition - Tel. 3083)
Dr. Soedomo R. (Dean)
Mr. H. Hartadi
Prof. Dr. Sukadji Ranawihardjo (Rector)
Dr. Busono (International Relations)
Gadjah Mada University
Yogyakarta, Indonesia

Dr. Everett J. Warwick
Dr. Loy V. Crowder
The Rockefeller Foundation
P. O. Box 63
Yogyakarta, D.I.Y., Indonesia

KENYA

UNIVERSITY OF FLORIDA
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

GAINESVILLE, FLORIDA 32601

ANIMAL SCIENCE DEPARTMENT
2103 McCARTY HALL
TELEPHONE 904-392-1911

June 14, 1982

Dr. Rodney Ward
Animal Scientist
Kiboko Range Research Project
P.O. Box 12
Makindu, Kenya, AFRICA

Dear Rodney:

Enclosed are the results of the mineral analyses on the 13 forage samples that we received from you in January, 1982. I find this information very interesting and I have made an attempt to give you my interpretation. Samples 6 and 7 don't fit the forage pattern but not being able to find them in the publications I have readily available, I am thinking they are legumes or browse or legume shrubs. I would be interested to know more about these forage samples.

I have listed the critical mineral levels for cattle then the mineral requirements for sheep, giving the range found in NRC Sheep, 1975, page 47, tables 10 and 11.

Calciums are somewhat lower than we usually find with the exception of samples 6 and 7. Panicum maximum, which we have analyzed, often falls into our normal range. Note: Nothing was said about the maturity of these forages and, of course, this is definitely a factor.

Phosphorus levels are somewhat below the requirement in some samples but not as low as we often find in tropical forages. Lactating ewes and rapidly growing lambs could be expected to respond to phosphorus supplementation if protein and energy were not limiting.

Sodium levels are all low as would be expected.

Cobalt is not limiting. Eliminating sample 6 in calculating the mean, it then becomes 0.15 rather than 0.23%.

Copper levels are relatively low and this, as we had anticipated, because of the previously reported low copper levels associated with the Rift Valley. Although you are outside the valley, previous reports from Kenya indicate a fairly widespread copper deficiency. Again, samples 6 and 7 are markedly different. Heteropogon contortus is the other extreme. Molybdenum levels are below the toxic levels of 5-20 ppm.

Dr. Rodney Ward
June 14, 1982
Page Two

Selenium levels appear to be adequate.

Zinc levels are low enough to cause concern and this again is what we would expect. These zinc levels are about 50% lower than what we have been obtaining in South America.

In general, situations where protein and energy may not be greatly limiting growth and milk production, these forage mineral levels would indicate low to deficient levels of sodium, copper, phosphorus, and zinc. We do know that some individual animals within the same species utilize minerals more efficiently than others. Some animals, over time, even adapt to lower levels. To what extent these factors are involved with the animals and breeds with which you are working is certainly not known.

This is the information we currently have. I hope this will be of value to your important project. If we can be of further assistance, please advise us.

With best wishes, I remain,

Sincerely,

Joseph H. Conrad
Professor and Coordinator
Tropical Animal Science Programs

JHC/dlr

cc: Dr. H.L. Popenoe
Dr. H.A. Fitzhugh
Dr. N.S. Raun
Dr. C.E. Haines
Dr. H.D. Wallace
Dr. G.L. Ellis
Dr. L.R. McDowell

Enclosure

(Kioko) 1982 In Coop with Dr Ward (Winrock)

Mineral Analyses - Forages - Kenya

Collected during dry season

Element	Ca	Mg	P	K	Na	Co	Cu	Fe	Mn	Mo	Se	Zn
% or ppm	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Critical level (Cattle)	0.30	0.20	0.25	0.60	0.06	0.1	10	30	30	>76	0.1	30
(Equivalent Sheep) ARC	.21-52	.04-.08	.16-.37	.50	.04-.10	.1	5	30-50	30-40	>.5 5-20	.1	35-50
Chloris roxburghiana	.23	.12	.13	.58	.02	.13	1.1	174	30	.82	.23	10
Chrysopogon aucher	.25	.14	.12	.35	.01	.15	2.0	111	36	.58	.20	11
Cynodon plectostachys	.29	.18	.15	.47	.01	.26	1.7	164	58	1.74	.17	20
Digitana milanjiana	.24	.13	.13	.38	.01	.12	2.1	143	31	.90	.25	11
Eragrostis caespitosa	.28	.14	.18	.21	.01	.15	1.9	82	65	.94	.12	20
Grewia tenax, perennial non-legume shrub	2.21	.13	.13	1.03	.03	.18	6.6	237	68	1.26	.28	21
Hermannia, S.P. perennial non-legume shrub	1.13	.39	.24	.86	.02	.16	7.0	153	20	1.00	.40	39
Heteropogon contortus	.14	.11	.12	.39	.01	.13	0.7	119	45	.56	.15	11
Panicum maximum	.37	.30	.21	1.05	.02	.31	1.5	196	55	1.12	.20	10
Pennisetum mezianum	.21	.13	.10	.53	.03	.15	1.4	121	18	.45	.12	5
Setaria (common)	.14	.11	.11	.56	.01	.08	1.9	125	15	.64	.12	20
Sporobolus congoensis	.28	.12	.15	.37	.02	.11	1.6	111	28	.10	.18	12
Themeda triandra	.16	.08	.10	.42	.01	.07	1.5	100	35	.56	.11	19
Mean	.46	.16	.14	.55	.01	.23	2.4	141	39	.82	.19	16

Cow N.L. .15 Cow N.L. 1.6

Analyses UNIVERSITY FLORIDA

WINROCK INTERNATIONAL

Kiboko Range Research Expansion Project
GOVERNMENT OF KENYA
MINISTRY OF LIVESTOCK DEVELOPMENT
P.O. Box 12 Makindu, Kenya Tel. 14, Makindu

27 July 1982

Dr. Joseph H. Conrad
Animal Science Department
2103 McCarty Hall
University of Florida
Gainesville, Florida 32601

Dear Dr. Conrad,

I received your letter of June 14 and carefully studied the results of the mineral analysis of our forage samples. These samples came from very dry, dormant plants. The samples numbered 6 and 7, Grewia and Hermannia, were perennial non-legume shrubs which are consumed by cattle, sheep and goats. Present research should tell us what percentage of the diet of cattle, sheep and goats come from these two plants.

Following the rains, we collected another set of samples from mature green plants. The species sampled were the same as the first group with the exception of the specie Setaria was not collected this time and a new specie, Cenchrus ciliaris, was added. This change was based on our re-evaluation of which plants are most available and most consumed. I have sent these samples to the U.S. with Dr. Dennis Child, who will forward them to you. We would like to compare the mineral levels between the wet and dry season plants. You may or may not wish to continue the analysis.

I would like to further investigate the copper and zinc deficiency. We could provide forage samples taken from esophageal cannulae of cattle, sheep and goats at monthly intervals over a period of one year. I know that such samples would be inappropriate for analyzing minerals contained in ruminant saliva, but thought we might obtain a valid estimate of ppm of Cu and Zn. If you feel further study is warranted, I would be pleased to provide the samples.

Thank you again for your interest and assistance in our research here at Kiboko.

Cordially,

Rodney Ward

Rodney Ward
Animal Scientist
Kiboko Range Research Project

UNIVERSITY OF FLORIDA
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

GAINESVILLE, FLORIDA 32611

ANIMAL SCIENCE DEPARTMENT
2103 McCARTY HALL
TELEPHONE 904-392-1911

August 5, 1982

Dr. Rodney Ward
Kiboko Range Research
Expansion Project
P.O. Box 12
Makindu, Kenya

Dear Dr. Ward:

Your letter of July 27 has been received regarding your response to the mineral analysis. Your comments were greatly appreciated concerning samples 6 and 7 because that certainly helped to indicate that they were not the perennial grasses. This also is more proof of why some of these animals can survive under relatively harsh conditions.

We are looking forward to the samples which you forwarded with Dr. Dennis Child. We would like to continue with the collaborative mineral studies as long as we have our current funding situation with A.I.D.

It appears that your interest in continuing with copper and zinc is well founded. I see no difficulty with analyzing some forage samples which will be obtained using the esophageal cannulae with cattle, sheep, and goats as you have indicated in your letter. There are a number of elements such as potassium and phosphorus which would be of little or no value because of the recycling in the saliva. However, the primary route of excretion of zinc is in the feces with very small amounts being excreted in the sweat. I have not been able to find a direct reference to the level of zinc in the saliva. The mean route of copper secretion is also in the feces with only minute amounts even in the sweat (Underwood, 1977, page 73 and 209). Therefore, I would encourage you to move ahead with the collection of some of these samples that could be used to study the copper and zinc status.

With best wishes, I remain,

Sincerely,

Joseph H. Conrad
Professor and Coordinator
Tropical Animal Science Programs

JHC/dlr

cc: Dr. Popenoe
Dr. Haines
Dr. McDowell
Dr. Ellis
Dr. Ammerman
Dr. Wallace
Dr. Raun
Dr. Fitzhugh

Malawi

A study has been completed which envolved soil, forage, blood, and animal tissue samples which were collected throughout Malawi, Central Africa. Animal tissue samples were collected from Lilongwe and Blantyre abattoirs of the Cold Storage Company during the dry season (July to September, 1979) and during the rainy season (January to March, 1981). During each period of collection, animals which had been sampled were traced back to the original owners where samples of soil and forage from pastures grazed were collected.

This research was the doctoral dissertation of Joshua Peter Mtimuni, a lecturer in Animal Nutrition at the Bunda College of Agriculture. The major objective of this research was to determine mineral deficiencies and toxicities as a basis for formulating mineral mixtures or supplements and for the modifications of mineral mixtures and supplements already in use.

Blood, liver, and bone samples were collected from 209 cattle during the dry season and 185 cattle during the rainy season. Seventy-eight and 127 forage samples of predominantly Brachiaria, Hyparrhenia, Paspalum, and Cynodon species were collected from upland and lowland areas in dry and rainy seasons, respectively. All samples were prepared to meet requirements of the Animal and Plant Health Inspection Service of the United States Department of Agriculture and taken to the Animal Nutrition Laboratory at the University of Florida for analyses.

In both seasons, minerals most likely to be deficient in forage were found to be calcium, copper, magnesium, phosphorus, selenium, sodium, and zinc. In all animal tissues except for liver molybdenum, concentrations of minerals were lower ($P<.05$) in the rainy season than in the dry season. Serum phosphorus was found unsuitable for assessing the phosphorus status of grazing cattle.

Liver and serum copper indicate severe deficiencies. Other research has shown copper to be deficient throughout the Rift Valley of East Africa. Bone parameters indicated severe calcium and phosphorus deficiencies.

During the course of this study, the supervisory professor Dr. Joseph H. Conrad was able to visit Malawi three times. Once in July 1979 to help plan the research and in January 1981 at the beginning of the rainy season collection period. Both of these trips were part of mineral research trips to other African countries. In addition, J.H. Conrad was part of a Malawi/USAID/University of Florida project design team which visited Malawi in March of 1980.

Dr. Joshua Peter Mtimuni is currently teaching and doing research at Bunda College of Agriculture, University of Malawi, P.O. Box 219, Lilongwe, Malawi. A complete copy of the dissertation can be obtained by writing to Dr. Mtimuni at the above address or to the USAID/University of Florida Mineral Research Project, Animal Science Department, University of Florida, Gainesville, FL 32611.

Malaysia

The first visit to determine the possibilities of cooperative mineral research in Malaysia was not made until December, 1977. At that time, it was found that there are two research groups in Malaysia that have the potential to undertake mineral research with grazing livestock. These are the Universiti 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 for these groups would be Dr. Rudi I. Hutagalung of the university and Dr. C. Devendra of MARDI.

Very little mineral research has been done with ruminant livestock in Malaysia. In the 1950's, some preliminary work showed a phosphorus deficiency based on low serum phosphorus levels. Later work demonstrated low blood copper levels; however, these low levels did not correlate with low levels in hepatic tissue. Low molybdenum concentrations have also been reported in soils for forages. Some of the best research has shown 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 and often resulting in death. In the experiment conducted by MARDI, there was a dramatic increase in liveweight gain as a result of vitamin B_{12} administration although no effects were obtained from copper or terramycin administration.

During a 1980 visit, plans were made to evaluate and set up more experiments to improve the production rates of a beef cattle operation named the Pahang Bif Cattle Company. The company has been plagued by low production rates and Mr. Keng Kee Sian and Mr. Ahmed Muda have been supplying mineral supplements for the ranch. In 1979, a visit by the Florida staff provided mineral supplements for the formula used this past year. The basic supplementation trial at the ranch involved four treatments of approximately 50 breeding animals each, in addition to four bulls per paddock. The four treatments were as follows: 1) concentrates for bulls and cows plus mineral block supplementation (10% phosphorus); 2) concentrates for bulls only, plus mineral block supplementation (10% phosphorus); 3) concentrates for bulls and cows, plus mineral supplementation containing dicalcium phosphate and salt in a ratio of 75% salt to 25% dicalcium phosphate (4.5% phosphorus); and 4) concentrates for bulls and cows, plus common salt. Animals allotted to the treatment were 3 to 6 years of age. Prior to allotment, animals were tested as to cycling and bulls were tested for semen quality.

In September of 1979, the pregnancy rates for the four treatments were as follows: Treatment 1 - 86%; Treatment 2 - 71%; Treatment 3 - 91%; and Treatment 4 - 84%. If this experiment were to be evaluated statistically, probably only Treatment 2 (only bulls receiving concentrates) would have been lower. Calving percentages were higher for all treatments than those recorded for the two previous years (calf crop was 66% for 1977 and 51.5% for 1978). It was for this reason that Mr. Braithwaite had asked for help from the University and ICI to determine if supplementation would be beneficial.

Blood phosphorus levels for the second and third collections averaged 6.3 and 6.8 mg% which would be considered normal. Forage phosphorus, however, averaged only .06% at 114 days. The issue of whether phosphorus was beneficial to reproductive rates was confused in that three of the groups received concentrates high in phosphorus and the fourth group received minerals high in phosphorus. A better experiment would have provided a control group which received salt only.

From the results, it was apparent that the concentrates and/or mineral supplements increased fertility levels. It was then decided that a new experiment would be designed to separate the effect of minerals versus concentrates. The new experiment involved four treatments as follows: 1) complete minerals (MIN) plus .68 kg concentrate (CON); 2) MIN + 1.3 kg CON; 3) salt only (S); and 4) MIN only.

	Treatment 1	Treatment 2	Treatment 3	Treatment 4
	MIN+68 kg CON	MIN+1.3 kg CON	S	MIN
# animals	38	47	53	55
% pregnancy	84.5	87.2	88.7	94.6

Mr. Braithwaite was extremely happy with the results. Animals receiving the complete mineral supplement had a higher performance. Likewise, the average birth weight for calves was around 23-24 kg for controls while for animals receiving minerals, it was 32.7 kg. Since minerals have been used for the past several years based on the formula of the University of Florida, production rates have been extremely good.

On the Pahang Bif Cattle Co. ranch, there has been a severe problem of animals losing condition and calves developing diarrhea. Ninety head were lost as a result and the animals that did recover from the diarrhea required a long time to recuperate completely and gain weight. Cobalt deficiency was suspected and cobalt bullets were given to all animals. This resulted in great growth response; however, no controls were involved in this treatment. Pasture levels have also indicated cobalt deficiency. Forages analyzed at several laboratories in Australia have all had values less than the requirements for cattle. The farm had previously used vitamin B_{12} injections to alleviate the condition. There was a definite response when animals received B_{12}; however, this effect lasted only two to three months.

On another ranch in the area (Dara Bif), mineral deficiencies were also likely a problem. Four years ago on this ranch, 70 weaned animals were lost due to what appeared to be cobalt deficiency. The animals lost weight rapidly, approximately 100 lb in a 3-week period prior to death.

Mineral research programs carried out by Dr. Hutagalung and Mr. Teng Yew Hew included one study involving water buffalo. Sixty animals, 2 to 3 years of age, were divided into two treatments, one consisting of salt only and the other of salt plus complete minerals. The results noted higher growth rates for those receiving complete minerals and also increased ovarian activity. In a sheep supplementation trial, 60 animals were allotted to the following treatments: 1) control; 2) minerals plus 1 lb concentrate; 3) 1 lb concentrate;

and 4) a mineral lick. In this experiment, however, no differences were found among the animals.

Another study looked at the phosphorus status of water buffalo from birth to 6 months of age. Blood samples were taken every 2 weeks. Blood phosphorus levels seemed to increase after 8 weeks of age. At 8 to 10 weeks, the blood phosphorus levels were between 6 and 7 mg%. Then, between 30 and 50 weeks of age, concentrations leveled off and blood minerals were lower for non-supplemented animals. Blood copper concentrations were low and liver copper concentrations were quite variable, averaging 102 ppm.

In other mineral research work, there was a monitoring of slaughtered animals for the purpose of analyzing mineral concentrations in bone, liver and blood. Most of the mineral analyses for the tissues were in the normal range; however, bone for some reason, was higher in calcium and phosphorus than would be expected. Analyses were also made of 60 to 70 forages to determine mineral content. Phosphorus levels were low, ranging from .06 to .08%. Copper levels were between 2.1 to 7 ppm and molybdenum, between .7 and 2.2 ppm. Sulfur was generally low, in the .05 to .08% range; zinc values were between 22 and 131 ppm, manganese values were between 83 and 236 ppm, and calcium levels were from .27 to 1.09%.

Assistance from the Florida-AID mineral project has been very limited, providing only technical advice, consumable supplies and literature.

Malaysia Contacts

Mr. Richard (Dick) Blaby
c/o U. S. Embassy
Kuala Lumpur, Malaysia

Mr. Sunny Heng Kee Siang (Tel. 943733)
Mr. Wan Ahmed Muda
Pharmaceuticals Department
ICI (Malaysia) Sdn. Berhad
Wisma Demansara
Jalan Semantan
Kuala Lumpur, Malaysia

Mr. Kung Yak Min
Dr. Rooli Mai Lam, Premix Marketing Manager
(Tel. 760122 or 760954)
Pfizer Private Ltd.
3 Jalan 241 Section 51-A
Petaling Jaya, Malaysia

Dr. C. Devendra
Dr. Syed Ali Abu Baker
MARDI
P.O. Box 202, UPM
Serdang, Selangor, Malaysia

Dr. R. I. Hutagalung (Tel. 355425/6, Home, 560038)
Dr. Syed Jalaludin (Dean)
Dr. Mahyuddin Dahan (Dept. Head)
Dr. Omar Abdul Rahman
Dr. M. R. Jainudeen (Reproductive Physiology)
Mr. Peng Yew Hew (Mineral Analyses)
Dr. Mohammed Ishak Djaffar
Department of Animal Science
Faculty of Veterinary Medicine and Animal Science
Universiti Pertanian Malaysia
Serdang, Selangor, Malaysia

Dr. James Vadiveloo
National Livestock Development Authority
Jalan Selangor, Petaling Jaya,
West Malaysia

Dr. Don H. Bushman (Tel. 737-62-63), Home 468-94-60)
Dr. Steve Chen
American Soybean Association
15th Floor, Room 1501, Liat Towers
Orchard Road, Singapore 0923

Mr. Brian Braithwaite
Pahang Bif Cattle Co.
Inchape Malaysia (Holdings) Sdn. Bhd.
80 Jalan Ampang
Kuala Lumpur, Malaysia
(Tel. 03-8421)

Mr. A. M. (Tony) Clayton, Manager
Dr. Rahim Yusof
Dara Bif Sdn. Bhd.
P.O. Box 494
15th Floor, Bangunan Hong Kong
2 Lebuh Ampang
Kuala Lumpur, Malaysia 01-19

Mexico

The first visit to Mexico was made in September 1981. Although this first visit did not occur until recently, a great deal of mineral research has already been completed in Mexico following the basic design of the Florida mineral project. Ing. Olga Fresnilla of Monterrey (Instituto Tecnológico de Estudios Superiores de Monterrey) has been responsible for a very active mineral research program. Mineral research was first discussed with Ing. Fresnillo in 1976 at the Brazilian symposium on minerals and has been followed up through correspondence since then.

Ing. Fresnillo has directed a large number of student theses since 1975, 20 of them directly related to mineral research with grazing cattle. A list of these theses are found in the appendix. The theses contain extremely good information in relation to the mineral status of three states in the vicinity of Monterrey. In one study (Raymundo Escamilla Martínez), a gain of 9 kg per animal per day was reported for animals receiving phosphorus supplementation. Another thesis (Lizandro M. Fernández Brown) reported greater weight gains for animals with either 4 or 8% phosphorus than for control animals. José Axel Ibarra Cruz also noted significantly higher gains for animals receiving either 5 or 10% phosphorus versus those of the control group. A thesis by David Arturo García Avila noted the economics of phosphorus supplementation.

A number of the theses noted low forage and serum phosphorus levels. Data from José Ibarra noted serum phosphorus for the control groups averaged 3.2 mg% and 7.9 and 11.11 mg% for the 5 and 10% phosphorus supplemented groups, respectively. Another thesis noted forage phosphorus levels of .14%, with 95% of the serum samples averaging less than 4.5 mg% (2.97 mg%). Three theses noted high forage but low serum copper concentrations. Another thesis, by Filiberto de las Fuentes Cabello, noted that 89% of the serum copper levels were low, averaging .44 ppm. The possible explanation for high forage but low serum copper levels could be that molybdenum forage concentrations were high. However, molybdenum analyses had not been done.

Low forage phosphorus concentrations were also reported by Victor A. Siller Chapa and José Luis Ortega. Ortega also reported low serum phosphorus levels and in this study, phosphorus supplementation was found to be economically beneficial. A thesis by Eduardo Siller Berain noted low phosphorus concentrations in both forages and serum during both the wet and dry seasons.

During conversations with Ing. Fresnillo, it was noted that there was a severe phosphorus deficiency in the Tampico area. Analyses from this region had indicated low phosphorus levels and a fairly high death rate was reported. Phosphorus supplementation had appeared to be beneficial. In this case, in addition to death, animals were having problems standing. The question remains, of course, as to whether this is a case of uncomplicated phosphorus deficiency or perhaps due also to other limitations.

Mineral research following the Florida design was also completed in Verz Cruz, Mexico by Hipólito Victor Barradas. Assistance was provided through correspondence and the results were published in a M.S. degree thesis at Michigan State University. The title of the thesis is "Interrelationships among the mineral content of soils, forages and cattle in the Central and Northern Regions of Vera Cruz, Mexico".

As a result of the September, 1981 visit, it was learned that there are 7 institutions that are interested in conducting mineral research in Mexico. One of the main institutions is the Institución de Enseñanza e Investigación en Ciencias Agrícolas in Chapingo. Starting next July, Ing. Ricardo Barcena Gama from Chapingo plans to begin a Ph.D. program at Florida in the mineral research area. A trip to Mexico is planned for February, 1982, to assist Ing. Barcena with initiating experiments for his Ph.D. program.

Mexico Contacts

Dr. Adrian Escobosa (Jefe) Tel. 5505125-4985
Dr. Humberto Troncoso
Dr. Ismael Escamilla
Departamento de Nutrición Animal y Bioquímica
Facultad de Medicina Veterinaria y Zootecnia
U.N.A.M.
Ciudad Universitaria, Mexico 20, D. F.

Dr. Aline S. de Aluja
Dr. Saul Fernándes Baca (FAO)
Facultad de Medicina Veterinaria y Zootecnia
Departamento de Patología - U.N.A.M.
Ciudad Universitaria
México 20, D.F., Mexico

Dr. Marcelo Perez
Dr. Everardo Gonzales Padilla (Sub-Director)
Ing. Fidel Castillo (Mineral Analysis)
Ing. Irma Tejada de Hernandez (Feed Composition)
Ing. Jorge Trinidad (Forage Analysis)
Depto. de Ruminología Básica
Instituto Nacional de Investigaciones Pecuarias
Km 15.5 Carretera Mexico-Toluca
Palo Alto, D. F., Mexico

Dr. Paul R. Nodot (Tel. 582-0573, Home)
Leo No. 124
Col. Prado Churubusco
04230 Mexico, 13, D. F.

Dr. Manuel Cuca García
Ing. Ricardo Barcena Cama
Dr. Ernesto O. Riquelno
Colegio de Postgraduados
Institución de Enseñanza e
Investigación en Ciencias Agrícolas
Chapingo, Mexico

Dr. Arturo Castellanos
Ing. José Luis Romano
Ing. Victor Monroy
Ing. Mario Valencia Z. (Coordinador Regional - I.N.I.P)
Inst. Nat. de Invest. Pecuarias (I.N.I.P)
Apartado Postal No. 100
Sucursal "D"
Mérida, Yucatán, Mexico

Dr. Juan Ku Vera
Dr. Fernando Herrera (Department Head)
Dr. David Harrison (British AID Program)
Facultad de Medicina Veterinaria y Zootecnia
Departamento de Investigación y Estudios Superiores
Universidad de Yucatán, Apdo. 116-D
Mérida, Yucatán, Mexico

Ing. Olga Fresnillo (Home Tel. 54-48-58, Office 58-20-00, Ext. 437
Ing. Candelario Carrera Marquez
Ing. Jesús Alburto Guevara Gonzalez
Instituto Tecnológico de Estudios Superiores de Monterrey
Sucursal de Correos "J"
Monterrey, N. L., México

Dr. David Rodriguez Maltos (Home Tel. 2-15-72, Office 4-31-00)
Ing. Fernando Ruiz-Zarate
Ing. Lorenzo Suarez (Department Head)
Dr. Carlos de Luna
Dr. Jesús Torralba (Nutrition)
Universidad Autónoma Agraria "Antonio Narro"
Buenavista, Saltillo, Coahuila, México

Ing. Ricardo Silva Carrón
Nueva España 335
Fraccionamiento Urdiñola
Saltillo, Coah., México

Ing. José Arroyo Luna (Home Tel. 2-14-92, Office 011-520841)
Muzquiz 727-5 PTE.
Saltillo, Coah., México

Mr. Ed Deathridge (Agriculture Attaché)
Mr. Tomas Donnlly (AID Representative)
United States Embassy
Mexico City, México

Panama

The first contact in relation to mineral research in Panama was made in August, 1981. The main contacts are Ing. Roberto Quiróz and Dr. Santiago Rios A. Ing. Quiróz was extremely interested in mineral research and had been to the University of Florida for laboratory training from September to December, 1980. While in Gainesville, a research proposal for mineral research in Panamá had been written up. This is found at the end of this section of the report.

Dr. Santiago Rios is the director of research investigations with livestock. Dr. Rios had received an M.S. degree from Costa Rica in which he did mineral research with cattle in Panamá.

At the end of 1981, samples had been collected from 20 farms. The majority of these have been taken from the regions of Bugaba and Gualaca. From each farm, one composite forage and one pooled soil sample were collected. Five blood, 2 liver and 2 bone samples were taken from growing steers from slaughterhouses in the vicinity of the farms.

From the Gualaca area, six farms were chosen for collecting additional samples. Forage samples have indicated that over three-fourths of the samples are deficient in phosphorus, being less than .15%. Soil phosphorus concentrations are also low, with 95% less than the critical level. Forage copper is low but there is quite a bit of variation between samples. Some samples had only traces of copper. Blood copper is low, with only 9 of 65 samples above .6 ppm. Serum zinc levels seemed adequate but forage levels were extremely low, with only 2 of 17 samples containing more than 30 ppm.

On a trip to Santiago, we observed animals chewing something which we assumed might be bones. Upon stopping the car and getting closer to the animals, we found that several were chewing on tin cans. This "pica" or abnormal appetite was indicative of phosphorus or some other mineral deficiency. Upon examining the mineral feeder, we found that only common salt was available to these animals.

The Florida project has been and will continue assisting the Panama mineral research program by providing consumable supplies and doing some of the more difficult analyses. Ing. Quiróz will be going to North Carolina this August to go on for his M.S. degree. In his absence, additional contacts in Panama will be Lic. Manuel de Gracia (chemist) and Dr. Jorge Gómez (veterinarian).

A Proposed Mineral Research Program for Panamá (IDIAP)

Introduction

In Latin America, livestock depend largely upon forages to supply their mineral requirements. However, only rarely can forages completely satisfy each of the mineral requirements for grazing animals. 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 countries, Mg in 17, Na in 14, Co in 21 and Cu in 20 countries (Fick et al., 1978; McDowell, 1976; McDowell et al., 1976).

In a recent survey made by IDIAP (1980), some important problems of livestock in Panamá were pointed out: advanced age of heifers at first calving, long calving intervals, low calving percentages and overall low production. These problems, at least in part, must be directly or indirectly related to mineral deficiencies or excesses. Mineral supplementation is an uncommon practice in Panamá.

Mineral deficiencies in Panamá have been reported by several investigators: Ca (Williamson and Payne, 1975); P (Chicco, 1972; Rios A., 1972; Poultney, 1972, personal communication; Rosas et al., 1969; and UNDP/FAO, 1968); K (Chicco, 1972); Na (Chicco, 1972); Fe (Chicco, 1972); Cu (Ammerman et al., 1974); and Zn (Chicco, 1972). It is important to point out contradictions among some of those investigators about specific mineral deficiencies. The reason might be different sampling times and procedures and different statistical designs.

Regarding biological responses to mineral supplementation, Poultney (1972, personal communication) reported an increase in calving percentage from 42.0 to 80.0% with bone meal. Rios A. (1972) reported an increase in calving percentage from 62.2 to 68.8%, a decrease in the time between calving periods and increased average daily gains with phosphorus supplementation.

Many investigators in Latin America have reported positive biological responses to mineral supplementation for both major and minor elements. Increasing fertility in grazing cattle with phosphorus supplementation has been reported in: Bolivia (B. Bauer, 1976, unpublished data); Brazil (Conrad and Mendez, 1965); Colombia (Stonaker et al., 1975); Perú (Echevarría et al., 1974); and Uruguay (Schiersmann, 1965; de León Lara, 1963). Bauer et al. (1979) reported an increase in average daily gains in cattle supplemented wtih phosphorus and within treatments, trace mineral supplementation resulted in nonsignificant higher gains versus control animals. Lopes H. (EMBRAPA - Brazil, 1978, unpublished data) reported an increase in liveweight gains during the wet season with phosphorus supplementation, which increased even more when additional trace minerals were included in the diet.

As mentioned above, mineral status of livestock in Panamá has not been well-defined. Therefore, it is extremely important to carry out mineral research in order to determine with more accuracy the mineral status of grazing cattle in Panamá.

Objectives

- To determine the mineral status in the more important livestock regions of Panamá.
- To evaluate bio-economical responses to mineral supplementation.
- To provide practical mineral supplementation recommendations in order to improve overall cattle production, including reproductive efficiency, in Panamá.

The following methodology refers only to the first objective, i.e., determining the mineral status of livestock in selected regions of Panamá, since this information is necessary before proceeding to the second two objectives.

Methodology

1. Sampling of ranches

1.1 Selection of regions. In each province, regions will be chosen based on the following criteria:

- Beef cattle production priority: It would be made according to the number of beef cattle ranches and the beef cattle population.
- Ecological conditions: According to the above criteria, ranches selected must be representative of ecological conditions of the zone.

1.2 Selection of ranches. In chosen regions, predominant beef cattle production systems will be determined (breeding and/or fattening). The quantity of animals per farm will depend upon the predominant management system. The research will be performed on farms where mineral supplementation is absent or only common salt is used (sodium chloride).

1.3 Selection of animals. The minimum quantity of animals per farm will be 24 (12 per class of animal) from a minimum of 2-3 ranches per region.

1.4 Collection of samples. Samples taken on farms would include blood, liver (biopsy), forage and soil. Bone samples would only be taken if animals were slaughtered on the ranch. The samples can be taken from 1-3 classes of animals, including growing animals (heifers or steers), breeding animals (pregnant-lactating cattle) and fattening animals.

2. Slaughterhouse sampling

Bone (rib) and liver samples to be taken from animals that were in active production.

3. Sampling periods

Two collections will be made, at the end of the wet and the dry seasons.

4. Sampling

4.1 Soil

4.2 Forages
4.3 Blood
4.4 Bone
4.5 Liver

5. Analysis

The analyses will be made following The Methods of Analysis for Plant and Animal Tissues prepared by Fick et al. (1979). This manual likewise describes methods for sample collections.

5.1 Soil. Complete soil analyses to include soil classification, soil structure, pH, organic matter and available forms of the following: P, Ca, Mg, K, Na, N, Al, Fe, Mn, Zn, Co, Cu, Mo and Se.
5.2 Forage: N, *in vitro* digestibility, Na, K, Mg, Ca, P, Fe, Mn, Cu, Zn, Mo, Co, Se and S.
5.3 Blood: P, Ca, Mg, Zn, Cu, Fe.
5.4 Liver: Zn, Cu, Fe, Mn, Mg, Co, Se, Mo, and possibly vitamin A.
5.5 Bone: Bone ash, specific gravity, Ca, P and Mg.

6. Statistical Design - split plot design

7. Mineral Research Program

Basic requirements for mineral research include a well-equipped laboratory, with the main instrument for analysis being atomic absorption. Mineral research fits very well into Ph.D. or M.S. degree programs. This would mean completing coursework at Florida, returning to Panamá, collecting animal tissue and forage samples, and completing the mineral analyses at Florida.

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Panamá Contacts

Mr. Tomas Ugarte
c/o U.S. Embassy
USAID/Panamá
APO Miami, FL 34002

Ing. Roberto A. Quiróz G. (Head of Laboratory, Gualaca)
Dr. Santiago Rios A. (Director de Investigación Pecuaria)
Dr. Rodrigo Tarté (Director General)
Instituto de Investigación Pecuaria (IDIAP)
David, Chiriqui
Panamá

Peru

The mineral research program in Peru did not start until February, 1977. However, a Peruvian student, Ricardo Valdivia, had been working towards his Ph.D. since 1975. Dr. Valdivia's dissertation was 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. Ricardo Valdivia and Dr. Oswaldo del Valle; b) Universidad Nacional Agraria (La Molina) - Dr. Juan Kalinowski; c) Universidad Nacional Pedro Ruíz Gallo (Lambayeque) - Ing. Hélido Vidal.

Universidad Nacional Mayor de San Marcos (IVITA): This institution has a great interest in mineral research and has had quite a bit of experience with mineral analyses. 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/ha, 500 kg/ha, 100 kg/ha plus direct phosphorus supplementation, and 500 kg/ha plus direct phosphorus supplementation. The direct phosphorus supplementation was a mixture of 40% dicalcium phosphate and 60% salt. Animals consumed approximately 50 g of minerals per day. Almost double the gains were noted for the treatments of 100 kg/ha of phosphorus plus direct mineral supplementation over that of the control of 100 kg/ha. The 500-kg/ha treatment was slightly higher; however, this proved not to be as economical as the treatment with only 100 kg plus direct phosphorus supplementation.

Additional IVITA experiments are underway or being planned for research with cameloids. Work is underway to increase the low fertility of cameloids. Better fertility has resulted from improved management. Llamas are spontaneous ovulators and breeding them several times will have a favorable effect in that the high embryotic death loss can be minimized.

A recently completed student thesis by Arturo Lorenzo Rosales Fernández entitled "Contribución al Estudio del Estado Nutricional en Minerales de los Camelidos Sudamericanos en el Altiplano" analyzed blood and liver samples collected at slaughterhouses from 96 alpacas, 9 llamas and 12 steers. Blood Cu, P and Mg levels were generally normal, although liver Cu from steers and alpacas averaged 9.7 and 4.8 ppm, respectively. Some of the forage analyses from La Raya are as follows:

Nutrient	Native (phalaris)	Improved Pastures
Ca, %	.12	.50
P, %	.08	.28
Fe, ppm	528	669
Cu, ppm	9.3	14.7
Protein, %	5.6	19.2
Ash, %	5.2	9.4

Mineral supplements administered as a drench to alpacas have not been successful. Some of the drenched animals died. It is not known if it was due to the minerals or incorrect drenching procedures. New experiments are being planned by Dr. Valdivia with the following treatments: control, injections of A-D-E and injections of Se-vitamin E. One would not expect a positive response from the Se-E injection since the altiplano is more of a Se-toxic area as evidenced by the presence of the genus Astragalus, a Se-indicator plant.

Another student thesis involved a disease condition in dairy cattle termed "temblera". This is characterized by nervous symptoms and irritability. When the animal enters certain pastures, it will be hypersensitive to noise and movement. Exercise will result in muscular tremors and incoordination. The clinical signs may last for many days, resulting in lowered milk production; however, the appetite is unaffected. The problem is associated with older established alfalfa pastures, however, it is felt that if the pasture is pure alfalfa, there is no problem; rather it is often other species (often weeds) that are in the pasture. The condition is cured by removing animals from "problem" pastures or feeding grain. Also injections of Ca, P and electrolytes have resulted in recovery. It is possible that Mg deficiency could be involved. The condition of "tembladera" occurs in southern Peru in the department of Tacna (next to Chile) and also in irrigated areas of Arequipa.

Universidad Nacional Agraria - The National Agrarian University at La Molina has been responsible for a great deal of agricultural research over the past years. Part of this research has included studies with mineral deficiencies.

There is currently a sheep experiment underway in the Central Highlands with 1200 animals. The treatments are as follows: 1) salt + iodine + copper + cobalt; 2) salt + iodine + copper + cobalt + zinc; 3) salt + iodine + copper + cobalt + zinc + phosphorus. A second experiment involves these same treatments but with growing lambs for six months. A third experiment at Pucallpa involves Nellore cattle, 6 years of age. 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 has been observed in sheep. It was felt that this was not caused by a simple copper deficiency or a molybdenum-induced copper deficiency. It is thought that possibly high zinc levels may cause a copper deficiency. Additional research has noted low cobalt and zinc areas in the Cuzco region.

Dr. Kalinowski has undertaken some extensive mineral supplementation trials with sheep. He has had some problem with the injectable copper solution in the form of copper glycinate. In one experiment, 1000 ewes were involved, with a large proportion having inflammation at the injection site. Some deaths from the inflammation resulted and the experiment was terminated. It was agreed that the Florida project would look for a more acceptable injectable copper solution (i.e., Cu complexed with EDTA).

Dr. Kalinowski recently completed a sheep mineral supplementation trial involving three treatments of 900 ewes each. Some of the results of this experiment are as follows:

	Cu, Co, I and NaCl	Co, Cu, Fe, Zn, I, and NaCl	Co, Cu, Fe, Zn I, NaCl and CaP
Ewes, Gain (kg)	34.4	39.4	41.2
Birth Wt. of Lambs (kg)	3.15	4.40	4.60
Lamb Mortality Rate	38.7	22.5	18.59
Percent Lamb Crop	77.7	86.0	84.7

The mortality rate was very high due to bad weather (rain) during lambing with the majority of deaths occurring within the first few days. The data would suggest a response from supplemental iron and zinc. Data from this experiment were presented at the 1979 ALPA meetings.

Dr. Kalinowski is doing some studies combining minerals with urea. Consumption of the mixture is 20 grams per day with 8 grams of the total being urea. Sheep have access to this mixture only 12 hours a day (at night). Continued access to this mixture did result in some toxicity.

Universidad Nacional Pedro Ruíz Gallo - The mineral research program in Lambayeque has been functional for almost 5 years. Most of the first one-and-a-half years were needed to obtain equipment and for practicing laboratory procedures. The program is now very active and it is, in essence, the regional center of mineral research for northern Peru. Ing. Hélido Vidal is the leader of the program along with Ing. Francis Villena. Ing. Luis Ara Valera is from the Universidad Nacional Técnica de Cajamarca and Ing. Vidal has been helping him to establish a mineral research program. The Florida-AID program has sent a number of materials and supplies to both Ing. Vidal and Ing. Ara. Ing. Ara is supervising students in collecting samples and is writing reports suitable for extension purposes with the data.

Ing. Vidal is planning some programs to determine if the etiology of "coquera" can be established. This disease is characterized by animals losing weight and becoming emaciated. Muscles of the face are often in atrophy, with a swelling of the cheek. One of the most characteristic clinical signs is the tongue often protruding from the mouth. The condition was first recorded in 1947. Since then, there have been some years with no incidence of the disease. However, during severe dry seasons, the condition is quite prevalent. During the wet season, there is no problem but during June and July, conditions are severe. Coquera affects cattle in all of the northern zone of the country.

In Batan Grande, a sugarcane-livestock cooperative named "Cooperativa Agraria de Producción", has conducted some mineral supplementation programs in relation to coquera. Animals received no minerals for 4 months and for the following 4 months, 100 g/day were consumed. The calving percentage was 60%. Forage provided to the animals was 8-12 kg/day (or 2-3 kg DM). During a visit to the area, discussions were held with the managers as to the proper procedure for studying this condition. It was hoped that tissue samples and forage samples could be taken for mineral analysis. Also, it was suggested that plants suspected of causing the condition should be force-fed to animals to observe the results.

During the last visit to Peru in September, 1980, two new publications were available. The first one is a thesis which involves the research program at Lambayeque. It is entitled "Estudio del contenido de calcio, magnesio y cobre en suero sanguíneo de vacunas y la reproducción"; the author is Pedro Luis Lizarzaburu. Also available was a publication entitled "Estudio de las

deficiencias y toxicidades de minerales en el norte del Perú". by Ing. Vidal, Ing. Francis Villena, Ing. Ara and three other collaborators. This document gives results of the various trials which were as follows: 1) Suplementación de minerales en ganado vacuno y lechero en la Campiña de Cajamarca; 2) Suplementación de minerales en el ganado vacuno de carne de la CAP Udima; 3) Diagnóstico de deficiencias minerales en la granja Procón-Cajamarca; 4) Diagnóstico de deficiencias de minerales en el ganado vacuno de Batan Grande (zona con problemas de coquera). Summaries of these experiments are included at the end of this section of the report.

INFORME PRELIMINAR

Proyecto: Estudio de las Deficiencias y Toxicidad de Minerales en el Norte del Perú.

Título del Proyecto de Tesis: Diagnóstico del Estado Nutricional Mineral del Ganado Vacuno en Jaén

Alumno Reponsable: Rafael Antonio Guerrero Delgado

Patrocinador: Hélido Vidal Dávila, I.A.M.Sc.

Otros participantes en el Proyecto: Francis Villena Rodríguez, I.Z.
Carolina Aguilar P.. I.Z.
Dr. L. R. McDowell

Instituciones auspiciadoras: Universidad Nacional Pedro Ruíz Gallo, Lambayeque, Perú.

Universidad de Florida, USA.

Objetivos del Proyecto: El presente proyecto tiene como objetivos: determinar los niveles de Ca, P, Mg y Cu en suero sanguíneo; Cu, Fe y Mn en el hígado; al igual que en forrajes se determinará Ca, P, Mg, K, Na, Mn y Cu, para ver si se presentan deficiencias o toxicidades de estos elementos en el ganado vacuno que se cria en la zone de Jaén.

De otra parte, permitirá establecer bases para futuros programas de suplementación mineral en dicha zona.

Tratamientios y/o disposición experimental:

Epocas de muestreo: Época de lluvias (dos muestreos) y época seca (un muestreo)
Sistemas de explotación: pastos cultivados y pastos naturales.
Número de animales muestrados por época:
Muestras obtenidas: sangre en animales in vivo; hígado y sangre en animales de camal; forrajes cultivados y naturales.

Fecha de inicio: Marzo de 1,978

Resultados a la fecha: Los resultados se muestran en los cuadros adjuntos al presente informe.

Comentarios: Durante la época lluviosa hay abundancia de pastos (más cantidad de pastos naturales). Se ha observado cierto grado de deficiencia en los elementos Ca, P y Cu, tanto en animales que consumen pastos cultivados, como aquellos que consumen pastos naturales. Es sorprendente observar que, la deficiencia de Fósforo es mayor en un régimen con pastos cultivados, lo cual tiene cierta relación con el contenido de fósforo del forraje de algunos pastos y el tipo de animales (mejorados). La deficiencia de cobre es definitivamente más alta en los animales que consumen pastos naturales, estrechamente relacionado con la disponibilidad de cobre en los forrajes.

En la estación seca, en los animales que consumen pastos cultivados, se incrementa notablemente el grado de deficiencia de calcio y baja el grado de deficiencia del fósforo, en relación al primer muestreo. En animales que consumen pastos naturales, el grado de deficiencia de fósforo se incrementa considerablemente en relación al primer muestreo.

CUADRO 1: Contenido de minerales en el suero sanguíneo de vacunos en la zona de Jaén, Perú. (Epoca lluviosa, Marzo de 1,978)

Minerales	Pastos cultivados	Pastos naturales	Muestras camal
Calcio			
Contenido de Ca (mg/100 ml)	8.2 ± 0.9	9.0 ± 2	8.1 ± 1.4
Grado deficiencia*, %	34.6	28.1	58.3
Fósforo			
Contenido de P (mg/100 ml)	5.1 ± 1.1	6.6 ± 2.6	5.7 ± 1.3
Grado de deficiencia*, %	30.7	12.5	18.7
Magnesio			
Contenido de Mg (mg/100 ml)	2.8 ± 0.4	3.0 ± 0.9	2.3 ± 0.3
Grado de deficiencia*, %	0	3.12	8.3
Cobre			
Contenido de Cu (g/ml)	0.6 ± 0.2	0.5 ± 0.2	0.7 ± 0.2
Grado de deficiencia*, %	18.5	43.7	4.3

*Para obtener los grados de deficiencia se han tomado los siguiente niveles marginales: Calcio, 8 mg/100 ml; Fósforo, 4.5 mg/100 ml; Magnesio, 2 mg/100 ml; Cobre, 0.5 µg/ml.

Se tomaron las siguientes muestras:

Pastos cultivados (número de animales): 26
Pastos naturales (número de animales) : 32
Camal (número de animales) : 48
Muestras colectadas de suero sanguíneo: 106

Cuadro 2: Contenido de minerales en el suero sanguíneo de vacunos en la zona de Jaén, Perú. (Epoca seca, Octubre de 1,978)

Minerales	Pastos cultivados	Pastos naturales	Muestras camal
Calcio			
Contenido de Ca (mg/100 ml)	8.1 ± 1.0	9.3 ± 1.4	7.4 ± 0.5
Grado de deficiencia*, %	54.1	8.7	90.6
Fósforo			
Contenido de P (mg/100 ml)	7.4 ± 1.7	6.4 ± 2.1	4.9 ± 1.6
Grado de deficiencia*, %	2.7	2.2	34.4
Magnesio			
Contenido de Mg (mg/100 ml)	3.0 ± 0.4	2.9 ± 0.4	2.6 ± 0.3
Grado de deficiencia*, %	0	0	0
Cobre			
Contenido de Cu (µg/ml)	0.7 ± 0.3	0.6 ± 0.2	0.3 ± 0.2
Grado de deficiencia*, %	22.2	39.1	81.3

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Calcio, 8 mg/100 ml; Fósforo, 4.5 mg/100 ml; Magnesio, 2 mg/100 ml; Cobre, 0.5 µg/ml.

Se tomaron las siguientes muestras:

Pastos cultivados (número de animales)	37
Pastos naturales (número de animales)	23
Camal (número de animales)	32
Muestras colectadas de suero sanguíneo:	92

Cuadro 3: Contenido de minerales en los principales forrajes de la zona de Jaén, Perú (Epoca lluviosa, Marzo de 1,978)

Forrajes	Procedencia	Ca %	P %	Mg %	Cu µg/g
Panicum máximum	Jaén	1.01	0.26	0.32	1.30
Panicum purpurascens	"	0.32	0.40	0.32	6.92
Panicum máximum	Quiracas	0.98	0.33	0.38	15.29
Pennisetum purpureum	"	0.32	0.42	0.20	11.37
Panicum purpurascens	"	0.42	0.20	0.27	7.87
Panicum máximum	Pucará	0.88	0.24	0.44	3.26
Acacia macrocantha	"	2.46	0.17	0.36	3.68
Cordia sp.	"	3.51	0.10	0.66	2.98
Boutelova aristidoides	"	0.20	0	0.10	1.44
Bejuco toro°	"	3.64	0.16	0.50	8.71
Luche°	"	1.98	0.14	0.61	13.75
Prosopis chilensis	Bellavista	2.16	0.16	0.27	2.56
Cordia sp.	"	3.24	0.26	0.42	3.26
Acacia macrocantha	"	1.06	0	0.15	0.46
P. máximum-Rinchozia	Pomahuaca	1.57	0.18	0.58	4.38
P. máximum-Rinchozia	"	0.50	0.14	0.36	2.84
Pennisetum purpureum	"	0.36	0	0.13	0.32
Panicum máximum	"	0.71	0.07	0.26	0.60
Rinchozia mínima	"	1.35	0.26	0.48	4.52
Mezcla forrajes°	Santa Fé	2.81	0.06	0.51	3.82
Mezcla forrajes°	"	2.83	0.17	0.52	3.40
Algodoncillo°	Colasay	1.64	0.12	0.48	3.68
Pata de perro°	"	2.08	0.10	0.27	2.70
Tuyo°	"	1.77	0.03	0.25	2.56
Niveles promedios en forrajes		1.61	0.18	0.37	4.5
Grado de deficiencia*, %		4.0	84.0	16.0	88.0

0 - could not detect.

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Calcio, 0.30%; Fósforo, 0.30%; Magnesio, 0.20%; Cobre, 10 µg/g.

°Falta identificar (género y especie).

INFORME PRELIMINAR

Proyecto: "Estudio de las deficiencias y toxicidad de minerales en el norte del Perú"

Titulo del Proyecto de Tésis: Diagnóstico del estado nutricional mineral del ganado vacuno lechero en la campiña de Cajamarca.

Alumno responsable: Pedro Antonio del Carpio Ramos (P.A. de Zootecnia)

Patrocinador: Hélido Vidal Dávila; I.A., M.Sc.

Otros participantes en el proyecto: Francis Villena, I.Z.
Carolina Aguilar, I.Z.
L. R. McDowell, Ph.D.

Instituciones auspiciadoras: Universidad Nacional "Pedro Ruíz Gallo", Lambayeque, Perú

Universidad de Florida, Gainesville, Florida, U.S.A.

Instituciones colaboradoras: Grupo Asesor Alemán; Universidad Nacional Técnica de Cajamarca; CAS Agrigan (Cajamarca); PRODAC (Cajamarca); Ministerio de Agricultura y Alimentación; Predio ganaderos de Cajamarca.

Lugar de ejecución: Campiña de la ciudad de Cajamarca, Perú.

Fecha de inicio: Marzo de 1978.

Objetivos del proyecto: Determinar en que estado nutricional mineral se encuentra el ganado vacuno lechero criado en los fundos de la campiña que rodea a la ciudad de Cajamarca, a fin de poder corregir las posibles deficiencias y/o toxicidades mediante suplementación.

Tratamientos y/o disposición experimental:

Epocas de muestreo. - Época lluviosa y época seca.
Sistemas de explotación - La explotación del ganado se realiza al pastoreo (especialmente los animales adultos) los cuales pastorean sobre pastos cultivados, Rye grass (Lolium multiflorum) y Trébol blanco (Trifolium repens), que se encuentran asociados en una proporción aproximada de 80% y 20%, respectivamente.
Número de animales muestreados por época: - Se han obtenido ochenta (80) muestras por época de muestreo.
Muestras obtenidas. - Se han tomado muestras de sangre en animales in vivo mediante punción yugular; de cada fundo muestreado también se tomó muestras de forraje. En el camal de Cajamarca se matan muy pocos animales procedentes de la campiña, razón por la cual casi no se tomaron muestras de hígado.

Resultados a la fecha: En los siguentes cuadros se muestran los resultados obtenidos hasta el momento.

Se puede observar que en ambas épocas hay deficiencia de Calcio, presentándose en mayor grado en la época seca, deficiencia que no concuerda con el contenido de Calcio en los forrajes debido a que todos ellos están con contenidos superiores al nivel crítico.

La ligera deficiencia de Fósforo en la época lluviosa y el incremento del grado de deficiencia durante la época seca está relacionada con el contenido de Fósforo en los forrajes, ya que además de presentarse niveles marginales existe, en algunos forrajes, una tendencia a decrecer la concentración de este elemento durante la época seca.

La concentración de Cobre en el suero en ambas épocas está en el nivel marginal (0.5 g/ml), observándose el mismo grado de deficiencia en ambas épocas. El grado de deficiencia de Cobre en los forrajes no es tan alta como en el suero; sin embargo tiende a acentuarse el grado de deficiencia en el forraje durante la época seca.

Cuadro 1. Contenido de minerales en el suero sanguíneo de vacunos lecheros de la campiña de Cajamarca (Epoca de lluvia, Marzo de 1978).

Minerales	Pastoreo en Rye grass:trébol
Calcio	
Nº de muestras	81
Contenido de Ca (mg/100 ml)	8.92 ± 1.63
Grado de deficiencia*, %	25.92
Fósforo	
Nº de muestras	81
Contenido de P (mg/100 ml)	7.55 ± 3.3
Grado de deficiencia*, %	11.11
Magnesio	
Nº de muestras	81
Contenido de Mg (mg/100 ml)	2.59 ± 0.84
Grado de deficiencia*, %	9.87
Cobre	
Nº de muestras	84
Contenido de Cu (µg/ml)	0.54 ± 0.2
Grado de deficiencia*, %	48.8

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Ca, 8 mg/100 ml; P, 4.5 mg/100 ml; Mg, 2 mg/100 ml; Cu, 0.5 µg/ml.

Cuadro 2. Contenido de minerales en el suero sanguíneo de vacunos lecheros de la campiña de Cajamarca (Epoca seca, Octubre de 1978).

Minerales	Pastoreo en Rye grass:trébol
Calcio	
Nº de muestras	83
Contenido de Ca (mg/100 ml)	8.5 ±1.73
Grado de deficiencia*, %	43.37
Fósforo	
Nº de muestras	83
Contenido de P (mg/100 ml)	6.24 ± 2.31
Grado de deficiencia*, %	27.71
Magnesio	
Nº de muestras	83
Contenido de Mg (mg/100 ml)	2.35 ± 0.42
Grado de deficiencia*, %	12.04
Cobre	
Nº de muestras	81
Contenido de Cu (µg/ml)	0.48 ± 0.2
Grado de deficiencia*, %	49.39

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Ca, 8 mg/100 ml; P, 4.5 mg/100 ml; Mg, 2 mg/100 ml; Cu, 0.5 µg/ml

Cuadro 3. Contenido de minerales en pastos cultivados utilizados en la campiña de Cajamarca; Epoca de lluvia, Marzo de 1978. (Base seca).

Predios	Ca, %	P, %	Mg, %	Cu, µg/gr
El Triunfo	0.62	0.5	0.25	9.7
La Colpa	0.69	0.23	0.21	9.7
La Victoria	1.09	0.35	0.21	12.6
Bethania	1.10	0.18	0.21	12.6
Huayrapongo	0.89	0.38	0.17	25.6
Miraflores	0.77	0.34	0.25	16.8
San Roque	1.03	0.45	0.24	13.0
Huacariz	0.86	0.23	0.21	11.1
Tartar	0.74	0.48	0.34	15.2
El Carmen	0.87	0.35	0.27	12.2
Mayopata	1.29	0.38	0.39	16.4
CAP. Cajamarca	0.83	0.45	0.22	30.4
Alto Otuzco	1.11	0.36	0.38	31.1
El Milagro	0.62	0.11	0.19	7.6

Cuadro 3. (Cont.)

	Ca, %	P, %	Mg, %	Cu, µg/gr
Promedio	0.89	0.34	0.25	16.01
Grado de deficiencia*, %	----	28.57	14.28	21.42

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Ca, valores menores a partir de 0.3%; P, valores menores a partir de 0.3%; Mg, valores menores a partir de 0.2%; Cu, valores menores a partir de 10 µg/gr.

Cuadro 4. Contenido de minerales en pastos cultivados utilizados en la campiña de Cajamarca; Epoca seca, Octubre de 1978 (Base seca).

Predios	Ca, %	P, %	Mg, %	Cu, µg/gr
Bethania	1.8	0.12	0.38	27.8
Bethania	1.4	0.25	0.21	22.2
San Roque	1.8	0.68	0.45	8.7
San Roque	1.4	0.56	0.43	5.1
Huayrapongo	1.4	0.44	0.34	5.1
Huayrapongo	1.4	0.66	0.49	30.8
Huacariz	1.1	0.30	0.18	10.1
Miraflores	1.5	0.22	0.16	18.6
Miraflores	1.3	0.14	0.10	16.4
El Triunfo	1.0	0.25	0.21	7.6
Tartar	1.0	0.35	0.16	19.3
El Carmen	1.0	0.61	0.31	14.8
Promedio	1.34	0.38	0.28	15.54
Grado de deficiencia*, %	----	50	33.33	41.6

*Para obtener los grados de deficiencia se han tomado los siguientes niveles marginales: Ca, valores menores a partir de 0.3%; P, valores menores a partir de 0.3%; Mg, valores menores a partir de 0.2%; Cu, valores menores a partir de 10 µg/gr.

Peru Contacts

Mr. Lauren Schults
Rural Development Officer
USAID/Peru
c/o American Embassy
Lima, Perú

Dr. Ricardo Valdivia (Elvira)
Dr. Oswaldo del Valle
San Marcos University
Laboratorio de Nutrición Animal
I.V.I.T.A.
Apartado Aéreo 4270
Lima, Perú

Ing. Mariano G. Echevarria,
I.V.I.T.A.
Universidad Nacional de San Marcos
Apartado Aéreo 4270
Lima, Perú

Dr. Juan Kalinowski
Universidad Nacional Agraria
Apartado Aéreo 456
La Molina
Lima, Perú

Ing. Helido Vidal (Agueda)
Ing. Francis Villena
Ing. Miguel Barandiaran
Universidad Nacional Pedro Ruíz Gallo
Lambayeque, Perú

Ing. Tomás Tello
Centro Regional de Investigaciones
Agropecuarias CRIA-II
Apartado Aéreo 116
Chiclayo, Perú

Ing. Luis Ara Valera
Ing. José Vigo Mendoza
Universidad Nacional Técnica de
Cajamarca
Departamento de Ciencias Agropecuarias
Jirón Lima No. 549
Cajamarca, Perú

Dr. Enrique Franco, Director
Dr. Julio Suman
Estación La Raya
Casilla 4270
Lima, Perú

The Philippines

The first visit to the Philippines was made in December, 1977. The organizations responsible for research in the Philippines 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. The main contact at PCARR is Dr. Alfonso N. Eusebio.

There has not been a great deal of mineral research done in the Philippines in the past. There is currently a three-year trace element research program but this is for soils only and 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. During the last year, equipment requirements for mineral research have been met through the World Bank loan program; however, time will be required for this equipment to become fully functional. In the fall of 1980, Mrs. Leticia Palo had been at the Nutrition Laboratory in Florida for a 3-month training session. The Florida-AID program has also assisted the Los Baños mineral program with consumable supplies, assistance with analyses and purchase of a muffle furnace.

Forage analyses completed in 1980 showed the following results: 1) 29 samples contained .06% sodium or less; 2) 21 samples contained .20% phosphorus or less; 3) 15 samples contained less than 10 ppm copper; 4) 35 samples contained less than 40 ppm zinc; 5) 7 samples contained less than 40 ppm manganese; 6) 27 samples contained less than .1 ppm cobalt (many of these cobalt values were actually zero - this probably indicates a lack of sensitivity in the instrument used to determine this mineral); and 7) Potassium, calcium, magnesium and iron were all in adequate concentrations.

One experiment carried out at Muñoz, Nueva Ecija, studied the effects of mineral supplementation. Seventy-three animals were divided into two groups, consisting of 1) salt only and 2) salt plus a complete mineral supplement. The pregnancy rate based on a 7-8 months palpation was 57 and 79% for groups 1 and 2, respectively.

The major mineral research project completed in 1981 was the publication of a Ph.D. dissertation entitled "Mineral Status Survey and Mineral Supplementation Trial with Breeding Beef Cattle in Calintaan, Occidental Mindoro", by Dr. Clenio T. Dumlao. An abstract of this thesis can be found in the appendix of this report. The experiment was conducted at three ranches in Occidental Mindoro with the purpose of determining the mineral status of the cattle in this region and the effects of mineral supplementation, alone and in combination with protein and energy. Of 75 grasses analyzed, 72, 17.3, 72 and 49% were deficient in phosphorus, potassium, sodium and zinc, respectively. Of the legumes, 70.7, 62.5 and 12.5% were deficient in phosphorus, sodium and zinc, respectively. In general, shrubs and broadleaf plants had higher concentrations of minerals.

All three classes of cattle appeared to be deficient in serum copper. Dry cows at all ranches had borderline to deficient phosphorus; lactating cows were deficient in phosphorus and magnesium. As expected, serum phosphorus was higher ($P < .07$) among supplemented cows. Serum magnesium levels

were highest ($P < .01$) during the wet season and lowest during the dry season. Copper plasma concentrations differed between age groups and period of collection, being highest during the rainy season.

Mineral supplementation did not affect liver concentrations, although animals receiving salt tended to have lower levels of copper, zinc and iron than those receiving minerals. Liver copper at initial biopsy was deficient; all others were in the low normal range.

Younger cows apparently responded better to mineral supplements, with pregnancy rates of 57.1, 71.4, 42.9 and 42.9 percent for complete mineral mixture, complete mineral mixture plus energy plus nitrogen, phosphorus and salt, respectively, versus 27.4% initial pregnancy rate. A general conclusion was that mineral supplementation had little effect of the pregnancy rates of older cows. Older cows, however, generally had significantly higher ($P < .06$) pregnancy rates than younger animals.

In early 1979, Dr. A. Calub and Dr. Lee McDowell had visited the Sarangani Cattle Company in Davao, Mindanao and at that time a discussion involving initiation of a supplementation trial with 4000 cattle took place. The treatments were to have been: 1) salt only, 2) salt plus bone meal, and 3) salt plus bone meal plus various minerals. The complete mineral supplement was formulated to contain between 60 and 80% phosphorus and between 50 and 100% of trace mineral requirements. All animals were to be weighed twice a year, in November and May. Records were to be kept as to weight gains and performance. The planned duration of the experiment was two years. Blood, forage and liver samples were to be taken; blood and liver from approximately 12 animals per treatment. Unfortunately, however, the experiment was never carried out due to inadequate funds at the University of Los Baños and PCARR.

In 1981, another possible experiment was planned to involve four treatments as follows: 1) salt only all year long; 2) complete minerals all year long; 3) complete minerals only during the wet season; and 4) complete minerals only during the dry season. Samples of forage, soil, blood and liver would be taken in the manner previously planned. If some animals were to be slaughtered, bone samples could also be collected. Another suggestion was to start out with either weaned heifers or bred heifers. Depending on the grazing pressure desired for the particular pastures, a combination of young animals and old animals could be used. A minimum of 100 animals per treatment would be required to determine meaningful differences in reproductive rates. At the present time, it looks very encouraging that some type of supplementation experiments will be undertaken eventually.

Philippines Contacts

Dr. Ed Rice (Tel. 59-80-11, Ext. 404)
Chief, Agricultural Research Division
USAID/Philippines
APO San Francisco, CA 96528
(Office: 1601 Ramón Magsaysoy Center, 1680 Roxas Blvd., 16'th Floor)

Dr. Arsenio D. Calub
Dr. Vicente Momoñgon
Dr. Perla L. López
Dr. Leo S. Castillo
Mrs. Leticia Palo
Dr. Benedicto Parker
Dr. Alberto Robles (Dairy and Pasture Husbandry Division)
Mr. Clenio T. Dhmlao
Dr. C. B. Pérez, Jr. (Dean)
College of Agriculture
University of the Philippines
Los Baños, Laguna, Philippines

Dr. Alfonso N. Eusebio
Director, Livestock Research Division
PCARR (Philippines Council for Agriculture and Resources Research)
Los Baños, Laguna, Philippines

Mr Antonio Nocom (Tel. 88-52-59 or 88-40-83)
Mr. Vic Nocom
Ansa Cattle & Crop Farm, Inc.
P.O. Box 122 C.C.P.O. Makati,
Manila, Philippines

Dr. Jimmy R. Escaño (Tel. 70-44-81)
Director, Agri-Business Development
Carnation Philippines, Inc.
Corner Reliance and Pine Streets
P. O. Box 427, Commercial Center
Makati, Metro Manila 3117, Philippines

Dr. S. K. Ranjhan
Project Manager (FAO)
Caribou Research and Development Center
c/o University of the Philippines
Los Baños, Laguna, Philippines

Dr. Solomon Bloom (Tel. 85-85-22)
Consultant, Livestock & Feed Industry
7582 de la Rosa Street
Makati, Metro Manila, Philippines

Mr. Carlos Mata
Mr. Alex Cauldo
Sarangani Cattle Co.
General Santos, S. Cotobato, Philippines

Dr. Bernardo Casio (Tel. 88-26-21)
Agricultural Manager, Pfizer, Inc.
Sixth Floor, Araza Bldg.
Corner Paseo de Rosas and Makati Ave.
Makati, Rizal, Philippines

Thailand

The first visit to Thailand in relation to mineral research took place in November, 1978. The chief contact there is Dr. Pravee Vijchulata, a recent graduate of the University of Florida who majored in ruminant nutrition. Dr. Vijchulata works at the University of Kasetsart. The University has outstanding new laboratory facilities that have only been in operation since November, 1978. The equipment is all new and every type of instrument for mineral analysis is available. This is a central laboratory which will be used by all departments of the University. It contains two atomic absorption units as well as a graphite furnace, all by Perkin-Elmer. Additional instruments are also available in the Animal Science Department.

The last two visits to Thailand were to attend the "First (and second) Mineral Nutrition Conferences in Thailand". At the second mineral nutrition conference in 1981, a talk by Mr. Sornthep Tumwasorn entitled "Responses of Beef Calves to Mineral Supplementation in Central Thail Villages". This research effort involved comparing the responses of animals with and without mineral supplementation in 7 villages approximately 100 km west of Bangkok. A total of 73 animals were involved and were made up of indigenous Thai native and one-fourth Brahman crossbred calves. An abstract of this research is found in the publication section. The basic conclusions from this study, as taken from the report, are as follows:

1) Forage mineral levels had the highest contents in the wet season and contained the lowest contents in the dry season.
2) Potassium levels in native grasses contained the highest content among different minerals throughout the year.
3) Native grasses contained 11% protein in the wet period and the amount would drop to 3% in the dry period.
4) The calcium level in the plasma would drop from the new born calves to the pregnant cows observed in the dry season.
5) The pregnant cow of indigenous native breed showed signs of calcium deficiency and contained very low calcium levels in the plasma observed in the dry season.
6) The phosphorus level in the plasma would increase from the new born calves to the pregnant cows observed in the dry season.
7) The potassium level in the plasma was at the normal range in all ages during the dry season.
8) One-fourth Brahman crossbred calves had higher percent improvement of liveweight change after supplementation than the native calves.
9) The animals responded the best to mineral supplementation in the dry season while the wet season supplementation had the lowest response.
10) Changes in hematocrit and hemoglobin parameters after mineral supplementation were not significant.
11) Supplemented cattle had higher mineral levels in the plasma after supplementation but not significantly different.
12) Supplemented cows had significantly higher conception rate than the nonsupplemented control group.

The main conclusion from Mr. Tumwasorn's research was that animals receiving the mineral supplement composed of bone meal, ground shell and salt had a higher conception rate by 17% compared to unsupplemented controls. The

previous year a seminar had also been presented by Mr. Tumwasorn and his data at that time from different farms indicated that there was an overall improvement in growth by 3.6%. The conception rate was likewise more favorable; from a total of 36 treated animals and 28 controls, there was a calving percentage of 63.9% for the former group and 42.8% for the latter. This experiment also showed a greater response to mineral supplements during the dry season than during the wet season. Part of this is due to the fact that during the wet season, animals are working in the fields and often are kept in confinement when not working. Thus, they have little access to forage. However, during the dry season, they are allowed to roam and search for forages and therefore are able to gain back weight they have lost during the working season.

The previous year Dr. L. R. McDowell had made some suggestions in relation to the complete mineral supplement used in the experiment made up of 1 part oyster shell, 2 parts salt and 1 part bone meal. The mixture was disturbing in that it contained approximately 3% phosphorus and 16% calcium. Mr. Tumwasorn had considered changing the mineral supplement for the second year but since he had received positive results, decided not to make the change. For the second year, however, he did run analyses of the supplement and found that the bone meal was adulterated and contained even less phosphorus than supposed. The results of the analyses were as follows:

Minerals	Percentage, Range
Nitrogen	0.64-0.865
Phosphorus	0.50-0.65
Potassium	0.05-0.50
Calcium	16.05-30.80
Magnesium	0.40-0.48
Iron	0.13-0.19
Manganese	0.07-0.08
Zinc	0.003-0.005

This certainly would be an inferior mineral mixture in view of the phosphorus and calcium contents but, nevertheless, it did provide a response during the trial.

Also at the first conference, data from the Chiangmai region was reported by Mr. Lindsay Falvey. Mr. Falvey is a livestock specialist from Australia working with the joint Thai-Australian agriculture project at Chiangmai. The title of Mr. Falvey's talk was "Cattle Nutrition Research in the Northern Thai Highlands" and contained the following observations: 1) Native pastures are the basis for the feed supply of livestock; 2) More often than not there is a problem of insufficient radiation due to cloud cover versus lack of moisture; 3) The highest rainfall is in August and therefore the lowest production of livestock; 4) Soils are poor in phosphorus and sulfur; 5) The soil conditions are such that protein levels of forages do not drop below the critical level of 7% until day 120; at this time, they still would not have gone below the critical phosphorus level of .18%; 6) Overgrazing results in an invasion by the species Eupotorium, which is useless since animals will not consume it; 7) Mineral supplements are administered orally in a drench; usually a beer bottle is used and this method is very effective; 8) Animals were not allowed to graze at night, which corresponds to the typical practice of the farmers; 9) The

response to minerals was mostly during the last part of the dry season; this would be contrary to other tropical studies which note the greatest response. to minerals during the wet season when there is adequate energy and protein. Nevertheless, this can be explained in that during the last part of the dry season, there is new grass growth which has resulted from the recent burning; under these conditions in northern Thailand, the soil moisture is adequate even towards the end of the dry season to produce new growth; therefore once again mineral supplement requirements are related to new available energy and protein supplies; 10) Studies are being conducted to determine factors influencing feed intake, which is measured by esophageal fistulas and chromic oxide; 11) Good results are being obtained from improved pastures composed mainly of desmodium. With desmodium, it is possible to have up to ten times the stocking rate; however, this needs to be researched further since at this stocking rate, it is unknown what the weed invasion will be.

Mr. Falvey finally reported on the results of a trial entitled "Sodium and Phosphorus Supplementation Studies in the Thai Highlands". In this study, two groups of cattle, one of which received a daily supplement containing sodium and phosphorus, grazed native highland pasture in Thailand for a period of 20 months. Significant liveweight gains were recorded and differences in reproductive and calf mortality rates amplified the response in terms of total productivity. It was concluded that the response was associated with the sodium fraction of the supplement rather than with the phosphorus. From the forage analyses, sodium values were .01% while phosphorus was always above the requirement of .18%. Likewise, sodium concentrations were lower in saliva, rumen fluid and feces. Phosphorus levels appeared normal. The tissue and also bone phosphorus and specific gravity levels were normal.

Another contact involved with mineral studies in Thailand is Dr. Southcombe of the New Zealand World Bank Team located in Khon Kaen. Dr. Southcombe has now returned to New Zealand. While in Thailand, he carried out mineral research with both buffalo and cattle in both the wet and dry seasons. The major response to minerals seems to have occurred in the wet season but this portion of the study is not yet completed. During the dry season, cows supplemented with minerals lost only 10 g/day while controls lost 100 g/day. Calves in the experiment gained 258 g while controls gained only 188 g. For buffaloes, animals receiving minerals gained 21 g daily during the dry season while the controls lost 22 g. There was little difference between calves, with the supplemented group gaining 282 g and the controls gaining 242 g. There were definite problems with this experiment in that 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 end. Dr. Southcombe noted that minerals were extremely expensive, costing $7.50/10 kg. He observed that results seemed to indicate that animals cycle better when receiving minerals.

At the second conference on minerals, talks were held with Dr. Yod Vadhanasindhu, the director of a dairy farming promotion organization in Thailand. Dr. Vadhanasindhy had previously done considerable work in the mineral nutrition area and would have to be considered the pioneer of this field in Thailand. Dr. Vadhanasindhu made the following comments in relation to mineral nutrition in Thailand: 1) Selenium concentrations in forages are low, with analyses being in the area of .01 ppm. 2) Reproductive problems in animals consuming diets of less than 30 ppm manganese. Bringing this level up to 80 ppm improved reproductive efficiency. He also noted that in one instance, adult animals did

not calve for two years but after supplemental manganese was provided, 17 became pregnant within 4 months. He related this deficiency of manganese to lowered semen quality. We are unfamiliar with data that supports this conclusion. 3) An experiment was carried out comparing the response of animals with and without mineral supplements. The mineral supplement used was 50 kg salt, 50 kg bone meal, 50 g copper sulfate and 60 g cobalt chloride. Animals not receiving the mineral supplement had a calving percentage of 40% compared to 90% for those receiving minerals. Following these animals beyond the treatments showed that mortality rates were extremely high for unsupplemented calves, being 45-50%, while those of supplemented dams were only 5-10%. In the same study, first-calf heifers had previously never calved until 4 years of age; however, with mineral supplementation, the average calving age was 3 years. This particular research was carried out in 1960. 4) Rice production for an area of 1600 m^2 was 300 kg when regular manure was used; when manure from mineral supplemented animals was used, the yield was 700 kg. 5) When 1 kg of sulfur was added per 100 kg total mineral mixture, footrot was prevented.

In regards to future mineral research, Mr. Tumwasorn noted that they had planned some more supplementation trials at the village level. These trials would combine the effects of supplementation and de-worming on the performance of calves. In the study, four villages will be involved, with a total of 20 households. There will be 24 animals used, with 6 animals per treatment as follows: 1) control; 2) control plus mineral supplement; 3) control plus de-worming treatments; 4) control plus de-worming plus minerals.

Dr. Vijchulata has been doing some mineral research by collecting tissue samples from slaughterhouses. Samples have been collected from 32 animals during the dry and 36 during the wet. Both male and female animals below 3 years of age have been sampled. Samples include blood, liver and bone. Phosphorus, magnesium and copper determinations are being done with the blood samples but results are not yet available.

In the near future, Dr. Vijchulata plans to undertake an experiment involving 20 head of cattle (10 male, 10 female). These animals will be removed from the regular herd and split into two groups, one receiving a complete mineral mixture and the other serving as a control. Dr. Vijchulata was advised to provide a more adequate mineral supplement than the one previously used by Mr. Tumwasorn, particularly in regards to phosphorus.

The contribution of the Florida-AID Mineral Research Project to the programs in Thailand has been providing only literature and consumable supplies.

THAILAND CONTACTS

Mr. David Bathrick
Director, Office of Rural Development
c/o U.S. Embassy
Bangkok, Thailand

Dr. Phaitoon Ingkasuwan, Rector
Dr. Sanchai Chansawang (Animal Breeding)
Dr. Pravee Vijchulata
(Tel. 5790113, Ext. 350; Res. 5794253)
Dr. Boonlue Phungphong (Nutrition Swine)
Dr. Norasih Trakulchang
Miss Sumalee Chaiputpanich
Dr. Charan Chantalakhana
Dr. Alan Andrews (Pastures)
Dr. Kanchana Makvichit
Dr. Pornsri
Department of Animal Science
Kasetsart University
Phaholyothin Road, Bangkhain
Bangkok, Thailand 9

Dr. B. K. Soni
Animal Production Health Commission
for Asia (APHCA)
FAO Regional Office
PHRA Atit Road
Bangkok, Thailand

Dr. David Creswell
Welgro Feedmill Thailand Co., Ltd.
292/3-5 Ratchadapisek Rd. Yanawa
Bangkok 12, Thailand

Dr. Metha Vannapath
Department of Animal Science
Khon Kaen University
Khon Kaen, Thailand

Dr. Ayus Pichaicharnarong
Department of Physiology
Faculty of Vet Science
Chula Long Korn University
Bangkok, Thailand

Mr. Suphon Ruttanapon
Veterinary Division
The East Asiatic Co., Ltd.
53-55 Oriental Ave.
Bangkok 5, Thailand

Dr. Sarote Khajaroen
Dr. yaowamarn Khajaroen
(Animal Nutrition)
Department of Animal Science
Faculty of Agriculture
Khon Kaen University
Khon Kaen, Thailand

Mr. Charnvit Chiaravannont
Mr. D.C. Boskett
Dr. Vorachart Chaicumpa
Pfizer International Corp.
Silom Bldg. - 8th Floor
197/1 Silom Road
Bangkok, Thailand

Dr. W. R. Young
The Rockefeller Foundation
G.P.O. Box 2453
Bangkok, Thailand

Professor Rapoe Sagaric
Kasetsart University
PHaholyothin Road, Bangkhain
Bangkok, Thailand 9

Dr. Bo Gohl
Project Secretary
International Foundation for Science
(IFS)
Sibyllegatan 47
Stockholm, Sweden

Dr. Yod Vadhanasindhu
Director, Dairy Farming Promotion
Organization of Thailand
7 Soi Chaptmait
Prachacheun Rd.
Bangkok 8, Thailand

Trinidad and the Caribbean

An interest in mineral research in the Caribbean Basin has been ongoing for many years. One of the first zinc deficiencies of cattle was reported in Guyana (Legg and Sears, 1960) Mr. Reeza Mohammed completed a Master of Science Thesis at University of the West Indies, St. Augustine, Trinidad entitled "The status of certain trace minerals in cattle in Trinidad". This work in 1979 indicated a possible copper deficiency.

The Mineral Project is currently analyzing samples of forage from Tobago which were collected by Dr. F.B.A. Mbatya, Department of Livestock Science, U.W.I. This collaboration was undertaken because Winrock International personnel who are providing technical assistance to the sheep project in Tobago thought certain minerals including copper may be limiting.

One of the sheep producers on St. Kitts described a condition concerning anemia, deaths, and apparent trace element deficiencies. This was reported in the proceedings of the "Small Ruminant Production Conference" which was held in Barbados in 1978. We are attempting to obtain some of these forage samples.

The University of Florida in a collaborative project with one of the cattle producers on the Caribbean Coast of Honduras has identified very low copper levels. This together with the long history of cobalt and copper deficiencies in Florida would indicate the need for continued mineral research in the Caribbean Basin. Results of preliminary studies in the Bahamas and Haiti have been included in previous reports.

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 16th, 17th and 18th, 1978 were spent there. More recently three to five days were spent there in July of 1979, 1981, and 1982.

Dr. Iam Newsam who was 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 came to Florida in September 1979 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 osteamalacia is a serious problem.

Ing. Agr. Adolfo Fernandez who works for Shell Uruguay Ltd. has had an extremely important role in the mineral research project in Uruguay. Government employees have difficulty obtaining funds to travel and conduct field trials. Shell Uruguay Ltd. has been interested in conducting field trials and demonstrating the value of mineral, protein and energy supplementation to grazing cattle. Consequently, Shell Uruguay Ltd. has assisted with supplying transportation, conducting field work and collecting samples while the analytical analyses have been conducted by the Rubino Veterinary Research Laboratory.

The following letter from Adolfo Fernandez to J. H. Conrad dated Oct. 1, 1980 will emphasize some of the mineral research activities in Uruguay.

This letter is to update you in respect to our mineral project, but before discussing the project in itself I want to mention that after many hours of work and debates, I feel that the Rubino Research Laboratory is working well again. You, of course, understand how important this is because from Shell's point of view without their participation our mineral project would lack basic, technical information and would be primarily a commercial project.

We can divide our project into two parts: the actual gathering of information and the subsequent transfer of this information to the productive sector. In respect to this last point, we can also divide our activity in two.

First, we held some twelve meetings with farmers (this was done by Shell) at which, in order to promote our supplements, talks were given including the basic information gathered (and no advertisement). Personally, I think it was a very positive experience. I found that after the meetings, farmers are aware of some of the problems they face (problems are named and figures mentioned) and how they can be solved. In this respect, we are planning to have some twenty farmer meetings as a joint venture between Animal Health and Animal Supplementation (Shell) in order to communicate the idea of healthy animal supplementation and to obtain improved productivity on the cattle farm.

The second way we tried transferring information was at technical meetings. This was done in combination with the Rubino Research Laboratory. A paper was written showing the results found at the first pasture survey undertaken by us and it was presented at the "1er Congreso de Ingenieria Agronomica" which was attended by some 600 agronomists from around the country. Three more papers were written during 1980 and presented at the "2ndo Congreso de Produccion Animal", a veterinarians' meeting.

The other part of our work is in relation to field research. We are now managing eight trials, three of which are run jointly with the Rubino Research Laboratory. Trials are now designed on a yearly basis so as to understand better animal perfonrmance in relation to surroundings and certain physiological parameters.

Taking this into account, one of the trials began in June of 1980 and will end in May of 1981. Three treatments and a replicate per treatment are included, i.e., a control, a mineral supplement, and a feed block group. Animals involved are actually two years old and were weighed every 28 days. On each weighing date blood and pasture samples are gathered and every three months bone and liver samples are obtained for biopsies. The objectives are to measure response to mineral and protein supplementation, understand animal performance in respect to nutrient intake, and see if supplements used are formulated correctly.

A second trial, quite similar to the above, tries to introduce the concept of a supplementation system. This means using a winter protein energy supplement and a mineral supplement during spring, summer, and autumn. Objectives and methods used are very similar to the other trial.

The third trial run in coordination with the Rubino Research Laboratory has just begun but is designed to study animal response in reproduction efficiency to mineral supplementation.

So as you can see, after all of my doubts at the beginning of the year, apparently 1980 is going to be a very productive year and especially a year during which we had the chance of putting together many of our ideas (papers written), during which we had a very rich human contacts (farmer and technician meetings), and during which we had a chance to set up very interesting trials which we are enjoying. Obviously we are having many problems but as work goes on, we manage to solve them.

A number of publications have resulted from the mineral research program in Uruguay. These include:

1. Levels of minerals in pasture and beef cattle tissues in Uruguay.
2. Levels of protein and minerals in natural pastures in Uruguay.
3. Mineral and protein supplementation of grazing steers in Uruguay.
4. Effect of mineral supplementation on reproductive performance and gain of Herefored females and mineral levels in forage and animal tissues of animals grazing native pastures in Northeast Uruguay.

The Animal Nutrition Research Laboratory has analyzed a number of samples in order to assist research in Uruguay and to verify some of their results.

In 1978 15 forage samples were analyzed. Phosphorus levels were between .07 and 0.12%, cobalt levels between .09 and .24 ppm, copper between 1.1 and 3.5

ppm, manganese between 296 and 606 ppm and zinc between 13 and 59 ppm.

Mineral analyses of 30 forages were completed in 1982. The levels of the 12 elements which were found and an interpretation follow. In additio a summary of 134 bone analyses conducted in Uruguay are summarized.

June 14, 1982

Dr. Teresita Alonso
Centro de Investigaciones Veterinarias
Miguel C. Rubino
Casilla de Correo 6577
Montevideo, Uruguay

Dear Dr. Alonso:

Enclosed are the results of the mineral analyses of 30 forages which I brought back from Uruguay. This was delayed some because of our slow up in selenium analyses.

You will note that we have listed the critical levels at the top of page one and the means at the bottom of page two. As usual, the phosphorus, sodium, copper, and zinc levels are very low compared to the critical levels and should receive first priority in a supplementation program. Calcium levels are borderline. Upon close examination, the selenium levels vary greatly although the mean level is the same as the critical level. Samples 136, 137, and 138 tend to markedly increase the mean whereas samples 102, 104, and 116 have very low .02 ppm values. It would be interesting to look at this closer from both a species and location affect.

I certainly hope you have had the opportunity to analyze these samples in your laboratory and I look forward to discussing these results with you in greater detail.

With best wishes, I remain,

Sincerely,

Joseph H. Conrad
Professor and Coordinator
Tropical Animal Science Programs

JHC/dlr

cc: Dr. H.L. Popenoe
Dr. C.E. Haines
Ing. Adolfo Fernandez
Dr. H.D. Wallace
Dr. L.R. McDowell
Dr. G.L. Ellis

June 1982

Composition of 30 Forage Samples - Uruguay, 1981

Sample No.	Ca	Mg	P	K	Na	Co	Cu	Fe	Mn	Mo	Se	Zn
% or ppm	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Critical levels	0.30	0.20	0.25	0.60	0.06	0.1	10	30	30	76	0.1	30
100	.58	.19	.11	1.2	.06	0.09	2.28	76	148	.62	.06	20
101	.49	.21	.14	.9	.09	0.11	2.89	83	88	.62	.06	18
102	.28	.15	.09	1.2	.04	0.28	1.84	57	453	.59	.02	22
103	.28	.19	.10	1.0	.06	0.21	1.07	60	242	.70	.08	18
104	.38	.21	.16	1.0	.08	0.14	2.42	102	50	.58	.02	19
105	.43	.22	.12	1.1	.05	0.09	1.69	95	207	.48	.15	19
109	.41	.24	.10	.9	.04	0.18	2.33	96	314	.71	.08	13
110	.36	.18	.12	1.2	.05	0.07	2.16	100	231	.81	---	16
111	.27	.16	.12	1.1	.03	0.18	2.25	114	191	.58	.05	15
114	.23	.15	.08	.8	.04	0.27	1.51	144	182	.58	.11	11
115	.22	.16	.03	.6	.04	0.28	2.87	696	249	.62	.11	13
116	.21	.12	.02	.7	.03	0.22	1.98	286	252	.55	.02	10
117	.24	.19	.05	.9	.07	0.20	1.69	199	299	.44	.09	14
118	.18	.16	.06	.8	.03	0.11	1.40	114	187	.49	.08	11
119	.20	.21	.04	.7	.05	0.14	2.27	211	318	.54	.11	14
120	.26	.21	.01	.9	.03	0.21	1.55	107	221	.89	.14	13
124	.26	.19	.07	1.0	.02	0.10	1.55	67	155	.83	.06	16

Composition of 30 Forage Samples - Uruguay, 1981
(continued)

% or ppm	Ca %	Mg %	P %	K %	Na %	Co ppm	Cu ppm	Fe ppm	Mn ppm	Mo ppm	Se ppm	Zn ppm
126	.35	.19	.10	1.0	.03	0.10	1.53	88	298	.59	.06	22
127	.22	.15	.08	1.2	.02	0.11	1.51	87	204	.58	.06	22
128	.47	.24	.10	1.0	.04	0.07	1.73	104	113	1.11	.07	17
129	.48	.20	.09	1.1	.03	0.09	2.12	155	126	.62	.05	16
131	.27	.27	.06	.8	.05	0.08	1.48	72	243	.67	.09	12
132	.24	.26	.02	1.0	.05	0.14	1.82	161	229	.80	.13	20
133	.28	.21	.05	1.0	.04	0.25	2.01	236	418	.67	.09	14
134	.28	.22	.03	.7	.03	0.10	1.17	144	220	.49	.05	10
135	.24	.20	.05	.9	.04	0.16	1.34	133	268	.50	.08	12
136	.27	.25	.04	.9	.04	0.40	1.71	165	209	.63	.30	15
137	.29	.29	.05	.9	.07	0.21	3.04	547	217	.66	.24	17
138	.22	.26	.04	.8	.06	0.20	1.53	190	218	.77	.26	13
139	.26	.23	.04	.8	.04	0.16	1.67	164	227	.54	.11	11
Mean	.31	.20	.07	.9	.04	0.16	1.88	162	226	.64	.10	15

Analyses conducted by USAID Mineral Proj Univ. Florida

UNIVERSITY OF FLORIDA
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

GAINESVILLE, FLORIDA 32611

IMAL SCIENCE DEPARTMENT
2103 McCARTY HALL
TELEPHONE: 904-392-1911

June 25, 1982

Dra. Teresita Alonso
Centro de Investigaciones Veterinarias
Miguel C. Rubino
Casilla de Correo 6577
Montevideo, Uruguay

Dear Dra. Alonso:

Thank you for your letter of June 16 along with the partial analyses of 134 bone samples. We have been using the following values as critical levels to interpret our data:

Bone	Ca	Mg	P
% Fat Free	24.5	.45	11.5
% Ash	37.6	.67	17.6

Specific gravity in gm/cc <1.68

The data you sent are based on minerals as a percent of the ash. Therefore, we find that calcium is low in 82% (36 of 44), magnesium 31% (13 of 42), and phosphorus 67% (28 of 42). We don't have a normal for zinc in bone but according to the enclosed paper (Jour. An. Sci., 1954, 13:152), on composition of bone meal, the mean was 489 ppm. Many of your samples were much below that but the results of the forage samples that I sent June 14, 1982 indicated the mean level was 15 ppm or just one half of the required 30 ppm. We are using bone density values of <1.68 as the critical level. Using this criteria, only 10 values out of 64 were above 1.68 for the control group and only 2 values out of 59 were above 1.68 for the supplemented group.

This will give you an idea of the way we are interpreting our data and we can discuss these results futher.

With best wishes, I remain,

Sincerely,

Joseph H. Conrad
Professor and Coordinator
Tropical Animal Science Programs

JHC/dlr

cc: Dr. H.L. Popenoe, Dr. C.E. Haines, Ing. Adolfo Fernandez, Dr. H.D. Wallace
Dr. L.R. McDowell, Dr. C.L. Ellis

EQUAL OPPORTUNITY EMPLOYER

Contacts in Uruguay, 1982

Dr. Thomas H. Kachele
Facultad de Agronomía
Cátedra de Nutrición Animal
Avda. Garzón 780
Montevideo, Uruguay

Ing. Agr. Adolfo Fernández
Shell Uruguay Ltd.
Casilla de Correo 838
Montevideo, Uruguay

Dr. Hernán Caballero
IICA'Casilla de Correo 1217
Montevideo, Uruguay
Home tel. 50 27 51
Office tel. 91 33 78
91 27 93
Teleg. IICA Montevideo
Sec. Rosita

Agricultural Attache
Montevideo
Dept. of State (ID)
Washington, DC 20520

Dr. Perdomo, Director
Dr. Teresita Alonso
Centro de Investigaciones Veterinarias
Miguel C. Rubino
Casilla de Correo 6577
Montevideo, Uruguay
Home tel. 50 76 22

Sr. Gustavo Gutiérrez
Asamblea 749
San José, Uruguay

Sr. Pedro Gustavo Gutiérrez T.
A.P.L. de San José
Treinta y Tres 739
San José, Uruguay
Tel. 3997, 1980 L.A. Conf.

Prof. César Corengia
Universidad de la República
Facultad de Veterinaria
Pando 2642
Montevideo, Uruguay

Sr. Juan Angel Peri
Librería - Editorial
Representaciones Alzaibar 1328
Casilla de Correos 1755
Montevideo, Uruguay

Ing. Agr. Mario Allegri, Director
Ministerio de Ganadería y Agricultura
Centro de Investigaciones Agrícolas
"Alberto Boerger"
La Estanzuela
Colonia, Uruguay

Dr. Daniel Faggi, Decano
Facultad de Agronomia
Avda. Garzón 780
Montevideo, Uruguay

Dr. Luis Cuenca
(contact either Dr. Alonso or
Ing. Agr. Fernandez)

Dr. Armando Sans, Nutritionist
Dr. Luis A. Bonifacino A., Animal Prod.
Dr. Mario C. Aragunde, Decano
Facultad de Veterinaria
Avda. Alberto Lasplaces 1550
Universidad de la Republica
Montevideo, R.O. Uruguay

Dr. Mauricio E. Martinez
Uruguay 391
Salto, Uruguay
Tel. 2936

Dr. Artigas Lacabanne
Jefe Servicios Veterinarios Zonales
Gral. Artigas 1151
Libertad, Uruguay
Tel. 60
(Sr. Miguel Arce)

Ing. Agr. Pittaluga
CIAP Alberto Boerger
Gral. Flores 390
Tacuarembo, Uruguay

Venezuela

Contacts were first made in December, 1975, in relation to cooperative mineral research in Venezuela. Three research groups interested in investigating the mineral status of cattle in Venezuela were contacted as follows:

University of Zulia in Maracaibo - The Veterinary and Agronomy Faculty at the University of Zulia is 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) divided into combinations of treatments to include steers vs. bulls, Ral-Grow, selenium-vitamin E and copper. The results of the 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. Further mineral research at Maracaibo for the past 2 years has been at a slow rate.

Dr. Fausto Capote has been our principal contact for mineral research in the Maracaibo region since initiation of the program. There are two Venezuelan graduate students from Maracaibo at Florida at the present time; these two students are part of Dr. Capote's programs at the University of Zulia. One of the students is Mr. Esvan Paz who is working for an M.S. degree. His thesis research involves the value of basic slag as a phosphorus supplement. Mr. Paz is comparing the retention of phosphorus as basic slag versus monosodium phosphate. Basic slag is a by-product of the iron industry and Venezuela is one of the top ten countries in world production of iron ore (basic slag); hence the value of this research could be a very important contribution to Venezuelan agriculture. In the research, Mr. Paz is feeding basic slag to both sheep and poultry. Preliminary results of the experiment with sheep indicates that basic slag has 75 to 80% of the value of monosodium phosphate. More research in this area is needed.

The other student from Maracaibo in the mineral research area is Mr. Oswaldo Rosero. Mr. Rosero, like Mr. Paz, is a member of the faculty of the University of Zulia. Mr. Rosero's research invovles the principles of mineral supplementation and carry-over effects of energy and protein deprivation on mineral metabolism. This is likewise very applicable to Venezuelan agriculture as cattle go through severe loss of weight during the dry season. The experiment is attempting to simulate the effects of the wet and dry season on animal production and particularly on mineral metabolism. This experiment is 18 months in duration and began with lambs, taking them through growth, pregnancy and lactation. The University of Zulia provided $10,700.00 to support this research program.

Dr. Capote would like to spend a one-year sabbatical at Florida sometime during the next 1-2 years. The main objective of Dr. Capote's sabbatical would be: 1) To analyze raw data from mineral supplementation and analysis experiments carried out in the Maracaibo region. This would include the use of both statistical facilities and the nutrition laboratory. Journal articles from this research would be written up and submitted at this time. 2) To prepare for teaching a course entitled "Ruminant Nutrition and Feeding". This would be a course for M.S. degree students at the University of Zulia for which the Florida staff will assist with backstop activities. 3) To make plans for future research in mineral

nutrition and forage quality evaluation in the Maracaibo region. This would include learning procedures for mineral analysis as well as biopsy techniques. 4) To carry out the following experiments to asses mineral analysis: a) The effects of forage and grain sample preparation on mineral concentrations; b) The effects of stress, feed and sample preparation on blood mineral analysis. 5) To statistically reevaluate data in experiments involving voluntary intake as affected by age and size of sheep and quality of forage.

Maracay - The main research effort involving Florida in Maracay has been the M.S. degree program of Ing. David Morillo. Ing. Morillo's research program consisted in collecting samples from nine ranches in several llanos states in Venezuela one year prior to coming to study at the University of Florida. Samples consisted of forages, soils, blood, liver and feces. The samples were collected twice a year, at the end of the wet and dry seasons. Tissue samples were collected from two classes of animals: growing animals versus those in pregnancy and lactation.

All the analyses of samples have been completed as well as a large part of the statistics. There were some problems with the statistics in that it was not always possible to make collections from the same animal during each season. Also several farms were missing completely during the dry season. Several farms had refused permission for animal sample collections because, in their own words, "when animals were moved during the dry season, some would break their bones". As a result, there is a certain amount of missing data which complicated the statistical analysis. Early results indicate severe nutritional limitations, including protein, phosphorus and copper deficiencies.

Unfortunately, Ing. Morillo returned to Venezuela prior to completing his thesis. He now feels that he will be able to return to the University of Florida for a three-month period for the purpose of finishing the thesis, possibly during 1982. Prior to arriving in Gainesville, Ing. Morillo will complete the statistical aspect of the research using the facilities at Maracay.

At the present time, a new mineral research program is in progress by Ing. Alexis Moya. Ing. Moya received his M.S. degree working with Dr. C. B. Ammerman one and a half years ago. For his Ph.D. research, he is interested in mineral supplementation and evaluation of the mineral status of cattle in the llanos of Venezuela. Ing. Moya plans to return to Florida within two to three years to pursue his studies for the Ph.D. In the meantime, hopefully, he will have collected all the data from his proposed supplementation programs.

Ing. Moya is planning 3 experiments, the first being undertaken at a ranch named Turagua. This experiment was initiated on March 20, 1981 with 591 weaned heifers of two years of age. One-hundred and fifty of these animals will receive only salt, while 441 will be receiving complete mineral supplements. The duration of the experiment will be three years. Pregnancy rates for these heifers usually are about 25 to 35%. In this particular design, animals have free choice access to minerals but are only in the area where the minerals are two or three times a week. Apparently this procedure has been successful to-date since the mineral consumption is quite high, averaging 60 g/day.

A second experiment is being undertaken in Barquisimeto at a ranch named Moron. In this experiment, there are four identical pastures where two-year old bulls are fed specific treatments as follows: 1) Minerals all year long; 2) Common salt all year long; 3) Minerals only during the dry season; and 4) Minerals only during the wet season. The number of animals per treatment are

150, 70, 90 and 90, respectively. The experiment was initiated June 15, 1981 and will probably last one year. The animals used in the experiment were very uniform, the average weight being 236 kg. The experiment will continue until animals reach 400 kg and weights will be taken every two months. Liver, blood and forage samples will be collected periodically throughout the experiment. The product Ral-grow has been given to each animal.

The third experiment is in Apure state at a ranch named Hato El Frío. This experiment will consist of three treatments of approximately 200 to 350 animals per treatment as follows: 1) Salt plus bone meal and Rumavite: 200 animals will be selected to receive combinations of treatments of selenium-vitamin E injections, copper injections and cobalt bullets; 2) A complete mineral supplement; and 3) Salt only. Animals will be weighed three times per year and forage, liver, blood and bone biopsy samples will be taken.

Jusepín - In Jusepín, Ing. José Velásquez of the Universidad de Oriente has undertaken a very active mineral research program. Ing. Velásquez received funds from CONICIT (a research funding organization) to carry out this mineral research program. Ing. Velásquez is involved in taking soil, forage and blood samples from 5 Llanos states. The first collections took place in the state where Jusepín is located, Monagas. Samples from both the wet and dry seasons have now been collected from 7 farms in Monagas comparing pregnant, lactating animals to steers and heifers. Ing. Velásquez has also collected samples from 27 other farms in the states of Bolívar (10), Antioquia (7) and Guárico (10) during the wet season. In March, 1980, dry season collections were made for these same farms. In 1981, he collected from a larger part of Guárico state and also began making 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 reported on farms in Guárico state. This observation was also confirmed by research undertaken by David Morillo from Maracay.

Ing. Velásquez has published a 58-page document summarizing the results of sample collection and analysis in the state of Monagas entitled "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%; 0.1[illegible] and 0.19%; 0.08 and 0.14%; 176.21 and 567.54 ppm; 105.97 and 145.23 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; 3.05 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 1030

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 pmm 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.

For 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 - Eleven 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 copper and selenium-vitamin E injections 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 designed. 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 obtained during the wet season from the three main states under investigation are 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.

The most recent mineral research was carried out on 11 farms from the state of Guárico. The analyses from this area have been completed and samples from 10 farms in Apure state are now being analyzed. Average forage analyses for both the wet and dry seasons included 256 and 157 samples, respectively. The average analysis data are as follows (for the wet and dry seasons, respectively): Protein, 5.25 and 3.56%; Phosphorus, .08 and .06%; Magnesium, .24 and .24%; Calcium, .23 and .25%; Zinc, 41 and 33.8 ppm; Copper, 9.5 and 20 ppm; Iron, 193 and 26 ppm; Manganese, 170 and 100 ppm. From these data, it is obvious that protein and phosphorus levels are extremely low. Because of the extremely low levels of phosphorus, the analyses were repeated; however, the results were the same. There was great variation between farms for zinc and copper concentrations.

In Guárico state, there are great problems with animals exhibiting broken bones and also eating bones. The condition of botulism is also observed.

Blood data from Guárico state are as follows (for the wet (119 samples) and dry season (42 samples),respectively): Calcium, 10.59 and 10.15%; Phosphorus, 3.59 and 3.56%; Magnesium, 3.40 and 3.94%; and Copper, -- and 0.13 mg/100 ml. From the data it would appear that cows have significantly lower phosphorus values than do growing animals.

Ing. Velásquez is no longer at the Universidad de Oriente in Jusepín. Since June 1981, he has been working at the Instituto Universitario de Tecnología de El Tigre. As director of this institution, unfortunately, Ing. Velásquez's research activities will be curtailed. In discussing this with Ing. Velásquez, he noted that he will no longer be teaching and felt that he would still have time to pursue his research activities with minerals.

For the various mineral research programs, the University of Florida-AID program is mainly providing consumable supplies, mostly used for sample collections and injections of various minerals. Also, analyses of the more difficult to determine minerals, Se and Co, are being completed at Florida.

Venezuela Contacts

Mr. George Dietz (Agriculture Attaché)
Mr. Fernando (Freddy) Rondón
c/o La Embjada de los E.E.U.U.
Caracas, Venezuela

Ing. David Morillo Andrade
Av. 12 No. 49-67
Maracaibo Venezuela
(Home tel. 061 427385)
Apartado 1316 CIARZU
(Office tel. 061 516343)

Dr. Fausto Capote
Facultad de Veterinaria
Universidad de Zulia
Maracaibo, Venezuela
(Home Tel. 516706)
(Office Tel. 227286)

Dr. Max Ventura S.
Urb. Doral Sur Calle 49C
#12-91
Maracaibo, Venezuela

Dr. Ivan Hernandez A.
Av. 2 Esq. Av. 3C
Resid. Irazu Apto
Maracaibo, Venezuela

Ing. Eliecer Alberto Velásco
Ing. Agr. José Hill
Mr. Edward Berbeu
C.A. INVEGA
Apartado 29
Valencia, VENEZUELA

Ing. José Velásquez G.
Director
Instituto Universitario de
Tecnología de El Tígre
Carretera Salida
El Tígre Cdad. Bolivar
Zona Universitaria, El Tígre
VENEZUELA

Ing. Hernan Agmad
(same as above)

Dr. Alexis Moya
Centro Nacional de Investigaciones
Agropecuarias
Apdo. Postal 4653
Maracay 200, Aragua
Venezuela

Dr. C. Chicco
Director
(same as above)

Dr. J. T. Perdomo
Facultad de Ciencias Veterinarias
Universidad Central de Venezuela
Maracay, Venezuela

Zaire

Kiatoko Mangeye, Professeur a l'I.F.A., B.P. 28, Yangambi, Haut, Zaire, Republic of Zaire received his Ph.D. at the University of Florida in Animal Nutrition - Minerals in 1978. After his return to Zaire, he continued his interest in mineral research and deficiencies but he was without a functioning analytical laboratory to conduct the analyses.

During the visit of J.H. Conrad to Zaire in March of 1981, 68 dried liver samples and 9 bone samples were brought to the University of Florida for analyses. The mean calcium and phosphorus levels were found to be 16.9 and 8.1% as a percent of fat free bone. Normal levels are considered to be 24.5% for Ca and 11.5% for P indicating that all samples were markedly deficient in both calcium and phosphorus. All liver samples were analyzed for cobalt, copper, iron, manganese, molybdenum, selenium, and zinc. Twenty-two of the liver samples had copper contents below the critical level of 75 ppm and 24 of the liver samples had iron contents below the critical level of 180 ppm.

This mineral research project will continue to collaborate as best we can with Dr. Kiatoko Mangeye who has a continuing keen interest in mineral research in Zaire.

a. Interpretation of Data and Supporting Evidence: Available research data indicates that phosphorus is the most widespread mineral deficiency for grazing livestock. Copper and cobalt deficient regions extend over wide areas of many tropical countries 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 needs for more specific data.

b. Research Design: Currently we are cooperating with mineral research programs in 23 countries and each country has a number of different regions. Research personnel in these countries have certain problems and priorities. A major effort is being made to assist each country in developing and applying acceptable mineral research designs and scientifically based research techniques.

Research emphasis is being placed on reported "problem" areas which suggest mineral deficiencies or excesses. This approach is more feasible than attempting to map large areas where deficiencies or toxicities are not apparent

Sample collection and preservation under field conditions is a problem. Separation of the serum or plasma from whole blood rapidly and without hemolysis under field conditions is difficult. New techniques involving bone biopsy to determine phosphorus status have recently been demonstrated in various countries to avoid the difficulties of interpreting blood samples collected under less than ideal conditions.

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 are representative of what the animals consume is often difficult and the logistics of carrying on field research at locations distant from research institutions can also be complicated. However, we were aware of these problems at the beginning of the program and methods of improving sample collection, storage and analysis are constantly being evaluated. Many worthwhile research publications, particularly in Latin America, are not readily available to libraries and abstracting journals.

E. <u>Dissemination and Utilization of Research Results</u>

In 1976, 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 1979, both the English and Spanish editions were revised and second editions of the manual were published and distributed. The revised Portuguese edition was available the following year.

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 have now been distributed. Other articles that have been presented at symposia and scientific meetings have also 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, 300 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 the problems existed; 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. A listing of major presentations can be found under the Distribution and Application of Results Phase of this report.

   It is significant and noteworthy that organizations not directly involved with the Florida/AID contract often 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 in Brazil which was attended by 250 people was our first most effective way to expand the use of research results. For five days, participants heard and discussed mineral research results and problems. One day mineral conferences have since been held in Colombia and Thailand (2) during the past 2 and 1/2 years.

   Many people have expressed an interest in finding the solution to mineral problems. This project has encouraged them, provided standard techniques for research and provided some materials for them to get started. The following situation is frequently found: The interest exists along with

some of the materials necessary for carrying out mineral research. Governmental personnel recognize that minerals are limiting production but this is not one of their top priorities. Research reviews and sample research designs, often written in Spanish or Portuguese, have been provided by the University of Florida. This information along with personal visits is often sufficient to stimulate an in-country mineral research program. By beginning in areas where mineral problems are evident, the probability is good that a solution can be found and that it will be applied by livestock producers in the area.

Mineral research for selected tropical countries is an extremely ambitious program. We are currently working in 23 tropical 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 reconnaisance and recruitment phase of this contract, only interested personnel at institutions with means of support for mineral research were selected. The majority of both human and physical resources for mineral research are still provided by the cooperating countries.

   a. Planning the project: The mineral research project does not have a standardized research plan that can be used in every country. However, standard models do exist and can be modified by personnel to best coincide with specific conditions in each 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 technical information and ideas, consumable supplies which are difficult to obtain within the cooperative 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 are the property of that country. The University of Florida assists wtih some of the more difficult analyses, interpretation and summary of data when requested. Permission must be obtained in writing and credit given as co-author and cooperating agency when applicable.

F. <u>Work Plan and Budget Forecast for Coming Year</u>

1. Each of the 23 cooperating countries are in different stages of their mineral research programs. Comparatively speaking, the most advanced efforts have been made in Brazil, Costa Rica and Colombia. The most expansize mineral supplementation trials have occurred in Bolivia and a second supplementation trial with weaned cattle will be undertaken in the Trinidad region of Bolivia in early 1982.

   Mineral research programs are moving ahead in all countries except El Salvador. Programs in the Dominican Republic, Honduras, Panama and Mexico have been initiated only within the last two years. Even more recently, cooperative programs have been initiated in Africa - in the Sudan, Senegal

Kenya and Zaire. Due to the limited time remaining on the contract, extensive follow-up in many of the latter countries will not be possible. In these countries, the purpose of visits will be mainly for technical support.

Graduate student programs are now active or expected for the following countries: Malawi, Bolivia (2), Guatemala(2) Dominican Republic, Colombia, Venezuela (3) and Mexico.

2. Procedures to be used and activities to be carried out during the coming year including the following:

   - Provide personnel and facilities at the University of Florida to help train 2 to 3 technicians in analytical procedures for mineral analysis for 3 months or more.
   - Work with new procedures for evaluating minerals (e.g., bone biopsy).
   - 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 in journals as well as 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 attendance at conferences, seminars and workshops.
   - Make personal visits to cooperating countries from one to two times annually and provide limited financial resources and difficult to obtain expendable materials.

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 relation 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 copies of the "Latin American Symposium on Mineral Research with Grazing Ruminants" is still being distributed in Spanish and English. The revised second edition of the manual "Methods of Mineral Analysis for Plant and Animal Tissue" has been completed in the past two years and is still being distributed in participating countries and in 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 and 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.

BUDGET
FISCAL REPORT

April 1, 1982 - June 30, 1982

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

Category	Funds Available 11/1/74-9/1/82	To Date 6/30/82	This Period 4/1/82-6/30/82
Salaries	$ 448.426.00	$ 394,413.10	$ 25,255.95
Fringe Benefits	68,814.00	58,890.35	4,893.56
Overhead	298,492.00	262,363.76	27,643.32
Cooperating Country & 3rd Country Nationals	33,285.00	33,285.43	-0-
Travel and Transportation	191,615.00	191,772.17	9,556.10
Equipment, Materials & Supplies	295,970.00	319,665.03	28,977.53
Other Direct Costs	62,370.00	27,718.38	21.00
Totals	$1,398,972.00	$1,288.108.22	$ 96.347.46

Overhead:

On Campus: 44.4% x 47,772.00 = $21,210.77
Off Campus: 31.6% x 20,356.18 = 6,432.55
$27,643.32

The undersigned hereby certifies: (1) that payment of the sum claimed under the cited contract is proper and due and that appropriate refund to AID will be made promptly upon request in the event of disallowance of costs not reimburseable 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 AID at the Contractor's home office or base office, as appropriated.

BY_____

Title: Administrative Manager
IFAS
University of Florida

Date:_____

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 - Nitaroi) and Jurgen 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.

hh) Valdivia, R., C. B. Ammerman, J. P. Feaster, P. E. Loggins and P. R. Henry. 1977. Effect of aluminum on phosphorus utilization by lambs. 1977 American Society of Animal Science abstracts p. 265.

ii) Conrad, J. H. 1976. Phosphorus supplementation for increasing reproduction in cattle. Ruminant Livestock Production System Seminar. Georgetown, Guyana.

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.

a) 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. Universidad de Costa Rica, Facultad de Agronomía, Escuela de Zootecnia, San José, Costa Rica.

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. Santhiranegram, 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., D. 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.

k) 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 forman intensiva en la República de El Salvador. INCAP, República de El Salvador.

l) Flores, J. R., J. A. Flores, M. T. Cabezas y R. Bressani. 1978. Estado de nutrición mineral del ganado de carne en 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.

m) 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.

n) 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.

o) 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.

p) Gil, Arturo, Lucía Pabón y Patricia Jiménez. 1977. Molibdenosis en Colombia. Procedimientos VI Reunión ALPA. Habana, Cuba.

q) Gil, Arturo y Gonzalo Gurmán. 1977. Tratamiento de la selenosis en el bovino. Procedimientos VI Reunión ALPA. Habana, Cuba.

r) Gil, Arturo, Lee McDowell y Joseph Tritschler. 1977. Minerales para bovinos en Colombia. 1977 ALPA proceedings, R-74. Habana, Cuba.

s) 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 Caños Dulces, La Cruz y Filadelfia. Vol. 1:37 (abstract). III Congreso Agronómico Nacional, San José, Costa Rica.

t) 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.

u) 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.

v) 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).

w) 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.

x) 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.

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

z) 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.

aa) 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.

bb) 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).

cc) 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.

dd) McDowell, L. R., M. Kiatoko, C. E. Lang, H. Fonseca, E. Vargas, J. K. Loosli and J. H. Conrad. Latin American mineral research Costa Rica. IV World Conference on Animal Production. Buenos Aires, Argentina (In Press).

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.

ff) 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.

gg) 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.

hh) Montoya Segura, Víctor 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.

ii) 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.

jj) 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.

kk) 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.

ll) 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.

mm) 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. San José, Costa Rica.

nn) Peducasse C., Armando. 1978. Mineral evaluation on the milk valley of Santa Cruz (Andrés Ibañez and Santiatevan provinces, Bolivia.) Thesis. University Gabriel Rene Moreno, Department of Health Sciences.

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APPENDIX

5. Abstracts (or summaries) of selected papers submitted for publication or published since June 1, 1979. Abstracts dated earlier which were not included in the last annual report are also listed.

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92) Vargas, Emilio, Ruth Vargas and Carlos Campabadal. 1981. Contenido de proteína y mineral de especies forrajeras durante la época seca y lluviosa en Costa Rica. VIII Reunión Asociación Latinoamericana de Producción Animal (ALPA) Resumenes, P-8.

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95) Villarreal Buenfil, Miguel H. 1977. Determinación de deficiencias y toxicidades minerales de ganado bovino en pastoreo en el municipio de Abasolo, N. L. (Invierno 1976). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Anzules Sánchez, Angel A. 1980. Determinación del estado de nutrición mineral del ganado bovino en la zona de Santo Domingo. III Asamblea Nacional de la AEPA, Portoviejo, Ecuador.

Resumen

Con la finalidad de diagnosticar el estado de nutrición mineral del ganado de 4 fincas de la zona de Santo Domingo, se realizaron 3 muestreos de sangre y de forraje durante el año en Abril, Julio y Noviembre. Se analizaron el contenido de Ca, P, Mg, Cu, Fe y Zn en la sangre de 20 vacas mestizas. Así mismo se determinó la concentración de Ca, P, Mg, Na, K, Fe, Cu, Mn y Zn en la materia seca de pasto guinea de potreros destinados a la alimentación. El contenido promedio para el Ca, P y Mg fue de 9.85, 5.46 y 2.05 mg/100 ml respectivamente, manteniéndose constante todo el año, a pesar de que los promedios fueron normales se reportó que el 8.73, 12.60 y 9.56% presentaron valores por debajo de los niveles considerados adecuados para cada uno de los elementos. En cuanto al Cu, Fe y Zn se obtuvieron promedios de 130.93, 251.32 y 119.64 µg/100 ml, respectivamente, notándose que el 30.75% del total de las muestras analizadas presentaron niveles críticos para el Cu, no así para los dos restantes. A pesar de existir diferencia significativa entre períodos de muestreo del primero con relación a los restantes estos dos elementos presentaron valores por encima de los límites de requerimiento. A excepción del P, el contenido mineral de los pastos fueron normales para todos los elementos en las cuatro fincas y en las tres épocas de muestreos; notándose que el contenido de Cu fue elevado con relación al Cu sérico lo que hace pensar de que existe bloqueo de parte de otro elemento.

Por lo anotado anteriormente se puede concluir que existe deficiencia de Cu en el ganado bajo estudio a través de todo el año, acentuándose la hipocupresemia al final de la época seca, no obstante que las concentraciones de dicho mineral en el pasto son adecuados. En cambio que el P de los forrajes se encuentra dentro de los límites críticos para esta clase de animales lo que hace pensar que los programas de suplementación mineral son adecuados para el ganado de la zona de Santo Domingo, Ecuador.

Anzules, A., R. de la Torre, J. Rivadeneira and L. R. McDowell. 1981. Valor de los análisis de calcio y fósforo sérico. VIII Reunión Latinoamericana de Producción Animal, Santo Domingo, Dominican Republic. (Abstract).

Resumen

Cuatrocientas dieciocho muestras de suero sanguíneo de vacas de carne de la Región Litoral ecuatoriana en varios estados fisiológicos fueron analizadas convencionalmente por los contenidos de calcio y fósforo, con el propósito de evaluar el estado nutricional de estos minerales y establecer su relación con su contenido en los pastos. Al momento de recolectar las muestras de sangre se tomaron también muestras de forraje de los potreros en los cuales pastaban los animales examinados. Los pastos, predominantemente Panicum maximum, constituían la única fuente de nutrimentos, pues durante el último año, previo al muestreo, ningún animal había recibido ningún otro suplemento que no sea sal común. Las concentraciones de calcio sérico encontradas variaron de 5.0 a 16.7 mg/100 ml de suero, promediando 9.9 mg, y las de fósforo de 3.0 a 8.6 mg/100 ml de suero, con un promedio de 5.7 mg. Los contenidos de Ca y P en el forraje fluctuaron de 0.25 a 0.65% y de 0.08 a 0.52%, respectivamente, con promedios de 0.46 y 0.22%, en su órden. Los coeficientes de correlación entre los contenidos de estos elementos en el suero sanguíneo y en el pasto fueron de 0.39 y de 0.08, para Ca y P, respectivamente. Los resultados obtenidos confirman el poco o ningún valor de los análisis de Ca y P en el suero sanguíneo como índices del estado de nutrición de estos dos minerales, razón por la cual se debería descontinuar su práctica y recurrirse más bien al análisis de otros tejidos que reflejen la verdadera condición nutricional de los mismos.

Title: Effect of mineral supplementation on reproductive performance and gain of Hereford females and mineral levels in forage and animal tissues of animals grazing native pastures in Northeast Uruguay.

Authors: Gonzalo Arroyo and Enrique Mauer, for Ing. Agr. Degree, Faculty of Agronomy, University of the Republic, Montevideo, Uruguay, 1982.

Soils: Yaguari considered good fertile soils.

Pastures: Unfertilized native pastures containing primarily Paspalum dilatatum, Paspalum notatum, Axonopus compressus, Axonopus afinis, Bothriocloa laguroides and Eragrostis lugens.

Chemical analyses were made at the Rubino Veterinary Research Laboratory, Pando.

SUMMARY

Sixty-two adult cows, 21 cows of first calf breeding and 28 heifers were evaluated during spring 1980 and summer 1981 at the Agronomy Experimental Station in Cerro Largo, Uruguay. Each category was distributed at random in two groups: A control group and another one which consumed a mineral supplement. The mineral mix contained 8% P, 16% Ca, and trace elements (Mg, Cu, Zn). These elements were studied in tissue samples.

The results showed that there was no effect in the reproductive performance of the adult cows because of the mineral supplementation. The pregnancy rate was higher ($P<0.01$) in the group of first calf heifers which consumed the mineral mix than those in the control group (70% and 27% respectively). All the heifers calved in both groups the first year.

There was no difference in the daily gain of adult cows between the group which consumed the mineral mix and controls during the period of 40 days post partum to weaning (0.414 kg/day and 0.384 kg/day, respectively). The daily gain of the first calf heifers was higher ($P<0.01$) in the group which consumed the mineral mix than those in the control group (0.430 kg/day and 0.225 kg/day, respectively). There was no difference in the average daily gain of heifers during spring nor summer between groups. During the total period the heifers which consumed the mineral mix had a higher daily gain than the controls ($P<0.01$) (0.407 kg/day and 0.329 kg/day, respectively).

The analysis of blood serum samples showed that 56% of the samples taken from the control group and the 26% of the samples taken from those animals which consumed the mineral mix averaged lower P concentration than 4.5 mg/100 ml (considered as normal). The Ca serum values were higher in the control's samples (9.4 mg/100 ml) than in the supplemented group's samples (8.9 mg/100 ml). There was no significative difference. The Mg, Cu and Zn serum values were normals. The liver Cu levels were normal. The liver Zn levels were lower than those considered as normal (57 ppm in the control group and 61 ppm in the supplemented group). The P bone levels were lower than normals during the first two months of lactation (16.8% in controls and 16.9% in supplemented cows). At the end of lactation, the P bone levels were normals (18.7% in controls and 17.8% in supplemented cows). During the whole period the Ca bone levels were lower than the normal (35.9% in controls and 34.9% in supplemented cows). The Mg bone levels were lower than the normal (0.61% in both groups).

Samples from the native pastures were taken each fortnight. Minerals and protein levels were analyzed. The protein level was higher during spring (10.1%) than in summer (8.6%) ($P<0.01$). The mineral levels during spring were: P, 0.13%; Ca, 0.50%; Mg, 0.20%; Cu, 6.2 ppm; Zn, 24 ppm; and Mn, 411 ppm. During summer the levels studied were: P, 0.13%; Ca, 0.43%; Mg, 0.25%; Cu, 6.2 ppm; Zn, 23 ppm; and Mn, 331 ppm. There were significative in Ca, Mg and Mn ($P<0.01$). The Ca:P ratio was 3.6:1 during spring and 3.3:1 during summer. During spring the pasture protein levels were above the NRC's requirements for a cow of 350 kg. During summer the pasture protein levels were lower than the NRC's requirements. Only P levels were deficient in the native pastures. Even though the Mn levels were high, there was no evidence of manganese toxicity.

Axel Ibarra Cruz, José Christian. 1979. Suplementación de minerales a ganado bovino en pastoreo de zacate guinea (Panicum maximum Jack) durante la época seca en región subtropical. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que se realizó este experimento se puede concluir lo siguiente:

1. Al inicio del invierno se encontraron niveles de fósforo deficientes en el suero sanguíneo de los animales y en el forraje.

2. Los novillos que recibieron la suplementación con un nivel de 5 y 10% de fósforo respondieron positivamente en cuanto a sus aumentos de peso, con respecto al testigo durante la etapa experimental de Enero a Abril de 1979. El tratamiento con 10% fue el mejor.

3. Los niveles de fósforo en el suero sanguíneo al final del experimento fueron mayores en los animales suplementados con 5 y 10% de fósforo en comparación al grupo control; estos niveles fueron aún mayores en los que recibieron un nivel de 10% de fósforo en el suplemento.

4. La relación Ca:P al final del experimento fue más estrecha en el suero sanguíneo de los novillos que consumieron las mezclas fosforadas con 5 y 10%, en comparación al testigo y aún más, en los que recibieron el nivel de 10%.

5. La suplementación de fósforo fue económicamente redituable en los grupos tratados en comparación al grupo no tratado y sobre todo, en el que recibió un nivel de 10% de fósforo.

Balcázar Rodriguez, Carlos Guillermo. 1980. Contenido mineral y otros valores nutritivos de las melazas de caña de azúcar del norte del Perú. Tésis. Universidad Nacional Pedro Ruiz Gallo, Lambayeque, Peru.

Resumen

Con el objeto de obtener una información adecuada del valor nutritivo de las melazas de caña de azúcar del Norte, para su uso racional en la alimentación animal, se analizaron 42 muestras de melaza de caña provenientes de seis muestreos (uno/mes/Cooperativa), en siete Cooperativas Azucareras, 3 del Departamento de La Libertad (Casa Grande, Cartavio y Laredo) y 4 del Departamento de Lambayeque (Cayaltí, Pomalca, Pucalá y Tumán).

Los elementos nutritivos y/o parámetros analizados fueron los siguientes brix, azúcares totales, azúcares reductores y sacarosa real (Lab. C.A.P. Pomalca) y extracto libre de nitrógeno, materia seca, cenizas totales, proteina cruda, pH, energía bruta Ca, P, Mg, Na, K, Cu, Zn, Mn y Fe (Lab. de Nutrición de la U.N.P.R.G.).

El diseño experimental empleado fue B.C.R. con 7 tratamientos (Cooperativas) y 6 repeticiones (épocas de muestreo). Se efectuó análisis de variancia completados con prueba de Tuckey, realizando además correlaciones y las más importantes regresiones.

Los valores promedios expresados en porcentaje y/o base seca fueron de 70.5, 86.4, 4.3, 15.4, 80.1, 74.0, 22.1 y 51.9, para materia seca, brix, proteína cruda, cenizas totales, extracto libre de nitrógeno, azúcares totales, azúcares reductores y sacarosa real respectivamente. El pH promedio fue 5.7 y la energía bruta 3,984.7 Kcal/kg.

Los porcentajes promedios de Ca, P, Mg, K y Na expresados en base seca fueron respectivamente como sigue: 0.93, 0.08, 0.54, 5.49 y 1.03. La concentración de los micro minerales Cu, Zn, Mn y Fe fueron 10.5, 11.2, 20.0 y 342 ppm en base seca respectivamente.

El análisis de variancia mostró significación estadística entre Cooperativas para todos los nutrientes y/o parámetros estudiados con excepción de la energía bruta y Na; entre muestreos sólo fueron significativos los valores de proteína cruda, cenizas totales, extracto libre de nitrógeno, azúcares totales, sacarosa real, Mg, Na y K.

En las relaciones entre los elementos nutritivos y/o parámetros analizados de todas las muestras de melaza de caña, se observaron líneas de regresión positivas y estadísticamente significativas entre Brix y Potasio, entre Cenizas Totales y Potasio, entre Azúcares Totales y Energía Bruta y entre Potasio con p H. Líneas de regresión negativas y con significación estadística se observaron entre Materia Seca con Azúcares Totales y con Energía Bruta; y finalmente se efectuaron ecuaciones de regresión cuadráticas entre Cenizas Totales con pH y entre Cenizas Totales con el elemento Calcio.

Barradas Lagunes, Hipólito V. and Robert M. Cook. 1981. Contenido mineral de suelos, pastos y ganado en dos regiones tropicales del estado de Veracruz, Mexico. VIII Reunión Asociación Latinoamericana de Producción Animal (ALPA) Resumenes, R-40.

Resumen

Las regiones estudiadas fueron la Central y Norte del Estado de Veracruz. Tres ranchos con Pangola (Digitaria decumbens) y tres con Guinea (Panicum maximum) fueron muestreados en cada región durante la temporada de lluvias de 1979. En estos ranchos no se ofrecía suplementación mineral al ganado, excepto sal común y no se fertilizaban los potreros. Las muestras de suelo y pastos se tomaron en un área de 30 hectáreas en cada rancho. Los animales muestreados por rancho fueron 10 vacas en ordeña, 10 vaquillas y 10 becerros. Los minerales analizados fueron calcio (Ca), fósforo (P), magnesio (Mg), potasio (K), cobre (Cu), hierro (Fe), selenio (Se) y zinc (Zn). Se determinaron por espectrofotometría de absorción atómica Ca, Mg, K, Cu, Fe y Zn, por colorimetría P, y con fluororimetría Se. Se observaron niveles muy bajos de fósforo extractable (<5 ppm) en suelos de las dos regiones. El contenido de selenio total también fue bajo (<.1 ppm) en algunos suelos de la región Central. Se encontraron deficiencias de calcio y fósforo (<.30% de la M.S.) y de selenio (<.1 ppm) en los dos forrajes analizados, pero especialmente en la Pangola, en la región Central. Estos mismos elementos fueron también deficientes en el suero de parte del ganado de ambas regiones, con valores menores de 9.0 y 4.0 mg/100 ml para calcio y fósforo, respectivamente, y de .05 µg/ml para selenio. Estas deficiencias serán más severas durante la estación seca, necesitándose continuar los estudios de mapeo para lograr establecer programas de suplementación mineral adecuados a cada región y época.

Bauer, B., E. Galdo, L. R. McDowell, M. Koger, J. K. Loosli and J. H. Conrad. 1981. Mineral Status of Cattle in Tropical Lowlands of Bolivia. Fourth International Symposium on Trace Element Metabolism in Man and Animals (TEMA-4) Programme and Abstracts, Perth, Western Australia, p. 30.

Abstract

A 3-year experiment was designed to determine the mineral status of grazing beef cattle in the Beni of Bolivia. For Year 1, 872 steers and 894 female 12-15 month old Zebu-Criollo crossbred cattle were assigned to 3 treatments: 1) control - no minerals (C), 2) common salt only (S), and 3 salt (60% + bone meal (40%) (S + BM). Injections of Se-vitamin E, Cu, I and Co bullets were administered singly and in all possible combinations to 160 animals within each major treatment. At 338 days, cattle receiving S + BM had higher gains of 96.4 vs 82.7 and 79.4 kg ($P < .001$) for C and S treatments, respectively. Males had larger ($P < .001$) gains of 88.8 vs 83.5 kg. There was a nonsignificant advantage for trace mineral treated over nontreated animals for each of the trace elements (1.3,1.2,0.1 and 2.3 kg for I, Co, Cu and Se, respective,ly). Year 2 pregnancy rates for 655 animals for the S and S + BM treatments were high, 89.5 and 88.5%, respectively. Second pregnancy rate comparisons (Year 3) for 298 animals were 13.9% higher for S + BM vs S treatments (87.1 vs 73.2%). Analyses were made of nonfertilized, native forages, blood and liver (biopsy) samples taken during June (dry season) and November (wet season) for each year. Season and year differences in mineral concentrations were found ($P < .05$). Mean forage mineral analyses for June and November 1977 and June and November 1978, respectively, are as follows: Ca, .49,.44,.16,.20%; K, .53, 1.02,1.55,2.59%; Mg, .19,.19,.24,.23%; Na, .03,.03,.04,.02%; P, .20,.18,.30, .19%; Cu, 4.6,5.8,7.8,6.1 ppm; Co,.38,.60,.36,.20 ppm; Fe,162,178,249,96 ppm; Mn, 416,365,434,326 ppm; Mo, 1.38,1.56,.32,.72 ppm; Se, .11,.14,.18,.16 ppm; Zn, 25,23,17,22 ppm; and protein, 6.5, 11.4,11.9 12.5%. Borderline to deficient mineral concentrations of Ca (<.30%), K (<.6%), Mg (<.2%), Na (<.06%), P (<.25%), Co (<.1 ppm), Cu (<10 ppm), Se (<.1 ppm), Zn (<30 ppm) and protein, (<7%) were found in June and November 1977 and June and November 1978 as 8, 17,100,86; 67,0,0,0; 58,67,20,43; 92,83,100,100; 75,89,30,93; 83,94,70,86; 0,0,0,21; 33,22,0,7; 75,89,100,86; and 86,10,17,0 percent of the total forages, respectively. All forage Fe and Mn levels were above the requirement and Mo concentrations were not in excess. The percentages of mean liver Cu (<75 ppm), Fe (<180 ppm), Zn (<84 ppm), Se (<.25 ppm) and serum Cu (<.65 µg/ml), Mg (<2 mg%) and Zn (<.80 µg/ml) that were low to borderline to deficient were 81,79,36,86; 43,46,32,34; 28,63,42,31; _,_,17,10; 22,29,3,0; 58,83,31,10; and 7,17,0,0 for June and November 1977 and June and November 1978, respectively. Liver Co (< .07 ppm) and Mo (1-5 ppm) and serum Ca (<8 mg%) and P (<4.5 mg%) were generally in the normal ranges. On the basis of forage, liver and blood serum analyses, deficiencies of Ca, Fe, Co and Mn, or toxicity of Mo, are unlikely.

Bauer, Bernardo, Enrique Galdo, L. R. McDowell, Marvin Koger, J. K. Loosli, J. H. Conrad, R. C. Littell and C. B. Ammerman. 1979. Situación mineral de ganado de carne en Beni, Bolivia. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-38.

Resumen

Se diseñó este experimento para determinar la situación mineral del ganado de carne en pastoreo en Beni, Bolivia. Se analizaron muestras de forrajes, suero sanguíneo y tejido de hígado. Se recolectaron muestras de seis y nueve pastos nativos en junio (época seca) y noviembre (época húmeda), respectivamente. También durante ambos períodos se recolectaron muestras de suero sanguíneo y biopsia de hígado de 48 animales de la raza CebÚ-Criollo que inicialmente tenían 12-15 meses de edad. Los promedios de análisis minerales de junio y noviembre, respectivamente, fueron: P, .19, .19%; Ca, .49,.46%; Mg, .19, .18%; Na, .03, .03%; K, .60, 1.02%; Fe, 162, 177 ppm; Cu, 4.6, .58 ppm; Zn, 25, 255 ppm; Co, .38, .57 ppm; Mn, 422, 401 ppm; y Mo, .95, .90 ppm. Se encontraron concentraciones de marginales a deficientes en Cu (<10 ppm), K (<.6%), Mg (<.2%), Na (<.06%), P (<.25%) y Zn (<30 ppm) en junio y noviembre con valores de 83, 89; 83, 0; 67, 56; 100, 89; y 83, 78% del total de forrajes, respectivamente. Los promedios en el hígado de Co, Cu, Fe, Mo y Zn y en el suero de Ca, Mg, P, Cu y Zn en junio y noviembre, respectivamente, fueron los siguientes: .48, .37 ppm; 51, 49 ppm; 239, 197 ppm; 2.8, 1.7 ppm; 115, 94 ppm; 10.8, 11.6 mg%; 2.0, 1.7 mg%; 6.7, 7.5 mg%; 1.02, .79 g/ml; y 1.06, .96 g/ml. Los porcentajes medios en el hígado de Cu (<75 ppm), Fe (<180 ppm) y Zn (<84 ppm) y en el suero de Mg (<2.0 mg%), P (<4.5 mg%), Cu (< 55 µg/ml) y Zn (<80 µg/ml) que estaban bajos o de marginales a deficientes fueron 79, 77; 42, 44; 27, 65; 48, 77; 10.2; 23,31 y 13, 23 en los períodos seco y húmedo, respectivamente. El Co (<.07 ppm) y Mo (1 -5 ppm) en el hígado y el Ca (<8 mg%) en el suero estaban normales en ambas épocas.

Bauer, Bernardo, Enrique Galdo, L. R. McDowell, Marvin Koger, J. K. Loosli, J. H. Conrad, R. C. Littell and C. B. Ammerman. 1979. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-39.

Resumen

Se llevó a cabo este experimento con 872 novillos y 894 hembras de 12-15 meses de edad de la raza Cebú-Criollo para determinar las necesidades de suplementación mineral en la región de Beni, Bolivia. Se clasificaron cinco grupos por proporción de cruces de Cebú y Criollo, los cuales se sometieron a tres tratamientos principales: 1) testigo (T), sin minerales; 2) Sal común solamente (S); y 3) Sal + harina de hueso (SHH). Se utilizaron 333, 534 y 988 animales respectivamente en los tres tratamientos. Se le administraron inyecciones de Se-vitamina E, Cu, I y balas de Cobalto, separadamente y en todas las combinaciones posibles a 160 animales dentro de los tres tratamientos principales. El promedio general para el período de 338 días fue de 86 kg con una desviación normal de 25.9 kg. El ganado que recibió SHH tuvo las más grandes ganancias de peso con 96.4 vs 82.7 y 79.4 kg ($P < 0.001$) en los tratamientos T y S, respectivamente. Hubo ventaja no significativa de los animales tratados sobre los no tratados con cada uno de los elementos (1.3, 1.2, 0.1 y 2.3 en I, Co, Cu y Se, respectivamente). Los promedios de ganancias por razas fueron 92.5, 90.7, 86.8 y 83.2 kg para 7/8 o más Cebú, entre 1/2 y 3/4 Cebú, menos de 1/2 Cebú y 3/4 Cebú, respectivamente. Los machos tuvieron más ganancias que las hembras ($P < 0.001$) con 88.8 ± 1.16 (EE) vs 83.5 ± 1.17 (EE), respectivamente.

Bauer, Bernardo, Enrique Galdo, L. R. McDowell, M. Koger, J. K. Loosli and J. H. Conrad.1981.Beef Cattle Mineral Status in the Tropics of Bolivia. J. Anim. Sci. Abstracts No. 624.

Abstract

A 3-year experiment was designed to determine the mineral status of grazing Zebu-Criollo crossbred cattle in the Beni of Bolivia. Year 2 pregnancy rates for 655 animals for both the 1) control - salt only (C), and 2) salt (60%) + bone meal (40%) (S + BM) treatments were high, 89.5 and 88.5%, respectively. Second pregnancy rate comparisons (year 3) for 298 animals were 12.6% higher for S + BM vs C treatments (86.4 vs 73.8%). Analyses were made of non-fertilized native forage, blood and liver (biopsy) samples taken during June (dry season) and November (wet season) for each year. Season and year differences in mineral concentrations were found ($P < .05$). Mean forage mineral analyses for June and November, 1978, respectively, are as follows: Ca, .16, .20%; P, .30, .19%; Cu, 7.8, 6.1 ppm; Co, .36, .20 ppm; Fe, 249, 96 ppm; Mn, 434, 326 ppm; Mo, .32, .72 ppm; Se, .18, .16 ppm; Zn, 17, 22 ppm: and protein, 11.9, 12.5%. Borderline to deficient mineral concentrations of Ca (<.30%), Mg (<.2%), Na (<.06%), P (<.25%), Cu (<10 ppm), Co (<.1 ppm), Se (<.1 ppm), Zn (<30 ppm) and protein (<7%) were found in June and November 1978 as 100, 86; 20, 43; 100, 100; 30, 93; 70, 86; 0, 21; 0, 7; 100, 86; and 17, 0% of the total forages, respectively. All forage Fe, K and Mn levels were above the requirement and Mo concentrations were not in excess. The percentages of mean liver Cu (<75 ppm), Fe (<180 ppm), Se (<.25 ppm), and serum Cu (<.65 µg/ml) and Mg (<2 mg%) that were low to borderline to deficient were 36, 86; 32, 34; 42, 31; 17, 10; 3, 0; and 31, 10 for June and November 1978, respectively. Liver Co and Mo, and serum Ca, P and Zn were generally above critical levels. On the basis of forage, liver and blood analyses, deficiencies of Ca, Fe, Co and Mn, or toxicity of Mo, are unlikely.

Bauer, Bernardo, Enrique Galdo, L. R. McDowell, Marvin Koger, J. K. Loosli, J. H. Conrad and C. B. Ammerman. 1981. VIII Reunión Asociación Latinoamericana de Producción Animal (ALPA), Santo Domingo, Dominican Republic. R-39 (Abstract).

Resumen

Un experimento fue diseñado para determinar el estado mineral de ganado de la raza de Zebú-Criollo en Beni, Bolivia, cuya duración fue de 3 años. En el año 2 del experimento, los porcentajes de preñez para las 655 vacas bajo los tratamientos de sal (S) y de sal + harina de hueso (S + HH) fueron altos: 89.5 y 88.5%, respectivamente. En comparación los porcentajes de preñez para 298 vacas en el año 3 fueron el 12.6% más altos para el tratamiento de S + HH contra el de sólo S (86.4 contra 73.8%, respectivamente). Se analizaron muestras de forrajes nativos sin fertilizantes, de sangre y de hígado (de biopsia) que fueron recogidas en Junio (época seca) y en Noviembre (época lluviosa) para cada año del experimento. Se encontraron diferencias ($P < .05$) de año y de época entre las concentraciones minerales. Para los períodos de Junio y Noviembre de 1978 y Junio y Noviembre de 1979, se encontraron concentraciones de marginales a deficientes en Ca (<.30%), Mg (<.2%), Na (<.06%), P (<.25%), Cu (<10 ppm), Co (<.1 ppm), Se (<.1 ppm), Zn (<30 ppm) y proteína (<7%) en 100,86, 71,75; 20,42,39,50; 100,100,71,100; 30,93,71,100; 70,86,93,38; 0,21,0,0; 0,7, 93,88; 100,86,57,88; y 17,0,21, y 0 por ciento de los forrajes, respectivamente. Todas las concentraciones de K, Fe y Mn sobrepasaron las necesidades y las de Mo no estaban en exceso. Concentraciones de minerales en muestras de hígado o suero fueron de marginales a deficientes en Cu, Zn, Ca, P y Mg durante una o más estaciones. Basado en los análisis de forraje de hígado y de suero, deficiencias de K, Fe, Co y Mn, y toxicidad de Mo, son poco probables.

Benavides Ramirez, Alvaro. 1979. Estudio del contenido mineral de los forrajes y suero sanguíneo del ganado bovino en los cantones de Cañas, Bagaces y Liberia de la Provincia de Guanacaste , durante la época lluviosa. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente estudio se realizó en los cantones de Cañas, Bagaces y Liberia, de la provincia de Guanacaste, durante la época lluviosa del año 1978.

Se escogieron fincas representativas en cada cantón y se muestrearon pastos y sangre de ganado bovino en pastoreo.

En suero sanguíneo se analizaron los minerales calcio, fósforo, y magnesio. En pastos se analizaron los minerales calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc; también se analizó el porcentaje de proteína cruda.

Los niveles promedios de calcio, fósforo y magnesio en sangre fueron: 10.99, 5.28 y 2.70 mg/100 ml de suero, respectivamente.

Los niveles promedios de calcio, fósforo, magnesio, potasio son: 0.271, 0.143, 0.134 y 1.88% en base seca, respectivamente. Los niveles promedios de hierro, cobre, manganeso y zinc fueron: 322, 6, 42 y 31 ppm en base seca, respectivamente. La proteína cruda presentó un promedio de 8.08% en base seca.

Se concluyó que los minerales deficientes en la zona son: fósforo cobre, zinc, calcio y además la proteína cruda.

Se realizaron análisis estadísticos para analizar la variación entre cantones, distritos, fincas, sexos, (especies de pasto), edad (estado vegetativo en pastos) y la muestra. Se procesaron regresiones por el método de "Stepwise," para determinar variables que afectan el contenido de minerales en el suero sanguíneo, resultando que las variables cobre y magnesio en pastos afectan el nivel de calcio en sangre. Las variables mes y finca afectaronel nivel de fósforo en sangre y las variables mes, especie de pasto, calcio y cobre en pasto afectaron el nivel de magnesio en sangre.

Se hicieron correlaciones entre los minerales y la proteína cruda, en pastos y en el suero sanguíneo.

Calub, Dr. Arsenio D. and M. Aripin Amril. 1979. How to Raise Rate of Pregnancy. Philippine Farmers Journal.

Ranchers should better try a new method, tested at the University of the Philippines at Los Baños, of increasing the number of pregnant cows in a herd.

A study conducted by Dr. Arsenio D. Calub and M. Aripin Amril at the UPLB have shown that ranchers would be able to get more calves from their cows by giving them a complete mineral mixture.

In the experiments they conducted at Sitio Singpuan, Barrio Burgos, Carranglan, Nueva Ecija, they found that cows given complete mineral supplements were easier to get pregnant.

In experiment involving Brahman crossbred cows, they found that those who licked complete mineral supplements had a 79 per cent pregnancy rate during the mating season.

This was much higher than the 57 per cent pregnancy rate of cows whose mineral supplement consisted only of salt.

They found that cows given salt consumed 29.51 grams per day, while those given complete mineral mixture consumed only 22.9 grams.

The complete mineral mixture that the two researchers used was composed of bone meal, 40 per cent; salt, 57.75 per cent; $CuSO_4$, 0.008 per cent; ZnO, 0.615 per cent; $MnSO_4$, 0.288 per cent; KIO_3, 0.026 per cent and $FeSO_4$, 1.24 per cent.

Camargo, Waldemar V. de A., João S. Veiga and Joseph H. Conrad. 1981. Cu, Mo, S, Zn and Periodontitis in Brazilian Cattle. Fourth International Symposium on Trace Element Metabolism in Man and Animals (TEMA-4) Programme and Abstracts, Perth, Western Australia, p. 23.

A periodontal disease widely known as "cara inchada " (swollen face) has been associated with cattle production in Brazil for more than 50 years. Highest incidences are found in cattle grazing newly established lush pastures which have been planted on fertile soils with pH around 6.0 or higher. Currently, the incidence in calves is often 20% or more in widespread areas of Mato Grosso and other regions of the Amazon basin. Examination indicates a periodontitis in calves as young as 30 days of age, followed by loosening and shedding of premolars and molars and enlargement of the maxillary and, less frequently, mandibular bones. Gingivitis appears to be aggravated by forage consumption and reduced integrity of the periodontal ligament permits forage impaction which impedes normal mastication. A severe diarrhea and emaciation accompanies the oral lesions which result in unproductive animals and/or eventual death from starvation. An initial experiment with 100 cattle in 10 groups near Rondonopolis, Mato Grosso North, a region with an extremely high incidence, indicated that the consumption of 50 grams or more daily of a mixture of macro and trace elements prevented periodontitis. A subsequent experiment was conducted on a ranch near Paranaiba, Mato Grosso South, where Panicum maximum forage contained 4, 2 and 20 mg/kg of Cu, Mo and Zn, respectively. Cows during gestation and lactation consuming a mineral mixture which supplied 75, 75 and 45 mg daily of Cu, S and Zn, respectively, produced healthy calves while one-third of the calves from cows receiving common salt without the trace elements above exhibited periodontitis at 50 days of age. Controlled experiments and extensive field trials indicate that low Cu and Zn, in addition to the Cu-Mo-S interrelationship, are involved in periodontitis of Brazilian cattle. Details of the etiology remain to be studied but this major deterrent to cow-calf production in vast areas of Brazil and to a lesser extent in Bolivia can be controlled with adequate and balanced trace element supplementation.

Chi Chang, Horacio. 1978. Evaluación del estado de nutrición mineral del ganado bovino de los distritos del Rio Cuarto de Grecia, Venecia de San Carlos y Horquetas y La Virgen de Sarapiquí, durante la época lluviosa. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo de investigación se realizó en los distritos de Rio Cuarto de Grecia y Venecia de San Carlos en la provincia de Alajuela y Horquetas y la Virgen de Sarapiquí en la provincia de Heredia. La evaluación se basó en el análisis de muestras de tejidos de animales (sangre e hígado) y de pastos.

Los elementos analizados en el suero sanguíneo fueron: calcio, fósforo, y magnesio; en el tejido hepático, hierro, cobre, manganeso y zinc y en los pastos la proteína cruda, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc.

El contenido promedio de calcio sanguíneo fue de 10.19±1.13 mg/100 cc, encontrándose diferencias significativas ($P<0.05$) entre las provincias y los cantones. El valor medio en el fósforo sanguíneo fue de 4.62±1.01, observándose diferencias ($P<0.05$) entre las fincas. El magnesio sanguíneo presentó un promedio de 2.56±0.37 mg/100 cc.

Los valores promedio encontrados de los elementos en el tejido hepático fueron: hierro 269.6 ppm, cobre 127.4 ppm, manganeso 7 ppm y el zinc 222.3 ppm.

Para los pastos se encontró en la proteína cruda un promedio de 10.53± 1.88%, observándose diferencias estadísticamente significativas ($P<0.05$) entre los cantones. El calcio presentó un valor medio de 0.231±0.053%, habiéndose encontrado diferencias significativas ($P<0.05$) entre las especies de pasto. El fósforo mostró un promedio de 0.164±0.043%. El promedio del magnesio fue de 0.161±0.035%, encontrándose diferencias significativas ($P<0.05$) entre las especies de pastos. El potasio tuvo un valor promedio de 2.16±0.56%. El valor promedio para el hierro fue de 109.94±29.82 ppm, indicando el análisis estadístico diferencias significativas ($P<0.05$) entre las provincias y las especies de pasto. El promedio de cobre fue de 19.68±25.48 ppm, indicándose así una heterogeneidad de datos, para este elemento se encontró diferencias significativas ($P<0.05$) entre los cantones estudiados. El promedio de manganeso fue de 114.13±35.37 ppm, y el zinc mostró un promedio de 20.36±5.46 ppm, observándose diferencias significativas ($P<0.05$) entre las especies de pastos analizadas.

Comas Esquivel, Axel. 1977. Efecto de la suplementación mineral sobre el comportamiento reproductivo de un hato bovino de carne en condiciones de época seca. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo se realizó en la finca Choluteca, situada en Orotina, provincia de Puntarenas, se utilizaron noventa vaquillas cebú encastadas de edad entre dos y tres años, con un peso promedio de 300 kg. que nunca antes habían parido, se dividieron en tres grupos de 30 hembras y a cada uno se le asignó un tratamiento, de la siguiente forma: grupo testigo, alimentación al pastoreo, más sal común, grupo con fosfato dicálcico, alimentación con fosfato dicálcico (17 kg.); grupo con mezcla completa, alimentación en la misma forma que los grupos anteriores más una mezcla mineral completa.

Se utilizaron para el empadre, con una duración de tres meses, cuatro toros Brahman a los cuales se les practicó examen de semen. El índice de concepción se determinó mediante al diagnóstico de preñez por palpación rectal a los cuarenta y cinco días después de haber sido finalizada la época de monta.

Las diferencias entre el porcentaje de concepciones fueron analizados mediante la prueba de Chi Cuadrado, no encontrándose diferencias significativas entre el testigo y los grupos suplementados.

Conejo Morales, Luis Bernal. 1981. Diagnóstico del estado mineral del ganado bovino, pasto y suelo en una finca lechera en el Cantón de Coronado, Provincia de San José. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo fué realizado durante los meses de julio y octubre de 1979, y enero de 1981; con el objeto de diagnosticar el estado de nutrición mineral de una finca en particular, tomando en cuenta como parámetros el suero sanguíneo, el pasto y el suelo.

En el plasma se estudió el nivel de calcio, fósforo y magnesio. En el pasto fué analizado el contenido de proteína cruda, y al igual que en el suelo el calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc.

En el suero sanguíneo se obtuvo concentraciones promedio de calcio, fósforo y magnesio de 10.37, 5.78 y 1.85 mg/100 ml. de suero respectivamente. En el pasto, se encontró porcentajes de calcio, fósforo, magnesio, potasio y proteína cruda de 0.23, 0.30, 0.16 y 20.66 respectivamente. Mientras que para el hierro, cobre, manganeso y zinc, se logró concentraciones promedio de 214.9, 10.76, 32.05 y 28.47 ppm. respectivamente. En el suelo se obtuvo niveles promedio para el calcio, magnesio y potasio de 4.33, 1.56 y 0.73 meq/100 ml. de suelo respectivamente.

En base a los resultados encontrados se llegó a las siguientes conclusiones:

1- Las concentraciones de calcio y fósforo en el plasma sanguíneo son normales, no así el magnesio, que está aproximadamente en un 40% de los animales bajo el nivel crítico inferior.

2- El contenido de proteína cruda, fósforo, potasio, hierro y cobre en el pasto Kikuyo satisfacen las necesidades (N.R.C., 1978) para el ganado lechero. Mientras que el calcio, magnesio, manganeso y zinc no logran satisfacer dichos requerimientos.

3- Todos los minerales presentes en el suelo tienen concentraciones normales, que permiten un adecuado crecimiento del pasto.

4- En general, el estado mineral de la finca es satisfactorio.

Conrad, J. H., L. R. McDowell and J. K. Loosli. 1981. Mineral deficiencies and toxicities for grazing ruminants in the tropics. Article presented at International Symposium-Animal Production in the Tropics, at the University of Gezira, Wad Medani, Sudan.

Summary

In tropical countries, mineral imbalances are a major limitation to ruminant livestock production. Often grazing livestock do not receive mineral supplememntation 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 percent; Cu, 47 percent; Mg, 35 percent; P, 73 percent; P, 73 percent; Na, 60 percent; and Zn, 75 percent. The most widespread mineral deficiency for livestock is that of P. Twelve reports from tropical countries illustrate the dramatic increase in calving percentage when breeding cattle were supplemented with P. Copper and Co deficient areas are widespread in tropical countries. 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, Asian and African institutions to initiate and establish mineral research. A systematic mapping technique, based on animal tissue and forage concentrations, can be employed to predict where mineral deficiencies or toxicities will occur. Data from research in Brazil indicate that positive correlations among soil and forage mineral concentrations for Mg, Cu, Fe, Mn, Na, Mo, and Zn were low or nonexistent. Attempts to raise livestock productivity in tropical countries will unsuccessful unless the nutritional environment, including adequate mineral nutrition, is likewise elevated. Mineral supplementation is a least cost input to improvement of liestock production.

Conrad, J. H., L. R. McDowell and R. M. Mason. 1981. Tecnica modificada de biopsia costela em bovinos. Sociedade Brasileira de Zootecnia

Resumo

O nivel de fósforo em bovino é melhor demonstrado atraves de amostr. a da costela do que o fósforo inorgânico de soro. A sensibilidade das costelas a mobilização e reposição de minerais é maior do que a dos ossos longos. A cinza, cálcio, fósforo e magnésio podem ser analizados a partir de osso e expressos em base de volume (mg/ml), percentagem de osso fresco e osso seco desengordurado. A gravidade específica do osso fresco é dada em mg/ml. Amostras de 700 a 1000 mg podem ser obtidas pela modifição do método de Little, D.A. (Aust. Vet. J. 48:668, 1972), usando-se uma broca-serra oca (trephine) de 1,5 cm em diametro.

Escolha a penúltima ou ultima costela, depele, escove com água e sabão, desinfete com alcool (iodado). Aplique 20 cc de anestésico local (Lidocaina - 2%) nos dois espaços intercostais. Incise a pele, fáscia , músculos e periostec (6-8 cm), afaste os tecidos expondo o centro da costela. Regule a broca na profundidade desejada (1-1,2 cm) tal que a medula seja atingida. Perfure lentamente para evitar aquecimento do osso (furadeira manual ou eléctrica de velocidade controlável para ser usada). Deslique e gire a furadiera com pequenos movimentos laterais para deslocar o pedaço de osso da costela. Retire a broca e remova a amostra. Examine a ferida, remova fragmentos osseo, aproxime músculos e fáscias e suture e pele.

Corapse, Hernan Ajamad. 1978. Diagnóstico de la situación Mineral en el Hato "El Estrecho" (Estado Monagas). Tésis. República de Venezuela, Ministerio de Educación, Instituto Universitario Pedagogico Experimental, Departamento de Educación Técnica, Sección de Agropecuaria, Maturín, Edo. Monagas, Venezuela.

Resumen y Conclusiones

El presente estudio fue realizado en el Hato "El Estrecho," situado en el pueblo de Costo Abajo, Municipio San Simón Edo. Monagas, Venezuela, durante los meses de julio-septiembre de 1977; con el objeto de determinar la situación mineral durante la época lluviosa en la finca antes mencionada.

El área experimental estuvo conformada por 12 potreros, donde predominaba el pasto pangola (Digitaria decumbens, Stent.) y 25 animales (10 becerros, 10 mautes, y 5 vacas lactantes), se tomaron 10 muestras de suelo/potrero, 10 muestras de forraje/potrero y una muestra de sangre/animal. Las muestras de suelos, forraje y sangre fueron analizadas en el laboratorio de acuerdo a los métodos requeridos por cada variable. El análisis estadístico utilizado fue la media aritmética, desviación stándard y regresión lineal.

Los promedios obtenidos en el estudio fueron: a) En suelos: 1.19, 0.81, 0.11, 9.91 meg/100 ml, para calcio, magnesio, sodio y aluminio, para el fósforo fue de 3.31 ppm. b) En el forraje de 0.39, 0.20, 0.30% de calcio, fósforo y magnesio y de 176.4, 314.3, 4910.0, 38.17 y 4.152 ppm de hierro, manganeso, sodio, zinc y cobre respectivamente. c) Para las muestras de sangre (mg/100 ml) en becerros de 5.53, 3.71, 2.19 para calcio, fósforo y magnesio, en mautes de 7.25, 3.56 y 2.88 para calcio, fósforo y magnesio.

De acuerdo a los resultados obtenidos en las condiciones del estudio se puede concluir lo siguiente:

1- Todas las variables estudiadas en suelo mostraron niveles debajo de lo normal.

2- Los niveles de fósforo y calcio, en forraje y sangre fueron deficientes, siendo mas acentuado para el fósforo en ambos casos.

3- El cobre presentó niveles deficitarios en forraje, no pudiendose detectar en sangre por no haberse hecho la determinación.

4- El magnesio fue el elemento que presentó mejores niveles tanto en forraje como en sangre, considerandose como suficiente.

5- Los minerales, sodio, zinc, hierro y manganeso mostraron contenidos suficientes en forraje, indicando escasa probabilidad de deficiencias.

6- El análisis estadístico mostró, que ninguna de las pruebas de regresión lineal fue significativa para todos los niveles de significancia.

Cuenca, L., A. Fernandez, T. Alonso and C. Decia. 1981. Levels of minerals in pastures and beef cattle tissues in Uruguay. Veterinaria 77:103-109.

Summary

In the present study, information on mineral concentration in natural pastures in different areas of Uruguay as well as in beef cattle liver, bone and blood serum of animals grazing these natural grasslands was sought. On field biopsy techniques (liver and bone) were also evaluated. Minerals studied were: phosphorus, calcium, magnesium, copper, zinc and manganese. Samples were obtained from nursing cows during late spring and summer and yearling steers during autumn. Results were as follows: low values of phosphorus in pasture (0.11 - 0.20% of DM), in serum (3.4 - 5.8 mg/100 ml) and in bone ash (15.9 - 17.3%); high levels of calcium in pastures (0.23 - 0.74% of DM), normal levels in serum (9.13 - 10.1 mg/100 ml) and in bone ash (36.4 - 40.0%); magnesium levels high in pasture (0.17- 0.25% of DM), normal in serum (2.16 - 2.76 mg/100 ml) and low in bone ash (0.53 - 0.71%); copper levels very low in pasture (1.28 - 2.98% of DM), normal in liver (129.4 - 307.3 ppm); low to normal levels of zinc in pasture (6.23 - 38.9% of DM), very high levels in liver (129.7 - 437.4 ppm); very high levels of manganese in pasture (102 - 475 ppm of DM). Extraction of animal tissues for biopsies proved to be feasible and a good technique for these studies under field conditions in Uruguay.

de las Fuentes Cabello, Filiberto. 1977. Deficiencias y toxicidades minerales del ganado bovino en pastoreo en Cadereyta Jiménez, N. L. (Invierno-primavera). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Resumen

El presente trabajo se llevó a cabo en el Municipio de Cadereyta Jiménez, N. L., durante la época de Invierno-Primavera de 1976. Consistió en muestreo y análisis de minerales en suero sanguíneo, suelo y forraje. Se muestrearon 10 ranchos en cada una de las estaciones, sin historia de suplementación mineral. Se siguieron las técnicas recomendadas por Fick y Col para la recolección y análisis. Los análisis se hicieron por Espectometría de Absorción Atómica en el CIANE y los de Colorimetría en los Laboratorios de Zootecnia del I.T.E.S.M. En el suero, forraje y suelos se determinaron: Ca, Mg, K, Na, Zn, Cu, Fe y Mn por Espectometría de Absorción Atómica. Los análisis de P en suero, forraje y suelo, se realizaron por Colorimetría, basándose en el método de Olsen modificado. Se interpretaron los datos mediante análisis de varianza, con una distribución completamente al azar y se comparó las medias generales encontradas con los estandares teóricos de la literatura.

Para el Ca sérico los niveles se encontraron abajo del rango estandard con un promedio de 4.8 mg%. Los valores bajos pueden ser debidos a las interferencias negativas $PO_4^{\equiv}$ y AL^{+++}, por el desconocimiento de los usos del cloruro de lantano, que podría haberlas evitado. Los valores bajos de P en gramíneas y arbustos 0.14% y 0.142% respectivamente, no cumplen los bovinos sus requerimientos así lo muestran los niveles séricos, ya que el 95% de los animales se encuentran abajo del nivel normal (4.5 - 6.5 mg%) con un promedio de 2.97% posiblemente debido a los altos contenidos de Fe en suero, gramíneas y arbustos ya que ingestas altas de éste reduce la absorción del P. Se reportan niveles altos para Mg en suero de 4.37 mg% en promedio, probablemente debido a los contenidos altos en el 100% de gramíneas (1.83%) y arbustos (1.36%). Cuando ocurre una ingesta en exceso, el Mg es excretado en la orina. El 72% de los animales presentan valores de K arriba del estandard, corroborando los niveles altos en los forrajes. En su totalidad los pastos y arbustos reportan niveles altos en Cu, no comportándose así los niveles séricos, ya que el 89% de las muestras están abajo del estandard (0.6 - 1.5 ppm) con un promedio de 0.44 ppm. Esta deficiencia posiblemente se deba a una influencia del molibdeno reduciendo los niveles en el suero. Se encontró diferencia altamente significativa ($P < .01$) para P, Mg, K y Fe, y significativa ($P < .05$) para el Na, al compararse las épocas. Para el período de Invierno, en la comparación entre ranchos, se encontró una diferencia significativa ($P < .05$) para el P.

En base a los resultados obtenidos se concluye lo siguiente:

1. Se encontraron niveles séricos arriba del estandard en Mg, K, Zn y Fe y bajos P, Ca, Cu y Mn.
2. En forrajes se reportan altos en Ca, Mg, K, Fe y Cu y bajos en P y Mn.
3. Hay diferencia altamente significativa ($P < .01$) entre épocas para P, K, Mg y Fe, y significativa ($P < .05$) para el Na.
4. Hubo diferencia significativa ($P < .05$) para el P en el período de Invierno, en la comparación entre ranchos.

de Sousa, J. C., J. H. Conrad, L. R. McDowell, C. B. Ammerman and W. G. Blue. 1980. Inter-relações entre minerais no solo, forrageiras e tecido animal. 2. Cobre e molibdênio. Pesq. Agropec. Bras., Brasilia, 15(3):335-341.

Abstract

An experiment was conducted with samples from six farms to study the inter-relationship among mineral levels in soil, forage, and animal tissues during the wet and dry season of the year. Soil extractable copper was normal, 4.4 ppm, only on farm 1. Mean soil levels between 0.7 and 1.9 ppm were considered low on the other farms. Soil extractable copper means were 2.1 and 1.5 ppm during the dry and wet season, respectively. Forage copper values were deficient on farms 1, 3, 4 and 5; with a mean copper of 2.7 ppm on farm 3 there was a toxic level of Mo (9.2 ppm). Forage copper was 5.4 ppm during the wet season compared to 2.4 during the dry season. Liver copper levels were normal on all six farms, due to mineral supplementation. Soil extractable molybdenum was considered high on all six farms, and ranged from 16 to 24 ppm. Apart from farm 3, the other farms had non-toxic forage Mo value between 0.1 and 1.4 ppm. Normal liver molybdenum values were in evidence; a somewhat higher figure (3.8 ppm) found on farm 3 was, however, below the considered toxic level of 4 ppm.

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Echevarría, Mariano, Nelson Clavo, César Reyes, Jorge Rodríguez y Ricardo Valdivia. 1979. Suplementación fosforada a toretes Nellore en pastos asociados (Yaragua-Stylo) en Pucallpa. V Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-21.

Resumen

Se determinó el efecto de la suplementación de fósforo sobre la ganancia de peso en toretes Nellore; se usó la asociación yaragua (Hyparrhenia rufa) + Stylo (Stylosanthes guyanensis), y se empleó un diseño completamente al azar con tres tratamientos, 4 animales/tratamiento. Los tratamientos fueron: A) Testigo (Yaragua solo), B) Yaragua-Stylo, C) Yaragua-Stylo + suplemento de fósforo. Los pastos asociados fueron fertilizados con 100 kg/ha de superfosfato cada 6 meses. Todos los animales consumieron sal común. El suplemento mineral contenía 50% de sal común y 50% de fosfato dicálcico; el consumo promedio del suplemento de fósforo fue aproximadamente 50 g/día, se pesaron los animales cada 56 días. En 356 días se han obtenido los siguientes resultados: ganancia de peso: .182, .409 y .483 kg/día/animal y 488, 1 289 y 1 522 kg/día/ha para los tratamientos A, B y C, respectivamente; en ambos incrementos de peso se obtuvieron diferencias significativas en favor de los animales que consumieron fósforo usando pastos asociados (Yaragua-stylo) y demostrando ser económicamente más rentables.

de Sousa J. C., J. H. Conrad, W. G. Blue, C. B. Ammerman, and L. R. McDowell. 1980. Anais do I Congresso Brasileiro de Zootecnia (XVII Reunião Anual da SBZ), Fortaleza, 20 a 25 de julho de 1980. Animal Science Department University of Florida, Gainesville, Florida, U.S.A.

Inter-relações entre minerais no solo, plantas forrageiras e tecido animal. 3. Manganês, ferro e cobalto.

Fez-se um estudo das deficiências minerais em seis fazendas localizadas ao norte do Estado de Mato Grosso, tendo sido amostrados os solos, plantas forrageiras e tecido animal, coletados durante as estações seca e chuvosa. As análises de Mn indicam que das seis fazendas estudadas, duas tinham níveis de Mn ao solo considerado baixo, 6 e 14 ppm, as outras quatro apresentaram níveis adequados, acima de 20 ppm. Os níveis de Mn nas forrageiras eram suficientes para atender às exigências dos bovinos, nas duas épocas estudadas. Entretanto, os níveis de Mn no fígado dos animais, foram deficientes em cinco das seis fazendas estudadas, sendo que na estação chuvosa a deficiência era mais generalizada do que no período seco. Supõ-se que um excesso de Fe e Co na dieta dos animais estivesse diminuindo a absorção ou dificultando a utilização do Mn pelos animais. As análises de Fe no solo mostram que duas fazendas apresentaram níveis ligeiramente baixos, mas as outras quatro tinham níveis médios adequados, acima de 20 ppm. Os níveis de Fe nas forrageiras foram suficientes para atender os requerimentos nitricionais de bovinos. Entretanto, em algumas fazendas, em pastagens nativas e de capim-gordura, os teores de Fe eram tão elevados que estavam dentro da faixa tóxica, acima de 400 ppm. O nível de Fe no fígado foi normal em todas as fazendas. Os solos da fazenda 1, 3 e 4, mostraram teores adequados de Co, entretanto as demais fazendas possuíam solos deficientes. Apenas as forrageiras das fazendas que tinham solos ricos em Co, possuíam esse mineral em quantidade suficiente para atender às exigências nutricionais dos animais; as demais fazendas tinham forrageiras deficientes em Co. Em todas as fazendas os animais apresentaram níveis adequados de Co, provavelmente devido a uma forte suplementação de cobalto, que era fornecida aos animais diariamente. As médias de Co no fígado foram mais baixas na estação chuvosa do que na estação seca.

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Dumlao, Clenio Tolentino. 1981. Mineral Status Survey and Mineral Supplementation Trial with Breeding Beef Cattle in Calintaan, Occidental Mindoro. Thesis. University of the Philippines at Los Baños.

Abstract

Three ranches in Occidental Mindoro were assessed to determine existing mineral deficiencies or toxicities and the classes of cattle most susceptible. The effects of mineral supplementation alone and in combination with protein and energy were studied in one of those ranches.

Phosphorus (P) and manganese (Mn) were deficient in all the soils. They were borderline to deficient in potassium (K) (one ranch), copper (Cu). Of 75 grasses analyzed, 72, 17.3, 72 and 49 percent were deficient in P, K, sodium (Na) and zinc (Zn), respectively. Sporobolus indicus and Paspalidium flavidum contained toxic levels of Mg (150 ppm). For legumes, 70.7, 62.5 and 12.5 percent were deficient in P, Na and Zn, respectively. Desmodium lasiocarpum and D. styracifolium contained possible toxic levels of Mn. For shrubs and broad leaf plants, 24.4 percent were deficient in P and 58.8 percent in Na. Toxic levels of Mn were present in Bridelia stipularis, Triumfetta bartramia and Sida acuta; iron (Fe) in Sida acuta.

All three cattle classes and ranches appeared to be deficient in serum Cu. Dry cows and all ranches were borderline to deficient in P. Lactating cows were deficient in P and magnesium (Mg).

Except for the November sampling and for the salt supplemented group, all others were below the adequate Ca level prescribed. Mineral supplementations apparently decreased serum Ca. Serum P was found higher ($P < .07$) among P-supplemented cows; likewise during dry season ($P < .07$). The levels were on the low range of the normal value except for the July sampling. Serum Mg levels were highest ($P < .01$) during wet and lowest during dry season. Serum Cu and Fe were not influenced by mineral supplementation. But Cu differed ($P < .05$) between age groups and period of collection ($P < .01$); it was highest during rainy season. Both decreased during dry season. All other levels were deficient except serum Cu during wet season.

Mineral supplementation did not affect liver concentration, although, animals receiving salt tended to have lower levels of Cu, Zn, and Fe. Liver Cu at initial biopsy was deficient, all others were in the low normal range.

Younger cows responded apparently better to mineral supplementations, with pregnancy rates of 57.14, 71.43, 42.86 and 42.86 percent for Complete Mineral Mixture (CM), CM + Energy + Nitrogen (CMEN), phosphorus, and salt, respectively, versus 27.39 initial pregnancy rate. These results, however, are merely indicative due to lack of experimental animals. Mineral supplementation had little effect on pregnancy rate of older cows. Nonetheless, older cows generally had significantly higher ($P < .06$) pregnancy rate.

Escamilla Martínez, Raymundo. 1978. Evaluación de la suplementación de minerales a bovinos en pastoreo de zacate guinea (Panicum maximum Jack) bajo condiciones de clima subtropical. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que se llevó a cabo este experimento se puede concluir lo siguiente:

1. - La zona en la que se encuentra localizado el Rancho "La Laguna", resultó bastante deficiente en Fósforo.

2. - Los animales respondieron positivamente a la suplementación de Fósforo. Se obtuvieron aumentos de pesos satisfactorios. (Aumentaron 1.67 veces más que el testigo/día/animal.

3. - Resultó económicamente redituable, una suplementación mineral de Fósforo a base de Fosfato monosódico.

Espinoza, J. Edmundo, Lee R. McDowell. 1981. Mineral status comparisons between llamas and sheep in the Bolivian altiplano. University of Florida, Gainesville.

Summary

An experiment was conducted in the central part of the altiplano of Bolivia to establish the specific mineral status of growing llamas compared to sheep.

Animal tissue (plasma, liver and bone), forage and soil samples were analyzed for mineral contents. A total of 24 llamas and 24 sheep (half males and half females) were included in this study.

No species effect ($P < .1$) was observed on liver Mg, Se and Zn. Llamas were higher ($P < .05$) in Co, Cu, Mn and Mo concentrations. All mean liver minerals were in the critical concentrations expect Zn in both species. No species effect ($P < .1$) was observed on plasma Mg. Sheep were higher ($P < .01$) in plasma Ca, Cu, Fe and Zn. Plasma Zn levels were below critical concentrations. Metacarpal P and Zn ($P < .01$) and Ca ($P < .05$) were higher in sheep. Rib P and Zn ($P < .01$) and Ca ($P < .1$) and Mg ($P < .05$) were also higher in sheep when expressed as mg/ml. While metacarpal Mg ($P < .05$) and P ($P < .01$) contents were higher in llamas, no species effect was found for metacarpal Ca. Rib Mg content was higher ($P < .05$) in llamas and no difference ($P < .1$) was found for rib Ca and P when expressed at percentage of ash. Calcium, Mg and P in sheep and llama metacarpal and rib were below the normal levels.

No sex x season, or specie x season interactions ($P < .1$) were found for any element, except for liver Fe content ($P < .05$).

Higher concentrations ($P < .05$) of Ca, Mg, Al, Mn and Se in soils were found during the dry season, and no season effect ($P < .05$) was found on P, K, Na, Cu, Fe and Zn.

Mean forage analyses for the wet and dry seasons, respectively, were as follows: Protein, 13.8, 6.9%; P, .05, .09%; Ca, .87, 43%; Mg, .25, .18%; Na, .22, .08%; K, 2.6, 1.4%; Fe, 323, 164 ppm; Cu, 10, 7 ppm; Zn, 49, 25 ppm; Co, .26, .36 ppm; Mn, 53, 81 ppm; Mo, .68, .53 ppm; and Se, .06, .06 ppm. Borderline to deficient concentrations of protein (<7.0%), Ca (<.3%), Cu (<5 ppm), K (<.6%), Mg (<.08%), Na (<.06%), P (<.25%), Zn (30 ppm) and Se (<.1 ppm) were found during the wet and dry seasons as 20, 53; 10, 40; 20, 53; 20, 20; 10, 20; 0, 40; 100, 100; 40, 60; and 90 and 93% of the total forages, respectively.

The percentages of mean liver Zn (<84 ppm) and Se (<.25 ppm), serum Ca (<8 mg%), Mg (<2 mg%), P (<4.5 mg%), Cu (<.65 g/ml), Fe (<1.1 g/ml), Zn (<,80 g/ml) and rib bone ash Ca (<36%), Mg (<.67%) and P (<.17%) that were low to borderline to deficient were 38, 63, 100, 100; 0, 17, 0, 17; 8, 0, 10, 0; 17, 20, 5, 10; 13, 40, 0, 40; 57, 8, 35, 0; 21, 4, 20, 10; 100, 52, 100, 75; 100, 100, 100, 100; 0, 50, 50, 100; and 0, 75, 0, 100 for llamas and sheep for the wet and dry season, respectively. Liver Co (<.07 ppm), Cu (<75 ppm), Fe (<130 ppm), Mn (<6 ppm) and Mo (1-5 ppm) were generally in the normal ranges. Nutrients most likely deficient were protein, P, Ca, Zn, and Se.

Espinoza, J. E., L. R. McDowell, Juan Rodriguez, J. K. Loosli and J. H. Conrad. 1981. Mineral Status of Sheep and Llamas in Bolivia. J. Anim. Sci. Abstracts No. 660.

An experiment was designed to compare the mineral status of grazing sheep and llamas in the highlands of Bolivia. A total of 24 llamas and 24 sheep, divided equally between sexes, were allotted to an unfertilized 20 hectare pasture of native species. Analyses were made of forage, blood, liver (biopsy) and bone samples taken during the wet (March) and dry (September) seasons. Mean forage analyses for the wet and dry seasons, respectively, are as follows: Protein, 13.8, 6.9%; P, .05, .09%; Ca, .87, .43%; Mg, .25, .18%; Na, .22, .08%; K, 2.6, 1.4%; Fe, 323, 164 ppm; Cu, 10, 7 ppm; Zn, 49, 25 ppm; Co, .26, .36 ppm; Mn, 53, 81 ppm; Mo, .68, .53 ppm; and Se, .06, .06 ppm. Borderline to deficient concentrations of protein (<7.0%), Ca (<.3%), Cu (<5 ppm), K (<.6%), Mg (<.08%), Na (<.06%), P (<.25%), Zn (<30 ppm) and Se (<.1 ppm) were found during the wet and dry seasons as 20, 53; 10, 40; 20, 53; 20, 20; 10, 20; 0, 40; 100, 100; 40, 66; and 90 and 93% of the total forages, respectively. The percentages of mean liver Zn (<84 ppm) and Se (<.25 ppm), serum Ca (<8 mg%), Mg (<2 mg%), P (<4.5 mg%), Cu (<.65 g/ml), Fe (<1.1 g/ml), Zn (<.80 g/ml) and rib bone ash Ca (<36%), Mg (<.67%) and P (<18%) that were low to borderline to deficient were 38, 63, 100, 100; 0, 17, 0, 17; 8, 0, 10, 0; 17, 20, 5, 10; 13, 40, 0, 40; 57, 8, 35, 0; 21, 4, 20, 10; 100, 52, 100, 75; 100, 100, 100, 100; 0, 50, 50, 100; and 50, 100, 100, 100 for llamas and sheep for the wet and dry seasons, respectively. Liver Co (<.07 ppm), Cu (<75 ppm), Fe (<180 ppm), Mn (<6 ppm) and Mo (1-5 ppm) were generally in the normal ranges. Significant ($P < .05$) species, sex, and season x species interactions were found. Nutrients most likely deficient were protein, P, Ca, Zn and Se.

Faria M., Jesús A., José Velásquez and Gustavo López M. 1981. Situación de la nutrición mineral en fincas de las sabanas orientales del estado Guarico. Boletín No. 6, Estación Experimental Nor-Oriente Guarico - FONAIAP - 42 pp. Valle de la Pascua, Venezuela.

Resumen

El objetivo del presente trabajo fué estudiar la situación de la nutrición mineral del ganado bovino en las sabanas del Edo. Guárico mediante análisis de muestras de suelo, forraje y sangre de bovinos en once fincas del Edo. Guárico, durante la época lluviosa de 1978 y época seca de 1979. En las fincas seleccionadas se muestrearon cuatro potreros, tomándose 10 muestras de suelo compuestas por potrero y 4 sub-muestras de forraje y se tomaron muestras de sangre de la vena yugular a 10 novillos for 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 y plasma sanguíneo, se les determinó nitrógeno, calcio, fósforo y magnesio. Los valores promedios obtenidos en las muestras de suelo para pH, materia orgánica, calcio, magnesio, potasio y fósforo durante la época lluviosa y seca fueron los siguientes: 5.21 y 4.9; 1.94 y 1.20; 0.64 y 1.50; 1.33 y 1.94; 0.08 y 0.14 meq/100 gr. de suelo; 2.90 y 5.08 ppm, repsectivamente. Los contenidos promedio de nitrógeno, calcio, fósforo y magnesio en las muestras de forrajes para la época lluviosa y seca respectivamente. La concentración promedio en el plasma sanguíneo para las épocas lluviosa y seca fueron: 10.59 y 10.15; 3.59 y 3.56; 3.40 y 3.94 mg/100 ml respectivamente. El 64% de los animales muestreados presentaron valores de fósforo inferior a 4 mg/100 ml durante la época lluviosa y 62% en la época seca. El 2% de los animales muestreados presentaron valores de calcio inferiores a 3 mg/100 ml, durante la época seca y 17% de los animales presentaron valores inferiores a 8 mg/100 ml. Solamente en la época lluviosa el 14% de los animales muestreados presentaron valores de magnesio en el plasma inferior a 2 mg/100 ml.

Fernández Brown, Lizandro M. 1979. Efecto de la suplementación fosfórica a vaquillas en pastoreo de zacate buffel (Cenchrus ciliaris L.). II. Respuesta biológica. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

De acuerdo a los resultados experimentales obtenidos y bajo las condiciones en que se realizó esta investigación se puede concluir lo siguiente:

1. Las vaquillas suplementadas con las mezclas de 4 y 8% P mostraron mejores aumentos de peso que aquellas a las que se les proporcionó la mezcla testigo (0% P).
2. Los consumos de las mezclas que contenían fósforo fueron mayores a los de la mezcla testigo.
3. Los niveles finales de calcio y fósforo en los animales suplementados con fósforo estaban dentro de los límites considerados como normales, a excepción de los no suplementados que se encontraban ligeramente deficientes en fósforo.
4. Mediante la suplementación fósforica es posible mejorar la relación Ca:P.
5. No se encontró respuesta a la suplementación fosfórica durante la etapa de crecimiento del zacate buffel (Cenchrus ciliaris L.).
6. El consumo de la mezcla casi fué nulo cuando el zacate buffel (Cenchrus ciliaris L.) estaba en crecimiento activo después de la lluvia.
7. Los aumentos de peso se incrementan en promedio en forma constante al aumentar el nivel de suplementación fosfórica.
8. La suplementación fosfórica a vaquillas en pastoreo de zacate buffel fué redituable.

Fernandez, Adolfo, Carlos Decia and Teresita Alonso. 1980. Proteins and minerals in the natural grass pastures of Uruguay. Presented at the Primer Congreso Nacional de Ingeniería Agrónomica, September 10-13, 1980.

Summary

From July 1976 to August 1977, 206 samples of natural grass pasture were taken from four locations in the country (Paysandú, basalt; Tacuarembó, sandy; Flores and Treinta y Tres, crystalline). The samples were analyzed for protein, phosphorus, calcium, magnesium, copper, zinc and manganese. The effect of season, location and region (mountain range, hillside and lowlands) on chemical composition was also studied.

The different seasons of the year showed a significant effect ($P < 0.01$) on protein levels which ranged from 8.0 to 10.0% of dry matter (DM). Phosphorus content ranged from 0.11 to 0.14% of DM; calcium ranged from 0.33 to 0.42% of DM; magnesium from 0.15 to 0.20% of DM; copper from 1.92 to 2.72 ppm; and manganese ranged from 222 to 413 ppm.

Significant differences were found among the different locations for all of the parameters studied. In Paysandú, the pasture was fourd to contain the highest levels of protein (10.0%), phosphorus (0.16%), calcium (0.49%), magnesium (0.22%) and copper (2.71 ppm). The highest levels of zinc (13.2 ppm) and manganese (405 ppm) were found in Tacuarembó where the lowest levels of protein (7.9%), calcium (0.30%) and copper (1.70 ppm) were also found. The lowest level of phosphorus (0.10%) was found in Treinta y Tres. The lowest levels of magnesium (0.15%) and zinc (9.4 ppm) were found in Flores while the lowest level of manganese (155 ppm) was found in Paysandú. No significant differences were found between the different regions for th parameters studied.

Flores, Antonio, Jorge R. Flores, René Pérez, Marco T. Cabezas, Ricardo Bressani and Lee R. McDowell. 1979. Estado de nutrición mineral del ganado de carne de la costa sur de Guatemala. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-41.

Abstract

Se seleccionaron 5 fincas de la costa del Pacífico de Guatemala, dedicadas a la explotación extensiva de ganado de carne bajo sistemas de rotación de pasto estrella de 30 días e irregular suplementación mineral. En 2 épocas del año (lluviosa, I; seca, V) se tomaron un total de 70 muestras de pasto, 60 de hígado y 270 de sangre de un número representativo de los potreros y animales existentes en cada finca. Se encontró que los contenidos de Ca, Na y Zn en la materia seca de los pastos era mayor ($P < 0.05$) en V (5.5 y 3.3,; 33 mg kg^{-1}) que en I (3.3 y 0.2 g; 27 mg kg^{-1}); mientras que el Fe fue menor en V (174 mg kg^{-1}) que en I (233 mg kg^{-1}). El resto de elementos no varió con la época del año, promediando 1.8 g P; 2.7 g Mg; 15.2 g K; 92 mg Mn y 4 mg Cu kg 1. El 94, 90, 66, 56 y 16% de los pastos analizados en I eran insuficientes en Na, Cu, P, Zn y Mg; mientras que en V el 94, 75, 72, 41 y 34% lo eran en Cu, Mg, P, Na y Zn, respectivamente. El P sérico fue afectado ($P < 0.05$) por la época (I, 68 y V, 75 g ml^{-1}) y la edad de los animales (jóvenes, 80 y adultos, 64 µg ml^{-1}), el Mg lo fue ($P < 0.05$) por la época (I, 31 y V, 23 µg ml^{-1}) y el Ca no dependió de ninguno de los dos factores (100 µg ml^{-1}). La época tampoco tuvo efecto sobre los niveles hepáticos de Fe, Cu y Mn, promediando 325, 12 y 143 g g^{-1}, respectivamente. A pesar de los promedios óptimos encontrados, se presentaron problemas deficitarios de Mg en V, de P en I y de Cu en ambas estaciones, concluyéndose que existe carencia de P, Mg, Na, Cu y Zn en los pastos de la zona y que éstos no son corregidos adecuadamente por las mezclas minerales actualmente en uso.

Franco, Luisa E. and José A. Velásquez. 1979. Suplementación mineral en el engorde de corderos. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-61.

Se realizó el presente trabajo con la finalidad de medir el efecto de la suplementación mineral a base de calcio, fósforo, sal común, cobre y cobalto en el engorde de corderos estabulados mediante los cambios de peso, consumo de alimentos, conversión alimenticia y concentraciones de minerales en la sangre. Se utilizaron 50 corderos mestizos West-African. Los tratamientos estudiados fueron: tratamiento I (ración de engorde), tratamiento II (ración + calcio + fósforo + sal común), tratamiento III (ración + calcio + fósforo + cobre + cobalto), tratamiento IV (ración + cálcio + fósforo + cobalto) y tratamiento V (ración + calcio + fósforo + cobre). La duración de la fase experimental fue de 12 semanas. Las diferencias entre las medidas de los tratamientos se determinaron por análisis de varianza. El consumo de alimento (g), aumento diario de peso (g) y conversión alimenticia (kg de alimento/kg de aumento), para los cinco tratamientos fueron los siguientes: 1 020, 1 015, 980, 990 y 985; 88, 86, 90, 69 y 82; 11.5, 11.8, 10.7, 14.3 y 12.0, respectivamente. Se encontraron diferencias estadísticas significativas ($P < 0.5$) en cuanto a consumo de alimentos y conversión alimenticia entre los tratamientos, resultando mayor el III con respecto a los demás; no se encontraron diferencias estadísticas significativas para la variable aumento de peso. Las concentraciones de los minerales en el plasma sanguíneo (mg/100 ml) al inicio y al final del ensayo para los cinco tratamientos resultaron ser para calcio: 10.5 y 12.8; 11.6 y 12.9; 11.1 y 12.9; 11.4 y 12.9; 12.40 y 12.70; para fósforo: 7.6 y 6.5; 7.6 y 8.6; 5.2 y 9.1; 5.6 y 8.5; 5.4 y 8.3; para magnesio: 3.0 y 2.9; 2.7 y 2.8; 2.3 y 2.7; 2.7 y 2.8; 2.8 y 3.40; para cobre: 0.095 y 0.090; 0.093 y 0.100; 0.088 y 0.120; 0.110 y 0.120; 0.110 y 0.90, respectivamente. En general los niveles de minerales en la sangre se incrementaron con la suplementación mineral.

García Avila, David Arturo. 1978. Suplementación de fosfato monosódico-cama de pollo a vaquillas en pastoreo de vegetación nativa en Gral. Cepeda, Coahuila (Mayo-Julio 1978). II. Respuesta biológica. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Resumen

La presente investigación se realizó en el rancho "La Rosa", localizado en General Cepeda, Coahuila, sobre la Carretera Saltillo-Torreón, Kilómetro 43.

El objetivo de esta investigación fue la de evaluar diferentes mezclas minerales por medio del peso vivo y la concentración de calcio y fósforo en el suero sanguíneo. La duración del experimento duró 84 días (inició 6 de Mayo, terminó 29 Julio 78), se utilizaron 27 vaquillas cruzadas con Cebú las cuales se sometieron a un manejo uniforme para su salud e higiene. Además se recolectó sangre a un 20% de la población, para determinación de calcio y fósforo encontrándose deficientes en fósforo.

En base a los resultados obtenidos se dispuso a hacer la mezcla mineral a la cual se adicionó a dos camas de pollo para proporcionar proteína y energía. Los animales se distribuyeron completamente al azar y se formaron 3 tratamientos.

Las mezclas minerales fueron las siguientes:

	Tratamiento I	Tratamiento II	Tratamiento III
Cama de Pollo (Zacate Buffel)	0	25	50
Sal Microminerales (VYMCO)	1*	0	0
Sal Común	57.33	34.37	10.41
Fosfato Monosódico	42.67	40.63	39.59

Los datos que se recolectaron para la evaluación de las mezclas minerales fueron:

1. - Peso
   a) Peso inicial individual.
   b) Peso cada 28 días (individual).
   c) Peso individual final.
2. - Consumo promedio de las mezclas.
3. - a) Nivel inicial de calcio y fósforo en el suero sanguíneo.
   b) Nivel final al calcio y fósforo en el suero sanguíneo.

El análisis estadístico empleado análisis de covarianza para ajustes de peso y diferencia mínima significativa (D.M.S.) para los aumentos de peso, y para los niveles finales de calcio y fósforo en el suero sanguíneo, se hicieron mediante análisis de varianza y posteriormente por prueba de Duncan.

*Mn, I, Co, Fe, Cu, Zn.

Los aumentos de peso fueron iguales para los tres tratamientos, no encontrándose diferencia significativa. Siendo los aumentos de peso, promedio gr/animal/día 211.00; 93.00; 227.00 para los tratamientos I, II y III respectivamente.

Para el consumo de fósforo promedio por animal por día los animales del Tratamiento III en comparación que los Tratamientos II y I debido a que estos últimos contenían mayor cantidad de sal la cual limitaba el consumo.

Las cantidades encontradas de fósforo final en el suero sanguíneo, fueron no significativas. (Análisis de Varianza y Duncan) pero se veía que había una ligera deficiencia en los Tratamientos II y III, mientras que el Tratamiento I era normal. Y esto se debía a la cantidad de cama de pollo encontrada en los tratamientos II y III. La cual tiene una relación Ca:P 1.3:1.

Para los valores de calcio final encontrados los análisis mostraron que no había diferencia significativa o sea que estaban dentro de lo normal. Pero se ve que el Tratamiento I y II tienen menos calcio comparado con el calcio inicial y es debido a la cantidad mayor en cama de pollo en el Tratamiento III.

La relación Calcio-Fósforo se encontraron rangos dentro de lo normal. Pero se ve que la relación era más estrecha en el Tratamiento I y se debía a que no contenía cama de pollo en su ración.

En el consumo de suplemento promedio por animal por día el Tratamiento III consumió más comparado con los Tratamientos II y I y se debía al contenido de sal en las raciones ofrecidas.

Conclusiones

Bajo las condiciones en que se llevó el experimento se concluye lo siguiente:

1. - La suplementación fosfórica a animales en pastoreo es económicamente redituable.
2. - Las mezclas de fósforo ofrecidas cumplieron con los requerimientos de fósforo.

Gomez Rosas, Hernan. 1977. Evaluación del estado mineral del ganado y los pastos en los distritos de Florencia y Cutris del canton de San Carlos durante el verano. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo evaluó el estado mineral de los distritos Florencia y Cutris del Cantón de San Carlos de la provincia de Alajuela.

El material de trabajo de este estudio consistió de 75 muestras de sangre, 22 de hígado y 57 de pasto, obtenidas de 15 fincas de la zona. En el suero sanguíneo se analizaron, los minerales calcio, fósforo y magnesio; en el hígado, hierro, cobre, manganeso y zinc; en el pasto, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso, zinc y proteina.

El promedio de calcio, fósforo y magnesio en el suelo sanguíneo en los animales de la zona fue de 8.07, 4.65 y 2.66 mg/100 cc de suero respectivamente. Solo se encontraron variaciones estadísticas ($P< 0.05$) del magnesio - por fincas.

En cuanto a los minerales en el hígado se obtuvo un promedio de 206, 85, 5 y 90 ppm para el hierro, cobre, manganeso y zinc respectivamente.

En los pastos se obtuvieron promedios de 10.22% para proteína, 0.22% para calcio, 0.10% para fósforo, 0.23% para magnesio, 2.40% para potasio, 213 ppm para hierro, 7 ppm para cobre, 117 ppm para manganeso y 28 ppm para zinc. Se encontraron variaciones estadísticas ($P<0.05$) de proteína por distrito y por especie de pasto, de fósforo y el magnesio por especie de pasto, de potasio por distrito y por especie y de cobre por especie de pasto.

Guardado Almaguer, Rafael Eduardo. 1977. Determinación de deficiencias y toxicidades minerales del ganado bovino en pastoreo en el estado de Nuevo León, Dr. Gonzalez, N. L. (Invierno). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que llevó a cabo este trabajo y de acuerdo con los resultados obtenidos se puede concluir lo siguiente:

1. Existe deficiencia de fósforo en la zona, ya que los valores de éste se presentaron bajos en el suelo, forrajes y suero sanguíneo.

2. Los niveles inadecuados de calcio en el suero, forrajes y suelo interactúan con los elementos fósforo y magnesio.

3. Existe una deficiencia de cobre en el suero sanguíneo, posiblemente debido a la interacción del molibdeno, sulfitos y sulfatos que actúan reduciendo su absorción.

4. El suero sanguíneo presentó valores altos de calcio, normales en potasio, sodio, hierro y manganeso, y bajos en fósforo y cobre.

5. En el forraje existen niveles altos en calcio, manganeso, potasio, hierro, magnesio y zinc, valores bajos en cobre, fósforo y sodio.

6. Se encontró una diferencia significativa ($P < 5\%$) entre ranchos con respecto al contenido de manganeso en los pastos.

Guzman Montero, Alvaro Edgardo. 1980. Evaluación del estado mineral en bovinos y forrajes de la Provincia de Cártago durante la época lluviosa. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

En la presente investigación se evaluó el estado mineral de bovinos y forrajes de los cantones Central, Paraíso, Oreamuno, Alvarado y Turrialba de la provincia de Cártago, durante la época lluviosa (Julio-Diciembre 1977).

En la zona estudiada se obtuvieron los siguientes valores promedios para los minerales analizados en el sueron sanguíneo: 10.20 mg de calcio/ 100 ml., 4.97 mg. de fósforo/100 ml. y 2.27 mg. de magnesio/100 ml. de suero. En los análisis de varianza se obtuvieron diferencias significativas ($P<0.05$) para el fósforo en las variables cantón y finca; y para el magnesio en la variable finca. Unicamente en el cantón de Paraíso se encontraron niveles subnormales de calcio y fósforo en el suero sanguíneo.

Los promedios encontrados para los elementos analizados en los forrajes experesados en base seca son: 0.22% de calcio, 0.18% de fósforo, 0.18% de magnesio, 2.45% de potasio, 322 ppm. de hierro, 29 ppm de zinc, 11 ppm. de cobre, 78 ppm de manganeso y 17.45% de proteína cruda. Se encontraron las siguientes diferencias significativas ($P<0.05$) en los análisis de varianza: las variables proteína cruda y cobre difirieron significativamente entre los cantones, el magnesio entre distritos, el hierro entre edades y cantones y el manganeso entre especies de forrajes.

Los niveles de calcio, fósforo y zinc son deficientes en todos los cantones y la concentración de cobre es deficiente en los cantones de Turrialba y Paraíso, en este último cantón se encontraron los niveles más bajos de proteína cruda. El manganeso se encontró en niveles excesivos para la alimentación de rumiantes en los cantones de Paraiso, Turrialba y Alvarado.

Los promedios para los elementos estudiados en el tejido hepático fueron: 253 ppm de hierro, 259 ppm de zinc, 247 ppm de cobre y 8 ppm de manganesio en base seca. Estos datos no fueron analizados estadísticamente por el reducido número de muestras.

La información generada también se analizó estadísticamente, somotiendose a los análisis de STEPWISE, MAX R^2 e interrelaciones.

Title: Mineral and Protein Supplementation of Grazing Steers in Uruguay

Authors: Alvaro Gomez Haedo and Julio Amorin, Thesis for Ing. Agr.

Place: Experimental Farm Banado de Medina, Cerro Largo, Kl 28, National Road 26, Agronomy Faculty, University of the Republic of Uruguay 1982.

Soils: Y aguari, considered good fertile soils.

Pastures: Native pastures consisting primarily of Paspalum dilatatum, adesmia bicolor, Paspalum quadrifarium, Cenchrus pauciflorus and Pitocheatum stipoides.

Chemical analyses were made at the Rubino Veterinary Research Laboratory, Pando. Animals were Angus, Herefords and crossbreds, initial weight 211-216 kg.

SUMMARY

Durante el período considerado como invierno (25.6 - 15.10.80) todos los animales perdieron peso. Los que recibieron el SPEM (blocks containing CP 30%, Ca 1.5%, P 1.0%, Shell Uruguay, Ltd.) promediaron perdidas diarias de 27 grs. los testigo 188 grs. y los que recibieron el SM (mineral mixture containing Ca 16%, P 7.9% and trace minerals, p. 73) 94 grs. Existieron diferencias significativas entre los tres tratamientos (P<0,05).

Durante la segunda rotación (15.10.80 - 7.1.81) las máximas ganancias fueron realizadas por los animales que recibieron el SM (875 grs/día), siendo éstas significativamente mayores que las de los animales testigo (798 grs/día) y de los que recibieron el suplemento SPEM (720 grs/día). (P<0,05).

Para el verano (7.1.81 - 1.4.81), las ganancias diarias de los tres lotes no presentaron diferencias estadísticamente significativas (P<0,05), siendo éstas de 577 grs para animales que recibieron el SPEM, de 512 grs para los testigo y de 552 grs para los que recibieron el SM.

Los contenidos de proteína en pastura no registraron diferencias significativas entre invierno (11,82%) y primavera (11,69%). Ambos fueron significativamente superiores (P<0,05) que el valor del verano (8,75%).

Respecto al contenido de fósforo en pasturas se registraron diferencias significativas (P<0,05) entre los valores de invierno (0,20%), primavera (0,19%) y verano (0,15%).

Hubieron diferencias significativas (P<0,05) entre las tres estaciones en cuanto a los tenores de calcio en pastoras. Los valores fueron de 0,76; 0,62 y 0,52% para primavera, invierno y verano respectivamente.

Los contenidos de magnesio en pasturas se hacen mínimos en invierno (0,17%), intermedios en primavera (0,20%) y máximos en verano (0,23%). Existieron diferencias significativas entre las tres estaciones. (P<0,05).

Los valores de cobre en pasturas mostraron su máximo en primavera (6,55 ppm), siendo este valor significativamente mayor que los de invierno (5,86 ppm) y verano (6,00 ppm). (P<0,05).

Los contenidos de zinc en pasturas de invierno (29,34 ppm) fueron significativamente mayores que los valores de primavera, (24,99 ppm) y de verano (24,30 ppm).

Los registros de manganeso en pasturas no presentaron diferencias significativas entre estaciones. Siendo los valores de 307 ppm para invierno, 312 ppm para primavera y 279 ppm para verano.

En invierno los valores de cobre en hígado fueron significativamente mayores para los animales que recibieron el SM (145,39) que para los que recibieron el SPEM (110,98 ppm) y los animales testigo (113,05 ppm). (P<0,05).

En primavera, fueron los animales que recibieron el SPEM los que tuvieron las menores cantidades de cobre en hígado (98,16 ppm), siendo significativamente menores que los de animales testigo (113,43 ppm) y de los que recibieron el SM (101,84 ppm).

En el verano son nuevamente los animales que recibieron el SPEM los que presentan los menores valores de cobre en sus hígados (147,09 ppm) y presentan diferencicas significativas con los valores de los testigo (184,53 ppm) y los que recibieron el SM (182,77 ppm).

En invierno las cantidades de zinc en hígado se hacen máximas para los animales que recibieron el SM (78,49 ppm), intermedias para los testigos y mínimas para los animales que recibieron el SPEM (66,82 ppm). Existieron diferencias entre ambos grupos suplementados (P<0,05).

La cantidad de zinc en hígado encontrada en primavera para el grupo que recibió el SPEM (76,69 ppm) fue significativamente mayor (P<0,05) que la de los testigos (67,31 ppm) y la de los animales que recibieron el SM (67,80 ppm).

En verano nuevamente el SPEM registró los mayores niveles de zinc en hígado (71,14 ppm), situándose en valor intermedio los testigo (65,79 ppm) y mínimo para los que recibieron el SM (59,47 ppm). Existieron diferencias significativas (P<0,05) entre ambos grupos de animales suplementados.

Los registros de fósforo en suero sanguíneo fueron de 7,71 mg/100 ml en invierno, 7,71 mg/100 ml en primavera y 5,40 mg/100 ml en verano. Existieron diferencias significativas entre los valores obtenidos en las dos primeras estaciones y el verano.

Los valores de fósforo en suero para los distintos tratamientos y considerando todo el período en estudio fueron de 7,07 mg/100 ml para animales que recibieron el SPEM, 6,71 mg/100 ml para los testigo y 7,04 mg/100 ml para aquellos que recibieron el SM. No hubieron diferencias significativas entre ellos.

En cuanto a calcio en suero sanguíneo, los registros fueron de 9,05 mg/100 ml; 10,03 mg/100 ml; 10,06 mg/100 ml para invierno, primavera y verano respectivamente. Considerando todo el período en estudio los valores de los animales que recibieron el SM fueron significativamente menores que los de los otros dos grupos (P<0,05).

Los máximos registros de magnesio, cobre y zinc en suero sanguíneo se dieron en primavera. A la vez no se registraron diferencias significativas entre tratamientos para todo el período en estudio. (25.6.80 - 1.4.81).

Huertas, Hugoberto, M. A. Laredo, J. E. Manzur, E. Ceballos. 1979 . Effect of supplementation of Cu, P and Ca on grazing beef cattle. Contribución del Programa Nacional de Nutrición Animal y del Programa de Ganado de Carne, Turipaná, de Ciencias Animales -CNIA, Tibaitatá. Bogotá, Colombia.

Summary

This experiment was carried out at Turipaná experimental station (Cordoba) using Brachiaria mutica.

During the trial samples were taken of forages, serum and biopsy of liver. Animals were weighed at 28 day intervals.

The content of minerals during the trial showed a little difference between the first and last period of sampling. The Ca, P and Mg decreased towards the final period in serum and Mn in liver. However, the Cu and Zn increased in serum with values for the number 3 and 2 salt respectively. The Fe and Zn content increased in liver, but the Cu content in the liver and the final was low for first and third treatment, and higher for the second treatment. The mineral content in forages, serum and liver could be good indicators of the nutritional status of the grazing animals.

Differences in weight gain although not significant was found between treatments (142, 137, and 127 kg for treatments 3, 2 and commercial mineral mixture respectively). The unit cost of the mineral salts number 2 and 3 mixture was only 64.4 and 34.0% of that of the commercial mineral mixture.

The use of mineral mixture including only the deficient mineral elements in the forage can induce similar weight gain to those induced by commercial salts, but at a lower cost.

Hutagalung, R. I., P. Y. Hew, T. A. Bongso, M. R. Jainudeen and Syed Jalaludin. 1981. Mineral Status of Grazing Farm Animals in Malaysia. Fourth International Symposium on Trace Element Metabolism in Man and Animals (TEMA-4), Programme and Abstracts, Perth, Western Australia, p. 31.

Low ruminant productivity in the humid tropics is due to many limitations, the most apparent being the low feed intake and poor nutrition, which consequently result in poor growth and reproductive rates. Phosphorus, cobalt and copper are among the minerals which have been shown to be the most limiting in grazing animals in Malaysia. Mineral composition of various soils, grasses, animal tissues and mineral supplements is presented. Several experiments have been undertaken in grazing animals, to study the effects of mineral and concentrate supplementation on productive and reproductive performances, including tissue minerals, rate of growth/gains, conception rate, calving percentage, birth and weaning weights and calving intervals. The results of these experiments of which some are underway, are highlighted. Significant improvement in rate of growth/gains, calving percentage, birth and weaning weights has been observed in grazing animals supplemented with minerals and concentrates.

Abstract of Thesis Presented to the Graduate Council
of the University of Florida in Partial Fulfillment of the
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MINERAL STATUS OF BEEF CATTLE
IN EASTERN DOMINICAN REPUBLIC

By

Maximo Jerez Gomez

May 1982

Chairman: Dr. Lee R. McDowell
Major Department: Animal Science

An experiment was designed to determine the mineral status of soil, plants and grazing beef cattle in 7 ranches consisting of Romana Red, Criollo and Brahman breeds in the eastern region of the Dominican Republic during the dry season. Twelve to 24 liver (biopsy) and serum samples were collected from mature (3-10 years) cattle.

Regional differences ($P < .05$) were found only for liver Co which was higher in region 3. Differences ($P < .05$) among farms within regions were found for serum Ca, P, Cu, Se ($P < .01$) and Mg ($P < .05$), and for liver Mg, Fe, Cu, Mn ($P < .01$) and Zn ($P < .05$). No significant ($P < .05$) correlations were found between those minerals analyzed in both liver and serum (Mg, Zn and Cu).

The percentages of mean serum Ca (< 8 mg/100 ml), P (< 4.5 mg/100 ml), Mg (< 2 mg/100 ml), Zn (< .4 μg/ml), Cu (< .65 μg/ml), Se (< .03 μg/ml); and liver Fe (< 180 ppm), Zn (< 84 ppm) Cu (< 75 ppm), Mn (< 6 ppm), Co (< .05 ppm),

Se (< .1 ppm) that were low to borderline to deficient were 30, 95, 19, 97, 100, 4; and 8, 4, 25, 2, 0, 0% of the total animals, respectively.

Eight to 14 forage samples were collected per ranch. No regional difference ($P < .05$) was found. However, differences among farms within regions were found for P, Na, Ca ($P < .01$), and for Mg and Mo ($P < .05$). Forage correlation coefficients ($P < .05$) above ±.5 were noted for P-K (r=.52), P-protein (r-.56), K-Cu (r=.54), K-protein (r=.58), Mg-Cu (r=.52), Mg-N.D.F. (r= -.59), Zn-protein (r-.52), Zn-N.D.F. (r= -.51) and Cu-N.D.F. (r= -.71).

Mean forage analyses (and the percentage of samples low or borderline to deficient) were as follows: Protein, 7.0% (50); Ca, 0.48% (24); P, 0.17% (83); K, 1.91% (0); Na, 0.07% (78); Mg, 0.26% (33); Fe, 154 ppm (0); Zn, 22 ppm (86); Cu, 9 ppm (64); Mn, 151 ppm (10); Co, 0.16 ppm (26); Mo, 0.31 ppm (0); and Se, 0.12 ppm (48).

The percentages of mean soil Ca (< 71 ppm), P (< 5 ppm), K (< 30 ppm), Mg (< 9.1 ppm), Fe (< 4.5 ppm), Zn (< 6 ppm), Cu (< 1 ppm), Mn (< 5 ppm), and Co (< 11 ppm) that were low to borderline to deficient were 0, 96, 0, 0, 65, 85, 54, 0 and 12% of the 26 total soil samples, respectively.

Lee R. McDowell

Chairman

Jerez, Máximo, L. R. McDowell, W. A. Hargus, J. H. Conrad and G. L. Ellis. 1982. Mineral status of cattle in the eastern region of the Dominican Republic. J. Anim. Sci. Abstracts 1982 (Submitted for regional Animal Science meetings).

Abstract

An experiment was designed to determine the mineral status of 7 grazing beef cattle ranches with crosses of Romana Red, Criollo and Brahman in the eastern region of the Dominican Republic during the dry season. From 4 ranches, 12 liver (biopsy) and plasma samples were collected from both young (12-24 months) and mature (3-10 years) cattle. Only mature animals were sampled from 3 additional ranches. Eight to 14 forage samples were collected per ranch. The following minerals were analyzed: liver (Cu, Zn, Fe, Mn, Co, Mg and Se) and plasma (Ca, P, Mg, Cu, Zn, Fe and Se). Significant mineral concentration differences ($P < .05$) among regions, ranches and classes of animals were found. Of the total liver samples analyzed, 22, 7, 9, 3 and 5% were borderline to deficient in Cu (<75 ppm), Zn (<84 ppm), Fe (<180 ppm), Mn (<6 ppm) and Co (<.07 ppm), respectively. Copper Zn, Fe, Mn and Co were borderline to deficient in 6, 3, 4, 2 and 2 ranches, respectively. Plasma Ca, P, Mg, Cu and Zn were borderline to deficient in 5, 2, 3, 6 and 0 ranches, respectively. The percentages of total forages borderline to deficient for Ca (<.30%), Mn (<30 ppm), Mg (<.20%), Na (<.06%), P (<.25%), Cu (<10 ppm), Co (<.10 ppm), Zn (<30 ppm), and protein (<7%) were found as 26, 10, 33, 77, 13, 61, 30, 86, and 47, respectively.

Kalinowski, Juan, Alfredo Postigo, Victor Talavera and Miguel Vallejos. 1979. Efecto de la suplementación mineral sobre la respuesta reproductiva de ovejas al pastoreo en pastizales naturales altoandinos. V Reunión Asociación Latinoamericana de Producción Animal, R-59.

Abstract

En la Sierra Central del Perú, en pastizales a 3 900 m de altitud, clasificadas como Páramo muy húmedo subalpino, se estudió la respuesta a la suplementación mineral de ovejas en pastoreo. El ensayo se inició en octubre de 1976 y concluyó en enero de 1978. Tres majadas, con 911, 895 y 890 ovejas Corriedale de 11 meses de edad cada una, fueron distribuidas al azar en 3 áreas de pastoreo de condición regular, con predominancia de gramíneas nativas de bajo valor nutritivo, con una carga de 1 ovino por ha/año. Los tratamientos fueron: sal más yodo, cobre y cobalto (A); A más hierro y zinc (B); B más fósforo (C). Para el registro de peso fueron identificadas 50 ovejas en cada majada, con un peso inicial promedio de 26 kg; para la evaluación reproductiva se consideró la majada completa. Después de 12 meses bajo los tratamientos se encontró diferencias estadísticamente significativas en las ganancias diarias de las ovejas siendo éstas (g/día): 34.4 (A), 39.4 (B) y 41.3 (C). Al finalizar la parición se encontró diferencias estadísticamente significativas en los porcentajes de natalidad y en el peso al quinto día de los corderos, siendo éstos: 77.7 (A), 86.0 (B), 84.6% (C) y 3.15 (A), 4.4 (B) y 4.6 kg (C), respectivamente. Los resultados indican que limitaciones en la ingestión de zinc y fósforo, principalmente, restringen la productividad del ganado ovino de la región, no descartándose la posibilidad de otros problemas minerales.

Kiatoko, M., L. R. McDowell, J. E. Bertrand, H. L. Chapman, F. M. Pate, and J. H. Conrad. 1979. Co, Mn, Zn, Se, Vitamin E, Vitamin A and carotene interrelationships between forage and animal tissues. University of Florida, Gainesville, Florida.

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 ($P<.05$) in cows than in heifers while liver vitamin A was 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 (<20ppm) 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 (<6.0ppm) concentrations.

Kiatoko, M., L. R. McDowell, J. R. Bertrand, H. L. Chapman, F. M. Pate, F. G. Martin, and J. H. Conrad. 1981. Evaluating the nutritional status of beef cattle herds from four soil order regions of Florida. I. Macroelements, protein, carotene, vitamins A and E, hemoglobin and hematocrit. University of Florida, Gainesville, Florida Agr. Exp. Sta. Journal.

Summary

The nutrient status of grazing beef cattle from four selected soil order regions of Florida was examined. Liver, blood, hair and feces samples from 14 heifers and 14 cows, plus forage samples, were collected during two periods of the year from nine ranches located in four different regions. Soil samples were collected during one period. The soil order regions were the Histosol (Southeast), Spodosol (Southwest), Entisol (Central) and Ultisol (Northwest). Mean forage P values were higher ($P < .05$) in the wet season, while mean hair P levels were higher ($P < .05$) during the dry season. Mean forage, plasma, liver and hair Mg values were higher ($P < .05$) in the wet season. Plasma vitamin E, liver vitamin A and forage carotene levels were higher ($P < .05$) during the wet season. Mean forage P content was deficient (<.25%) during both seasons and varied from .10% in the dry season to .16% during the wet season. Mean forage Mg (<.18%) and K (<.60%) concentrations were deficient in the dry season. Forage protein was deficient (<7.0%) in five of seven ranches during the dry season. Extractable soil Ca exchangeable soil Ca, Mn, Al, H, soil organic matter and effective cation exchange capacity were higher ($P < .05$) in the Histosol region. Extractable soil K was low (<60 ppm) in all regions, except the northwest. Forage P was critical (<.25%) during the dry season in all regions and varied from .08 to .15%, while plasma P was deficient (<4.5 mg%) in animals from the southeast during the dry season only.

Laredo C., Max Alberto. 1979. Informe de progreso 1979 programa de nutrición animal. Subgerencia de investigación, Division de Ciencias Animales, programa de nutrición animal. Research report. Ministerio de Agricultura, Instituto Colombiano Agropecuario, Bogotá, Colombia.

Resumen

Una serie de experimentos fueron designados y conducidos para determinar la localización de deficiencias y toxicidades minerales y los beneficios de suplementación mineral. Los títulos de los diferentes proyectos son los siguientes:

Proyecto 1. Deficiencias y toxicidades de minerales de ganado en Colombia.

Experimento 1.1 Efecto de la suplementación de Úrea y ácido fosfórico en la utilización de forrajes. Carimagua.

Experimento 1.2 Efecto de cobre, fósforo y calcio en ganancia de peso en ganado de carne. Turipaná.

Experimento 1.3 Efecto de la suplementación de nitrógeno y fósforo sobre ganancia de peso de bovinos. La Libertad.

Experimento 1.4 Efecto del cobre, zinc y ácido fosfórico en la ganancia de peso. El Nus.

Experimento 1.5 Efecto del calcio, fósforo y cobre en ganancia de peso con ganado para carne. Macagual.

Experimento 1.6 Efecto de la suplementación de fósforo y cobre sobre la ganancia de peso del ganado vacuno. Fondo Ganadero del Tolima.

Experimento 1.7 Efecto de la suplementación de cobre y zinc en los aumentos de producción de leche. Obonuco.

Experimento 1.8 Deficiencias y toxicidades de minerales para bovinos en el Valle del Cauca.

Experimento 1.9 Deficiencias y toxicidades de minerales en las Zonas del Tolima y Cundinamarca.

Laredo, Max Alberto, Juvenal López. 1981. Fluctuaciones Minerales en Pastos Tropicales. I. Braquiaria en los Llanos Orientales. Contribución del Programa Nacional de Nutrición Animal del Instituto Colombiano Agropecuario - ICA, Tibaitatá. Bogotá, Colombia.

Resumen

Se determinó el contenido de proteína y elementos minerales en pasto Braquiaria de muestras tomadas semanalmente durante un año, de 4 praderas bajo pastoreo contínuo con una carga de 2.4 animales por hectárea, en la Estación Experimental La Libertad, Meta.

Se encontró que el pasto Braquiaria puede suministrar hierro, magnesio y manganeso en cantidades suficentes, para llenar las necesidades de los animales en pastoreo y que sólo el nitrógeno, fósforo, cobre, magnesio y zinc están en niveles sub-normales o deficitarios.

Las variaciones estacionales muestran una tendencia a incrementar los valores en la época de sequía, pero no significativas, manteniéndose constantes durante el año sólo el fósforo y magnesio. Los niveles de hierro y manganeso se presentan demasiado altos como para constituír problemas por deficiencias, aunque lo podrían ser por exceso. Estos elementos fueron significativamente más altos en verano. El bajo contenido de minerales encontrados en invierno concuerda con lo registrado en la literatura, de que el aumento de follaje verde de los forrajes, produce la disminución en el contenido de minerales. Este hecho se complica cuando los animales incrementan el consumo de forraje y las necesidades de minerales. Lo hallado sugiere garantizar la suplementación de sal mineral, principalmente en época de lluvia.

Laredo, M. A., A. C. Matiz. 1982 . Estado de nutrición mineral en hatos lecheros de la sabana de Bogotá. Contribución del Programa Nacional de Nutrición Animal - División de Ciencias Animales - ONIA - Tibaitatá. Bogotá, Colombia.

Resumen

Se realizó un trabajo de muestreo en 14 fincas lecheras en la Sabana de Bogotá. El estudio comprendió la recolección de muestras de suelo, forraje sangre e hígado.

Se realizaron análisis para conocer el estado nutricional mineral en las anteriores muestras.

De esos análisis se encontró que solo el fósforo, cobre y zinc presentan valores sub-normales y deficitarios.

El consumo de los forrajes y sales minerales comerciales no son suficientes para garantizar el suministro de fósforo, cobre y zinc para ganado en producción de leche.

Lau... Sanabria, Juan Carlos. 1979. Evaluación del estado mineral del ganado bovino en [illegible] en los distritos de Pejibaye. San Isidro y Rivas del Cantón [illegible] Isidro de Pérez Zeledón [illegible] de San José durante la [illegible] lluviosa. Tésis. Universid[illegible] Rica, Facultad de Agronomía, Escuela Zootecnia, San José Costa Rica.

Resumen

El presente estudio evaluó el estado mineral de los forrajes y bovinos en los distritos de Pejibaye, San Isidro y Rivas del Cantón de San Isidro de Pérez Zeledón de la provincia de San José.

El material de la investigación consistió de 55 muestras de sangre, 14 muestras de hígado y 53 muestras de pasto, obtenidas de varias fincas de la zona en estudio, la recolección de las muestras se inició en julio terminándose en el mes de septiembre de 1977.

Los promedios de calcio, fósforo y magnesio en el suero sanguíneo en los animales fue de 11.44, 4.70 y 2.51 mg/100 ml de suero respectivamente, se encontró variación estadística ($P<0.05$) del calcio por distrito, mes y edad del animal; del fósforo por distrito y edad y el magnesio por distrito.

En cuanto a los minerales estudiados en el hígado se obtuvieron los promedios de 247, 284, 6 y 169 ppm para hierro, cobre, manganeso y zinc respectivamente.

En los pastos se obtuvieron promedios de 7.42% para la proteína cruda, 0.23% para el calcio, 0.13% para el fósforo, 0.14% para el magnesio, 1.17% para el potasio, 231 ppm para el hierro, 4.8 ppm para el cobre, 86 ppm para manganeso y 18 ppm para zinc; se encontraron diferencias significativas ($P<0.05$) del hierro por distrito, mes, especie; del calcio por distrito y especie; del fósforo por distrito y especie, del magnesio por distrito y especie; de la proteína por distrito y especie; del cobre por distrito y especie; del manganeso por distrito y del potasio por especie.

Las principales conclusiones del presente estudio son:

1. De los minerales analizados en el suero sanguíneo, únicamente el fósforo en el distrito de Rivas era deficiente.

2. De los minerales analizados en los pastos se encontró que el fósforo era deficiente en todos los distritos, el cobre lo fue en los distritos de Pejibaye y Rivas mientras el cobre fue deficiente únicamente en el distritos de Pejibaye.

3. Los análisis para proteína cruda en los forrajes nos indican que apenas se logran satisfacer los requerimientos mínimos en los distritos de Rivas y San Isidro, no así en Pejibaye.

Leal Villareal, José Luis. 1978. Evaluación del selenio y la peletización en la alimentación de pavos (Meleagris gallopavo L). Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

1. - El selenio dado en cantidad de 0.2 ppm en raciones para pavos en iniciación, tuvo una disminución en el consumo de alimento, como una mejora en la eficiencia de conversión alimenticia, y no afectó el peso de los animales.

2. - En lo que se refiere al aumento total con diferentes dosis de alimento en base a la suplementación de selenio a 0.0 ppm y 0.2 ppm de selenio y tipo de alimento en forma de harina y Peletizado no hubo diferencia ya que los cuatro tratamientos se comportaron semejantes.

3. - Con respecto a la peletización del alimento, éste no mejoró los consumos de alimento, ni los aumentos de peso de los pavipollos cuando se comparó con una dieta harinosa.

Lizarzaburu Ahumada, Br. Pedro Luis. 1979. Estudio del Contenido de Calcio, Fósforo, Magnesio, y Cobre en Suero Sanguíneo de Vacunos en Reproducción. Thesis. Universidad Nacional "Pedro Ruiz Gallo", Lambayeque, Perú. 75 pp.

Resumen

El presente trabajo se llevó a cabo en los establos de la Universidad Nacional Pedro Ruíz Gallo y Plantel y Centro de Recría de Lambayeque, ambos ubicados en el Departamento de Lambayeque.

Los elementos minerales analizados en el suero y en los alimentos fueron Calcio, Fósforo, Magnesio y Cobre. Se utilizó animales en reproducción de acuerdo a épocas de muestreo (cada 45 días de gestación), razas (Holstein, Brown Swiss, Fleckvieh) y edades (jóvenes y adultos).

El diseño experimental empleado fue un completamente randomizado con arreglo factorial (razas, épocas y la interacción razas por épocas). Los análisis de variancia fueron complementados con la Prueba de Duncan, realizando además regresiones y correlaciones para los elementos estudiados.

Los valores promedios de Calcio, Fósforo y Magnesio de todas las épocas de muestreo fueron de 8.53, 6.15 y 2.81, respectivamente. El contenido promedio de Cobre fue de 0.18 g/ml. No se obtuvo diferencias significativas entre muestreos para ninguno de los minerales mencionados.

Entre las razas, el análisis de variancia solo mostró significación estadística para Fósforo y Cobre destacando la raza Fleckvieh en Fósforo y la Holstein en Cobre. Entre edades (animales jóvenes vs. adultos) tampoco se observaron diferencias significativas de los minerales analizados.

En las relaciones entre los elementos estudiados, se observaron ecuaciones de regresión cuadrática positivas y estadísticamente significativas entre Fósforo y épocas de muestreo de Brown Swiss; entre Fósforo y días de gestación, en vacunos de 7°, 8°, 9° partos en Brown Swiss; entre Calcio y días de gestación en vacunos de 1°, 2°, 3° partos en Fleckvieh; entre Calcio y días de gestación en vacunos de 7°, 8° y 9° partos en Brown Swiss; entre Magnesio y días de gestación en vacunos de 1°, 2° y 3° partos en Fleckvieh; entre Magnesio y días de gestación en vacunos de 4°, 5° y 6° partos en Holstein; entre Cobre y días de gestación en vacunos de 1°, 2°, 3° partos en Brown Swiss. Así mismo se encontraron ecuaciones cuadráticas negativas entre Magnesio y días de gestación en vacunos de 1°, 2°, 3° partos en Brown Swiss.

Se observaron ecuaciones de regresión cúbicas positivas y estadísticamente significativas entre Cobre y épocas de muestreo de Fleckvieh; entre Calcio y épocas de muestreo en Holstein; entre Magnesio y épocas de muestreo en Holstein. Así miso se encontró una ecuación de regresión cuadrática positiva entre Cobre y épocas de muestreo en Brown Swiss.

También se realizaron ecuaciones de regresión y correlación múltiple entre elementos minerales en el suero sanguíneo, épocas de muestreo y la edad (número de partos) en las razas Holstein, Brown Swiss y Fleckvieh.

Martínez López, Carlos Alberto. 1978. Determinación del contenido mineral en los pastos y sangre de bovinos en los cantones de Guácimo, Siguires, y Pococí. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

En América Latina el factor nutricional resulta ser el más determinante sobre la productividad ganadera afectando directamente la reproducción animal. En Costa Rica se han reportado deficiencias y desórdenes minerales especialmente carencias en fósforo y calcio en los pastos y sangre de los bovinos en pastoreo; así también como niveles deficientes poco claros de otros elementos en los pastos.

Este estudio se llevó a cabo en los cantones de Guácimo, Siquirres y Pococí, pertenecientes a la provincia de Limón, Costa Rica.

La época de muestreo comprendió desde Noviembre de 1976 hasta Abril de 1977 obteniéndose un total de 85 muestras de pasto y 125 muestras de sangre. A las primeras se les determinó el contenido de calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso, zinc y proteína cruda mientras que a las segundas se les determinó el nivel de calcio, fósforo y magnesio presente.

Los resultados mostraron que los animales existentes en los cantones en estudio no presentan deficiencias marcadas en calcio, fósforo y magnesio sanguíneo con valores promedios de 12.04, 7.24, y 3.02 mg por cada cien mililitros de suero, respectivamente.

Las muestras de pasto reportaron una clara deficiencia en su contenido de fósforo con un promedio de 0.107 por ciento de la materia seca.

Por otra parte no se encontraron deficiencias marcadas en los otros elementos con un 20 por ciento de deficiencia para la proteína cruda, un 41.18 por ciento para el calcio y 12.94 por ciento de muestras deficientes en cobre. Para el magnesio, potasio, hierro, manganeso y zinc no se obtuvo ninguna muestra deficiente en los que al contenido de cualquiera de estos minerales en el pasto se refiere.

De cinco muestras de hígado analizadas se encontró un contenido promedio de 1987 ppm de hierro, 151.4 ppm de cobre, 4.2 ppm de manganeso y 164.2 ppm de zinc en base seca.

McDowell, L. R., Bernardo Bauer, Enrique Galdo, Marvin Koger, J. K. Loosli, and J. H. Conrad. 1981. Mineral supplementation of beef cattle in the Bolivian tropics. Article. San Rafael Ranch, Beni, Bolivia. University of Florida, Gainesville, Florida.

Summary

A 338-day experiment was designed to determine the mineral status of grazing beef cattle in the Beni region of Bolivia. A total of 1766 steer and female 12-15 month old Zebu-Criollo crossbred cattle were assigned to 3 treatments: 1) control - no minerals (C); 2) common salt only (S); and 3) salt (60%) + bone phosphate (40%) (S + BP). Injections of Se-vitamin E, Cu, I and Co bullets were administered singly and in all possible combinations to 160 animals within each major treatment. Cattle receiving S + BP had higher (P<.001) gains of 96.4 vs 82.7 and 79.4 kg. for C and S treatments, respectively. There was a nonsignificant advantage for each trace mineral treated over nontreated groups. Males had greater (P<.001) gains of 88.8 vs 83.5kg for females. Analyses were made of nonfertilized, native forages, blood and liver (biopsy) samples taken during June (dry season) and November (wet season). The majority of soil (<5 ppm) and forage (<.25%P) analyses indicated inadequacy in relation to requirements. Forage Mg (<.20%), Na (<.06%), Cu (<10 ppm) and Zn (<30 ppm) concentrations were at deficient levels during both seasons while protein (<7.0%) and K (<.60%) were low only during the dry season. Forage Se was less than .1ppm in 33% of the samples in June. Three-fourths of liver samples were low in Cu, with tissue Zn and Mg concentrations generally reflecting low forage levels of these elements. On the basis of forage, liver and blood serum analyses, deficiencies of Ca, Fe, Co and Mn, or toxicity of Mo, are unlikely.

McDowell, L. R. and J. H. Conrad. 1980. La importancia de los minerales en la producción ganadera. Técnicas Modernas de Producción Animal en el Trópico. Memorias del Simposio EXPICA 80, Tegucigalpa, Honduras. pp. 35-66.

Resumen

En Latinoamérica, desbalances minerales son la mayor limitación en la producción de ganado. Frecuentemente el ganado en pastoreo no recibe suplementación mineral y depende grandemente de los forrajes para suplir sus requerimientos. En muy raras ocasiones, sin embargo, pueden los forrajes satisfacer completamente todos los requerimientos minerales. Niveles marginales a deficientes de ciertos elementos fueron encontrados en muchos forrajes en las Tablas de Composición de Alimentos para América Latina de 1974: Co, 43%; Cu, 47%; Mg, 35%; P, 73%; Na, 60%; and Zn, 75%. La deficiencia de calcio se sospecha o confirma en 11 países de América Latina, Mg en 14, P en 23, Na en 7, Co en 13 y Cu en 13 países. La deficiencia más esparcida es la de P. Diez reportes de Latinoamérica informan que ha habido un aumento dramático en el porcentaje de partos cuando el ganado es suplementado con P. Las áreas de deficiencias de Cu y Co también están muy extendidas. Las deficiencias minerales prevalecen durante la estación lluviosa.

La Universidad de la Florida con la asistencia de la Agencia para el Desarrollo Internacional está cooperando con instituciones de América Latina para iniciar y establecer una investigación mineral. En la actualidad, se están llevando a cabo experimentos en Bolivia, Brasil, Colombia, Costa Rica, Guatemala, Ecuador, El Salvador, Perú, Uruguay y Venezuela. La técnica de mapeo sistemático, basada en concentraciones en los forrajes y tejidos animales, puede ser usada para predecir dónde pueden ocurrir deficiencias y toxicidades minerales. Datos del Brasil indican que correlaciones positivas entre concentraciones minerales de suelo y forrajes en Mn, Cu, Fe, Mg,Na, Mo y Zn son muy bajas o inexistentes. Los esfuerzos para incrementar la productividad del ganado en los países tropicales no serán fructíferos a menos que el medio ambiente nutricional, incluyendo nutrición mineral adecuada, sea también mejorado. La suplementación mineral es la inversión de más bajo costo en el mejoramiento de la producción ganadera.

McDowell, L. R., J. H. Conrad and J. K. Loosli. 1980. Mineral Deficiencies and Toxicities for Grazing Ruminants in the Tropics. Proceedings First Seminar on Mineral Nutrition in Thailand, Bangkok, Thailand. pp. 34-68.

Summary

In tropical countries, 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%. The most widespread mineral deficiency for livestock is that of P. Twelve reports from tropical countries illustrate the dramatic increase in calving percentage when breeding cattle were supplemented with P. Copper and Co deficient areas are widespread in tropical countries. 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, Asian and African institutions to initiate and establish mineral research. A systematic mapping technique, based on animal tissue and forage concentrations, can be employed to predict where mineral deficiencies or toxicities will occur. Data from research in Brazil indicate that positive correlations among soil and forage mineral concentrations for Mg, Cu, Fe, Mn, Na, Mo and Zn were low or nonexistent. 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., J. H. Conrad and J. K. Loosli. 1980. Mineral Deficiencies and Toxicities for Grazing Ruminants in the Tropics. Proceedings of the International Workshop "Studies on Feeds and Feeding of Livestock and Poultry Feed Composition, Data Documentation and Feeding Systems in the APHCA Region, Manila, Philippines. pp. 174-187.

Summary

In tropical countries, 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 percent; Cu, 47 percent; Mg, 35 percent; P, 73 percent; Na, 60 percent; and Zn, 75 percent. The most widespread mineral deficiency for livestock is that of P. Twelve reports from tropical countries illustrate the dramatic increase in calving percentage when breeding cattle were supplemented with P. Copper and Co deficient areas are widespread in tropical countries. Mineral deficiencies are often more prevalent during the wet season.

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McDowell, Lee R., Joe H. Conrad and J. K. Loosli. 1981. Deficiencia de minerales en ganado en pastoreo de forrajes tropicales. Memorias del Seminario Producción y Utilización de Forrajes Tropicales, Colegio de Postgraduados, Institución de Enseñanza e Investigación en Ciencias Agrícolas, Chapingo, Mexico. pp. 16-47.

Sumario

En Latinoamérica, desbalances minerales son la mayor limitación en la producción de ganado. Frecuentemente el ganado en pastoreo no recibe suplementación mineral y depende grandemente de los forrajes para suplir sus requerimientos. En muy raras ocasiones, sin embargo, pueden los forrajes satisfacer completamente todos los requerimientos minerales. Niveles marginales a deficientes de ciertos elementos fueron encontrados en muchos forrajes en las Tablas de Composición de Alimentos para América Latina de 1974: Co, 43%; Cu, 47%; Mg, 35%; P, 73%; Na, 60%; and Zn, 75%. La deficiencia de calcio se sospecha o confirma en 11 países de América Latina, Mg en 14, P en 23, Na en 7, Co en 13 y Cu en 13 países. La deficiencia más esparcida es la de P. Diez reportes de Latinoamérica informan que ha habido un aumento dramático en el porcentaje de partos cuando el ganado es suplementado con P. Las áreas de deficiencias de Cu y Co también están muy extendidas. Las deficiencias minerales prevalecen durante la estación lluviosa.

La Universidad de la Florida con la asistencia de la Agencia para el Desarrollo Internacional está cooperando con instituciones de América Latina para iniciar y establecer una investigación mineral. En la actualidad, se están llevando a cabo experimentos en Bolivia, Brasil, Colombia, Costa Rica, Guatemala, Ecuador, El Salvador, Perú, Uruguay y Venezuela. La técnica de mapeo sistemático, basada en concentraciones en los forrajes y tejidos animales, puede ser usada para predecir dónde pueden ocurrir deficiencias y toxicidades minerales. Datos del Brasil indican que correlaciones positivas entre concentraciones minerales de suelo y forrajes en Mn, Cu, Fe, Mg, Na, Mo y Zn son muy bajas o inexistentes. Los esfuerzos para incrementar la productividad del ganado en los países tropicales no serán fructíferos a menos que el medio ambiente nutricional, incluyendo nutrición mineral adecuada, sea también mejorado. La suplementación mineral es la inversión de más bajo costo en el mejoramiento de la producción ganadera.

McDowell, L. R., J. H. Conrad and J. K. Loosli. 1981. Effect of Mineral Deficiencies on Cattle Production in Asia and Pacific. Asian Livestock J.VI(2):11, Bangkok, Thailand.

Mineral deficiencies, imbalances and excesses are severely inhibiting the cattle production in tropical countries. At least 15 mineral elements like calcium, chlorine, magnesium, phosphrous, potassium, sodium, sulfur, cobalt, copper, iodine, iron, manganese, molybdenum, selenium, and zinc are nutritionally essential for ruminants.

This report deals with the incidence and significance of mineral deficiencies and toxicities for grazing livestock in the trpoics and the methods most appropriate for meeting these requirements.

McDowell, L. R., M. Kiatoko, J. E. Bertrand, H. L. Chapman, F. M. Pate, F. G. Martin, and J. H. Conrad. 1981. Evaluating the nutritional status of beef cattle herds from four soil regions of Florida. Article. American Society of Animal Science, Journal of Animal Science. Department of Animal Science University of Florida, Gainesville, Florida.

Summary

An experiment was conducted to determine the trace mineral status of grazing cattle from four selected soil type regions in Florida. Animal tissu forage and soil samples were collected during the wet (September-October) and dry (February-March) seasons from nine ranches located in four different regions. On the basis of reported critical forage levels, mean forage Co (<.1 ppm), Zn (<30ppm) and Se (<.1ppm) and liver and hair Se (<.25ppm), were low during both seasons. Soil Se (<.50ppm) and extractable soil Zn (<1.5ppm) were low in all regions except the southeast. Mean forage Se was low in all regions. Of all animals studied in the wet season, 36 and 32% had low liver Cu (<75ppm) and Se (<.25ppm) concentrations, respectively. In the dry season, 20 and 39% of the animals had low liver Cu and Se concentrations, respectively. Hair Se was low (<.25ppm) in 90% of the samples during the wet season and 100% during the dry season. During the wet season, forage Zn, Mn, Co and Se were low in 89, 26, 63 and 84% of the samples, respectively, while extractable (double acid) Zn, Mn, Co and total Se were low in 57, 79, 63 and 100% of the soils, respectively. In the dry season, 80, 20, 40 and 80% of forages were low in Zn, Mn, Co and Se respectively. Of the seven trace minerals studied, Se and Zn are most likely to be deficient, with Co and Cu insufficiency probable in selected areas.

McDowell, L. R., M. Kiatoko, C. E. Lang, H. A. Fonseca, E. Vargas, J. K. Loosli and J. H. Conrad. 1980. Latin American Mineral Research - Costa Rica. IV World Conference on Animal Production, Buenos Aires, Argentina. pp. 39-47.

Summary

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 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 sphacelata pastures may be responsible for the high incidence of a milk feverlike 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.

Mejía Ayala, Jr., Carlos. 1977. Determinación de deficiencias y toxicidades de minerales de bovinos en pastoreo en el Municipio de Cerralvo, Nuevo León (Invierno 1976-1977). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Resumen

El presente trabajo se llevó a efecto en el Municipio de Cerralvo, Nuevo León, durante la Estación de Invierno 1976-77 y consistió de un muestreo de suelo, zacates, arbustos y suero sanguíneo de bovino en diez ranchos representativos al área a muestrear, con el objeto de determinar los niveles, deficiencias y toxicidades en el ganado en pastoreo.

En el suelo se determinaron el pH y cationes extractables en el agua por colorimetría usando el método Olsen; en los zacates, arbustos y suero sanguíneo se determinaron los minerales Calcio, Magnesio, Potasio, Sodio, Cobre, Fierro, Manganeso y Zinc por el Método de Absorción Atómica en el Espectofotómetro del CIANE y el Fósforo en el suero sanguíneo se determinó por colorimetría usando el Método de Fiske y Subarrow.

Se encontró un nivel alto en el suero en Ca concordando con los altos valores hallados para arbustos y zacates. Estos valores se pudieron deber a una posible contaminación por este elemento durante su procesamiento aunado a otras posibles causas. El 90% de los animales tuvieron valores de P altos que con los valores elevados de Ca dieron una relación Ca:P normal (15). El 45% de los pastos y el 90% de los arbustos tuvieron niveles normales, pero solo el 20% de los suelos tuvieron un nivel satisfactorio de Fósforo inorgánico debido ésto quizás a las características propias de los suelos de esta región.

Los niveles encontrados en suero, arbustos y zacates para Potasio y Magnesio son normales al compararlos con el nivel Standard. Se obtuvieron valores normales de Sodio y Fierro en los animales, no obstante que para el primero solo el 10% de los arbustos y 35% de los zacates tuvieron niveles normales, atribuyendo ésto a la suplementación de la sal común dada por los ganaderos de la Región.

El 90% de los animales tuvieron niveles deficientes de Cobre y Manganeso, aún cuando lo tenían en su dieta. Esto se debe quizás a las interacciones y relaciones con otros minerales (Molibdeno, Cobalto, Cadmio), cuyos niveles no se determinaron. En cuanto al zinc, los altos valores hallados en el suero bovino pudieron estar dados por los altos valores del mismo en arbustos y zacates, así como por la deficiencia hallada en Cobre y los valores altos de Calcio.

Se halló así mismo, que los suelos para estas Zonas son calcáreos con pH promedio de 7.8 y bajos en Fósforo.

Así mismo se llegaron a las siguientes conclusiones: (1) Los análisis de forrajes reportan cifras altas en Ca, Fe, y Zn; adecuadas en P, Mg, K y Cu y cifras bajas en Na. (2) Los análisis séricos dan cifras altas en Ca, Mg y Zn; cifras adecuadas en P, Na, K y Fe, así como cifras bajas en Mn y Cu. (3) Para los análisis de suelos dan valores altos en Ca (suelos calcáreos), y bajos en P o sea suelos de poca materia orgánica.

Miles, Wayne. 1980. Article submitted to the Carta Ganadera of the Banco Ganadero, Colombia.

Resumen

Un factor tecnológico de mayor importancia para mejorar la producción ganadera en los trópicos bajos y húmedos es el uso de un suplemento mineral completo y a libre consumo. Muchos de los ganaderos ya han oido esta afirmación pero muchos no la practican por varias razones. Algunos ni dan la sal y otros mezclan un suplemento mineral escasamente adecuado con un exceso de sal adicional o la suministran de vez en cuando. El resultado es una baja producción.

Una gran variedad de razones son esgimidas por las personas que no usan los mineral en suplementación animal. Posiblemente el alto costo es el impedimento de mayor importancia. El costo de sal mineralizado en la Caja Agraria en Puerto López, Meta, hace poco era $695.00 y $795.00 por bulto de 50 Kg. para tipo ceba y cría respectivamente. Una vaca consume alrededor de 20 Kg. por año a un costo de $278.00 a $318.00 En áreas aisladas como el Vichada, por concepto de transporte se aumenta en aproximadamente $30.00 el suministro por vaca año.

Miles, Wayne H. 1981. Mineral supplementation can mean life or death in the humid tropics. Article. Rangelands. Society for Range Management. Bogotá, Colombia.

Summary

The 300 million hectares (750 million acres) of savanna rangelands and 550 million hectares (1,375 million acres) of forest of the low humid tropics of South America constitute an area having possibly the greatest potential for expansion of beef production in any similar area of the world. In general, current cattle production is at a low technological level with overall low production. It is said that South America has twice the cattle numbers of the United States and half the beef production. Since production levels in the tropics are well below the overall average, the production per cow is even less than a fourth of US averages in the low wet American tropics.

While disease and tropical climate are factors in lower production, low level of nutrition is considered to be the major problem. In recent years a great deal of progress is being made through research and rancher experience in the use of improved pastures based on Brachiaria decumbens, Hyparrhenia rufa, Panicum maximum and other grasses.

The International Center for Tropical Agriculture (CIAT), Cali, Colombia, is on the verge of a major breakthrough that will provide persistent perennial tropical forage legumes to use in combination with grasses. The four most promising legumes include two natives, Stylothanses capitata and Zornia latifolia, and two introductions, Desmodium ovalifolium and Pueraria phaseoloides (tropical kudzu). Low levels of protein now reduce cattle gains and these legumes promise to raise protein levels in forage. Daily cattle gains on experimental grass legume pastures are over 500 grams per day and compare favorably with those of the temperate zone. Average rates of gain on native range are now about 250 grams per day.

An area of nutrition research which is receiving minimal attention in the tropics, at the moment, is mineral nutrition. While the US Agency for International Development (AID) has recognized this as a major problem and is financing a program with the University of Florida at Gainesville to promote mineral nutrition research in Latin America, there seems to be very little current work in this field in Colombia where the author ranches.

While Colombia ranchers say that they favor the use of mineralized salt, most either provide minerals only occassionally or dilute the mineral mix with excessive amounts of salt. Many provide no supplement. One reason is high cost. Cost per cow is about US$8.00 per year for the 20kg (44 lb) needed. Another deterrent, according to personal experience, is that commercial mixtures do not adequately supply one or more of the minor element essential to top production including reduction of death losses.

To understand the importance of mineral nutrition to tropical beef production one must understand that the oxisols of the savanna grasslands

and ultisols of the tropical forests, which are the most common soils of the low humid tropics, are among the most severely leached, acid, infertile soils that occur. Acid, infertile soils produce forages deficient in a number of minerals that are essential to adequate nutrition for cattle. In the area where the author ranches, phosphorus, calcium, sodium. copper, cobalt, zinc, selenium iodine, and sulphur are either known deficient or are suspect.

Unfortunately, little forage analysis or liver analysis work has been done in the American tropics. More specific information is needed to develop mineral supplements to fit particular areas. Most mixtures have been designed with little or no research to show which mineral deficiencies important for cattle nutrition occur in the area.

The Colombian Animal Production Association, composed of graduates and advanced students of veterinary and animal science plus leading cattlemen, sponsored, in September, 1979, a symposium in Bogotá on mineral nutrition. Dr. Lee R. McDowell, a leader of the US-AID mineral nutrition project at the University of Florida, was invited the be a principal speaker. Hopefully this indicates an awakening interest in the field.

An important mineral nutrition project was carried out at the Carimagua Research Station in the Colombian "Llanos" in 1975-76 by Soekanto Lebdosoekojo and published as a doctoral dissertation at the University of Florida in 1977. Analysis of native forage as published in this report showed that calcium phosphorus, sodium, zinc, and copper are deficient and that cobalt that is barely adequate as a yearlong average is deficient in the rainy season. The word "deficient" is used to indicate that level of each of these minerals is below the requirements indicated in Nutrient Requirements of Beef Cattle (1976) and Nutrient Requirements of Dairy Cattle (1978) published by the US National Academy of Sciences.

The Lebdosoekojo analysis did not cover selenium, iodine, or sulphur, which are also suspect as being deficient. "Llanos" rangelands are usually burned each year and are maintained as grasslands by these recurring fires. Since selenium and sulphur are volatilized by fire and the soils have been subject both the long-term leaching and fire, either or both may be deficient. On our own ranch, thanks to the cooperation of Dr. McDowell of the University of Florida, we have had one detailed forage analysis. This showed selenium to be borderline with 0.1 parts per million (ppm). Prior to adding selenium to our own mixture, we gave several thin animals a Vitamin E-selenium injection. The animals treated appeared to improve.

I am not aware of any goiter among our cattle but feel that the inclusion of iodine is justified pending more definitive research, since our soils are so severely leached. Sulphur was not added to our mix due to the rather large dietary requirement. We have forage analysis pending with the University of Florida for sulphur and may add this mineral if the analysis indicates low levels.

To complete the mineral availability status of range forages as shown by the Lebdosoekojo research, potassium was barely adequate (.87% vs. 80% recommended), iron was excessive (563 ppm vs. 50 ppm recommended), molybdenum was very adequate at .54 ppm but not in the excessive range indicated in the literature as adversely affecting copper nutrition.

It is important to note that a more recent analysis of native grass from another part of the same Carimagua Station showed slightly less zinc (11 ppm vs. 13 ppm) and almost three times as much copper compared to the Lebdosoekojo study on the same ranch. This tends to support the theory that when a particular mineral is at or near minimal levels in a particular area that one pasture may be marginally sufficient and another nearby may be deficient. Until more adequate research is available, we decided to add minerals suspected of being deficient to our supplement rather than take a chance of lower animal production.

Concrete benefits resulting from the use of a "complete" mineralized salt are provided in the 1977 Annual Report of CIAT. This report summarizes the results of a 4-year trial comparing salt alone to salt plus minerals. The addition of minerals to the supplement reduced abortions, increased average cow weight, reduced preweaning death loss of calves, increased calving percent, and increased weaning weight of calves. Abortions were reduced from 9.3% with salt to 0.75% with minerals. Death losses prior to weaning were 19.2% with salt compared to 10.5% with minerals. Calves were weaned from 38.5% of cows on salt compared to 60.5% with minerals. Weaninv weight of calves increased from 116 kg (255 lb) on salt to 147 kg (323 lb) with minerals. The average weight of calf per cow measured at 9 months of age was 98% higher for the herd with minerals.

Even this does not tell the entire story, as there are several other animal health problems on ranches in the area around the Carimagua Station related to mineral nutrition. A problem called "secadera" (wasting disease) accounts in one study for about 25% of death losses in the Colombian Llanos. Symptoms are similar to starvation. Almost any cowboy in the Llanos recognizes the disease, but research has not pinpointed either cause or treatment. There may even be more than one cause of the problem. This caused about 25% death loss in our own herd in 1977 and again in 1978, but disappeared when a minor element mix of cobalt, copper, zinc, iodine and selenium was added to our bone meal and salt mix early in 1979.

Fractures of legs, spine, and pelvis are many times more prevalent than in US Ranches in the same area that have used a free choice mineral salt for several years report almost no fractures.

Another peculiar problem is called "calambre" (nervous collapse). An animal being worked in the corral will begin to tremble, lie down, and not be able to rise. It is usual to butcher these animals for meat because most die in about a week. A problem called "vaca inflada" (dropsy) affects pregnant cows. The placenta fills with fluid containing calcium crystals. This usually results in loss of the calf and sometimes the cow. Both these diseases have been studied by Dr. Charles Mullinax, DVM, who believes that both are a result of mineral imbalance or mineral deficiency, though specific cause has not yet been determined.

Review of research literature indicates that animals suffering from mineral deficiencies are weakened and may die of various unrelated infections. Some, including the author, feel that 50% or more of the death loss of cattle in the "Llanos" of Colombia is related to mineral deficiencies or imbalances.

It is important to note that even with "best" technology, 10% of the calves at the Carimagua Station die before weaning. This is excessive. The Carimagua mineral supplement has not been modified as a result of the Lebdosoekojo research and adds less than 2 ppm of copper and 3.5 ppm of zinc to the diet of range cattle. When these amounts are combined with levels in the forage as analysed by Lebdosoekojo, dietary levels reach only about 37 to 38% of recommended dietary levels (N.A.C.). The author would be interested to see a research trial to determine whether the addition of more copper and zinc plus selenium and sulphur to the Carimagua supplement might improve health and reduce preweaning death losses. On our own ranch, the addition of cobalt, copper, zinc, selenium and iodine to the supplement has brought an unhealthy herd back to health.

An idea of the prospects for increasing cattle production in the low, wet tropics is indicated by an analysis of current production compared to potential production in the Colombian Llanos principally by better nutrition The Llanos has an area of about 18 million hectares (45 million acres). Currently this area contains about 3 million head of cattle. Extraction rate is about 10% so about 300,000 head are marketed each year. With better pastures plus better mineral nutrition, cattle numbers could reach 18 million head and the extraction rate could double to around 20% to provide about 3,6000,000 head for sale each year.

The Llanos makes up only about 6% of the savanna grasslands, and only 2% of the tropical forest lands are also included, of the low, wet American tropics.

Annual burning of "llanos" range is common in Colombia. This is an old practice, in fact, it occurred naturally before cattle were introduced in the area. Purpose of burning is to remove unpalatable grass and to encourage more palatable regrowth. Cattle eat ash after a burn and this along with bone chewing are common symptoms of mineral deficiencies.

Better mineral nutrition is an area of technology that can be applied quickly and for relatively low costs. It appears to the author to be imperative that more research effort be directed to this important field.

Miles, Wayne H. and Lee R. McDowell. 1981. Mineral deficienies in llanos rangelands of Colombia. Article. World Animal Review (In press). Bogotá, Colombia.

Summary

Best available data indicate that mineral supplementation for cattle grazing the Colombian Llanos almost doubles kilos of weaned calf weight per cow for breeding herds as compared to herds receiving salt only. Mineral supplement sales figures indicate that 50% to 80% of Llanos cattle do not receive mineral supplementation. The emerging picture based on recently available forage analysis data from three widely separated sites is that calcium, phosphorus, sodium, zinc, copper, cobalt, sulfur and selenium are usually below recommended levels for proper nutrition of cattle. Magnesium and potassium tend to be borderline to adequate. Iron and manganese levels are high to excessive. Currently available mineral supplements provide calcium, phosphorus, sodium, cobalt and iodine but do not appear to be adequate in levels of copper, sulfur and zinc. None provide selenium. High levels of fractures and abortions plus several unusual animal health problems combined with high death losses all point to the need to improve mineral nutrition for the Llanos cattle through widespread use of more adecuate mineral supplements. Important weaknesses in the technological base for better mineral nutrition of llanos cattle are listed and a challenge made for research to improve knowledge for improved mineral nutrition of cattle for the low humid tropics.

Mohammed, Reeza. 1979. The status of certain trace minerals in cattle in Trinidad. Thesis. Department of Livestock Science, The University of the West Indies, St. Augustine, Trinidad, West Indies.

Summary and Conclusions

Research was conducted to obtain information on the status of certain trace minerals in various tissues of cattle, in Trinidad.

Liver zinc levels for both North and South cattle were normal. However, in the case of liver copper, 82.86 percent of the animals originating in the North and 93.37 percent of those in the South were deficient, with the rest of the animals showing a borderline deficiency. Liver manganese levels were also borderline to deficient in all the cattle studied. Of the North cattle, 42.86 percent showed deficient liver manganese levels whilst 28.95 percent of the South cattle were deficient. With respect to liver molybdenum levels, only 20.5 percent of the cattle originating from the South were molybdenum deficient, whilst the remaining cattle from both North and South had normal levels. Liver cobalt levels showed overall normalcy except for a deficiency in 2.86 percent of North cattle.

Serum zinc levels observed were normal for both North and South cattle. Serum copper levels for North cattle showed 91.43 percent to be deficient and the remainder to be borderline cases. All the cattle originating in the South had deficient serum copper levels. In the case of serum manganese levels it was difficult to arrive at a conclusion of the status of this mineral since serum manganese is of little diagnostic value of the status of this mineral. Also, the level of manganese in the serum is not normally a reflection of liver manganese levels. Of the cattle originating from North Trinidad 34.28 percent had serum molybdenum levels below 0.04 ug/100 ml, whilst only 2.64 percent of the South cattle had similarly low levels. There are no reports in the literature seen of molybdenum deficiency in cattle. Serum molybdenum levels, like manganese, do not reflect liver molybdenum status of the cattle studied from serum molybdenum levels.

It would appear that a deficiency of copper in the cattle studied may have had an adverse effect on carcass weight. The same cannot be said for manganese and molybdenum since it is not known whether these two minerals play any role in the live weight gains in cattle.

From the findings of this research, it is imperative to suggest that an in-depth study is needed, involving the analysis of soils, forages and animal tissues for both the trace and macro-minerals important in the nutrition of cattle. Mineral levels may then be correlated with both physiological and production parameters such as live weight gain, milk production, reproduction, fertility and general health of cattle, in an effort to improve the level of production of both dairy and beef cattle in Trinidad.

Montero Gamboa, Santiago. 1979. Evaluación del contenido mineral en los pastos y en los tejidos del ganado bovino en la provincia de San José en el Cantón de Pérez Zeledón y en la Provincia de Puntarenas en los Cantones de Buenos Aires y Osa. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo de investigación consistió en la evaluación de la situación mineral en que se encuentran los distritos de Pejibaye, San Isidro y Rivas pertenecientes al cantón de Pérez Zeledón, provincia de San José y para la provincia de Puntarenas los distritos de Volcán y Potrero Grande pertenecientes al cantón de Buenos Aires y el distrito de Palmar perteneciente al cantón de Osa.

Se analizaron muestras de sangre, de hígado y de pastos de la zona. En el suero sanguíneo se determinaron los minerales calcio, fósforo, y magnesio; en el tejido hepático hierro, cobre, manganeso y zinc; y en los pastos, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso, y zinc. Además, se determinó la proteína cruda en los pastos.

El nivel promedio de calcio en el suero sanguíneo de los animales de la zona fue de 9.23 mg/100 ml de suero. Se presentó variación ($P<0.05$) entre los distritos. Tambien se encontró variación estadística en el nivel de fósforo en el suero para los distritos cuyo promedio fue de 5.88 mg/100 ml de suero presentándose diferencia significativa ($P<0.05$) entre los distritos.

En el tejido hepático se obtuvieron los siguientes promedios: 292, 140.5, 6.5 y 180 ppm. respectivamente. Presentándose variación estadística entre los distritos únicamente para el manganeso.

Para los pastos se obtuvo un promedio de 0.289 para el calcio y 0.151% para el fósforo. Para los minerales magnesio y potasio, se obtuvo un promedio de 0.121 y 0.82% respectivamente. En lo referente al hierro, cobre, manganeso y zinc se presentaron promedios de 370, 5, 140.9 y 50 ppm respectivamente. Se presentó variación estadística entre distritos para los elementos fósforo, potasio y magnesio.

La proteína no presentó diferencias significativas para los distritos y su promedio fue de 6.85%.

Abstract of Dissertation Presented to the Graduate Council of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

IDENTIFICATION OF MINERAL DEFICIENCIES IN SOIL, PLANT AND ANIMAL TISSUES AS CONSTRAINTS TO CATTLE PRODUCTION IN MALAWI

By

Joshua Peter Mtimuni

December 1982

Chairman: Dr. J. H. Conrad
Major Department: Animal Science

An experiment was conducted in Malawi, Central Africa, in the dry and in the rainy season to determine the areas of mineral deficiencies or toxicities as a basis for formulating mineral supplements. Animal tissue samples were collected from abattoirs; whereas forage and soil samples were collected from pastures grazed by cattle the last six months prior to slaughter. Minerals were analyzed in samples of soil, forage and animal tissues (blood, liver, bone).

The minerals found to be most likely deficient in soil in both seasons are zinc, cobalt, phosphorus, iron, copper, potassium and manganese. Aluminum and iron in the soil were lower ($P < .05$) in the rainy season than in the dry season.

In both seasons, minerals most likely to be deficient in forage are sodium, selenium, zinc, calcium, magnesium, phosphorus and copper. Concentrations of most minerals in forage were higher ($P < .05$) in the

rainy than in the dry season, but calcium and magnesium concentrations were lower ($P < .05$).

In all animal tissues except for liver molybdenum, concentrations of minerals were lower ($P < .05$) in the rainy than in the dry season. Percent deficiencies for most minerals were significantly higher in the rainy than in the dry season except for serum copper and liver cobalt. Serum phosphorus was found unsuitable for assessing the phosphorus status of grazing cattle.

Liver and serum copper indicated severe deficiencies. Bone parameters indicated severe calcium and phosphorus deficiencies. Serum magnesium and liver cobalt were not deficient. Manganese, iron and zinc are likely to be deficient in the rainy season. Minerals most likely to be deficient in animals are copper, phosphorus, calcium, manganese and zinc. Sodium, selenium and potassium are likely to be deficient in animals because forages are deficient in these minerals.

Few correlation coefficients in soil, forage and animal tissues were greater or equal to $\pm .5$ at the probability level of .05.

Nogueda Otero, Roberto. 1976. Deficiencias y toxicidades de minerales de bovinos. China, N. L. (Invierno-Primavera). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

En base a los resultados obtenidos se concluye lo siguiente:

1. Los análisis hechos al forraje reportaron cifras de calcio, potasio, magnesio, hierro, manganeso, cobre y zinc adecuadas a los requerimientos de los bovinos.

2. Los forrajes resultaron bajos e inadecuados en distintas proporciones en sodio y fósforo a los requerimientos de los bovinos.

3. Se encontraron niveles séricos normales de magnesio y bajos en fósforo.

4. Existió diferencia altamente significativa ($P < 0.01$) entre Estaciones para calcio, fósforo y magnesio, excepto para cobre, potasio, manganeso y zinc séricos.

5. El número de animales para determinar calcio, fósforo y magnesio sérico, fue 100 ($P < 0.001$).

Obeso Santos, Hugo. 1977. Determinación de deficiencias y toxicidades minerales de ganado bovino en pastoreo en el municipio de Ciénegas de Flores, Nuevo León. I. - Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Resumen

El presente trabajo se llevó a cabo, en el municipio de Ciénegas de Flores, N. L. En los meses de junio a agosto de 1976, consistió en un muestreo y análisis de forraje (zacates y arbustos), tejidos animales (sangre) y suelo.

Se muestrearon 7 ranchos (en uno de los cuales se hemolisaron la totalidad de las muestras de sangre), sin suplementación mineral al ganado (con excepción de sal común).

Las técnicas utilizadas en la colección y procesamiento de las muestras, fueron las sugeridas por Fick y otros investigadores. Los análisis se hicieron por Espectofotometría de Absorción Atómica y por Colorimetría en los laboratorios de suelos del CIANE y de ZOOTECNIA de ITESM, respectivamente.

En el suelo se determinó el pH y los elementos Cu, Fe, Zn, Mn, Ca, Mg, Na y K, lo mismo que en forraje y suero sanguíneo, excluyendo en este último el fósforo.

La determinación de Fósforo en suero sanguíneo se efectuó en Colorimetría, basándose en la técnica de Fiske y Subarrow. El resto de los elementos se analizaron por Espectrofotometría de Absorción Atómica.

La interpretación de resultados se hizo mediante Análisis de Varianza con distribución completamente al azar para la comparación de niveles de minerales entre ranchos y pureba de "t" simple para la comparación de niveles de minerales de animales jóvenes contra adultos. También se compararon las medias generales encontradas para cada mineral con los estándares teóricos.

El 50% de los zacates y el 100% de los arbustos indicaron niveles arriba de los requerimientos para bovinos, mientras que los niveles séricos de calcio fueron un tanto bajos comparados con los niveles normales (8-12 mg%). Esto pudo deberse a que un 35% de los zacates resultaron pobres en calcio, los cuales son preferidos en la época de verano. Esta suposición es lógica puesto que en todos los ranchos muestreados, se encontraron resultados altos y bajos en la proporción Ca:P variando desde 0.21:1 hasta 9.5:1. Para adultos, y de 0.25:1 hasta 4.03:1 para animales jóvenes. Se encontró diferencia altamente significativa ($P < 0.01$) entre ranchos para este elemento, al compararse las medias utilizando la prueba "t", los datos resultaron iguales para los ranchos A y B, las restantes fueron diferentes. Se encontró diferencia significativa ($P < 0.05$) en el nivel de calcio en animales jóvenes contra adultos, siendo mayores los segundos lo cual no concuerda con la literatura.

La prueba de F del análisis de varianza, revela que la media de los niveles de Fósforo de los ranchos D, G, A y B son iguales mientras que la media de los ranchos C y F son diferentes al efectuarse la comparación entre ranchos. Se encontró significancia ($P < 0.05$) al comparar los niveles de Fósforo de animales jóvenes contra adultos, siendo de 6.42 mg% para los primeros y 5.39 mg% para los últimos respectivamente; esto fué corroborado por la literatura que cita niveles séricos de 4-6 mg% para animales adultos y de 6-8 mg% para animales jóvenes.

La relación Ca:P para animales jóvenes fué de 1.02:1 mientras que para animales adultos fué de 1.65:1. Según la NRC (National Research Council) (40) recomienda para animales jóvenes una proporción de 1.4 partes de calcio por una parte de fósforo, mientras que para animales adultos recomienda 1:1 partes de calcio por 1 de fósforo, per en un trabajo realizado por Barreck y Ordeza citados por Cohen (9) no encontraron diferencias significativas en las tasas de crecimiento de los becerros en proporciones de Ca:P de 1:1 y de 7:1, per sí afectaban las proporciones abajo de 1:1 y 14.3:1 presentándose transtornos fisiológicos y retrasos del crecimiento.

Los niveles de magnesio en suero se observaron desde normales hasta altos en todas las muestras tomadas debido a que el 100% de las muestras de forraje se encontraron por arriba del estándar normal, corroborando esto con la literatura que dice que es difícil que se presente una deficiencia de este mineral puesto que no hay hasta forraje que no contenga el 0.1% requerido por el animal (19). No se encontró diferencia significativa al comparar los niveles de animales jóvenes contra adultos. Para la comparación entre ranchos se encontró que las medias de los ranchos A, B, D fueron iguales y el resto diferentes.

El 86.2% de animales jóvenes presentaron niveles normales y altos de Potasio sérico comparado con el normal (18-20 mg%) (59), mientras que los adultos estuvieron arriba y normales comparados con el estándar teórico; esto probablemente se debe a que el 100% de los zacates y el 83.3% de arbustos contenían niveles mayores de 0.8% señalado como normal por McDowell (35). Hubo diferencia altamente significativa ($P < 0.01$) al comparar animales jóvenes contra adultos siendo la media para los primeros de 21.33 mg% y para los últimos de 18.85 mg%.

Los niveles de Sodio sérico fueron normales comparados con el estándar teórico citado por Fick y otros (22) que va desde 156 a 300 ppm. No se encontró diferencia al comparar los niveles de sodio de animales jóvenes contra adultos.

Los niveles de Hierro, Cobre, Manganeso y Zinc fueron normales para los dos primeros mientras que los restantes resultaron altos comparados con los estándares teóricos respectivos, debido a que el forraje presentó niveles adecuados y altos, respectivamente.

Las principales conclusiones de este trabajo fueron las siguientes:

Los análisis de suero indicaron niveles adecuados en Fe, Cu y Na; excesos en K, Zn, Mn y Mg, mientras que el Ca y P son deficientes principalmente en animales jóvenes.

Hay diferencia altamente significativa entre ranchos para los minerales Ca, Mg, K y no hubo variación para el contenido de P del plasma sanguíneo.

Los análisis de los zacates reportan cifras en Cu, Fe, Zn, Mg y deficiencias en Ca; mientras que los arbustos se observaron deficientes en Zn y altos en Cu, Fe, Mn, Ca, Mg y K.

Ortega del Angel, José Luis. 1979. Niveles de minerales en suelo, forraje y suero sanguíneo y suplementación fósforica a becerros en pastoreo de zacate Estrella africana (Cynodon plectostachyus Pilger) en región subtropical. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que se llevó a cabo este experimento se puede concluir lo siguiente:

1. En el invierno se encontraron niveles de fósforo al margen de la deficiencia en el suero sanguíneo de los animales, en la región donde se encuentra ubicado el Centro Subtropical de Investigaciones Pecuarias.

2. Los becerros respondieron positivamente a la suplementación con fósforo, en los porcentajes de 6.98%, 8.72% y 10.48% de fósforo en la mezlca mineral con sal común, sin que hubiese diferencia entre los incrementos de peso de los animales que recibieron los 3 diferentes porcentajes de fósforo. Este comportamiento fué el obtenido en los 84 días de experimentación.

3. En los dos primeros períodos experimentales no hubo respuesta a la suplementación fosforada, pero en el tercer período sí la hubo, resultando con mejores aumentos de peso los suplementados con 10.48% y 6.98% de fósforo, en tanto que el de 8.72% y el de 0% de fósforo en la mezcla mineral se comportaron iguales entre sí, dando menores aumentos de peso.

4. Los niveles finales de fósforo en el suero sanguíneo de los becerros estuvieron dentro del rango normal en todos los tratamientos.

5. La relación Ca:P al final del experimento fué más estrecha en el suero sanguíneo de los becerros suplementados con fósforo, en comparación con los que no lo consumieron en el suplemento.

6. Los consumos de las mezclas que contenían fósforo resultaron superiores a los consumos de la sal común sola.

7. La suplementación mineral de fósforo fué económicamente redituable y superior a la suplementación de sal común.

Abstract of Thesis Presented to the Graduate Council
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Master of Science

BIOLOGICAL AVAILABILITY OF PHOSPHORUS FROM BASIC STEEL SLAG

By

Esván A. Paz

May 1982

Chairman: Lee McDowell
Major Department: Animal Science

Basic steel slag (BSS) is a byproduct of the steel industry with a complex and variable chemical composition including a considerable amount of phosphorus (P). The byproduct has been successfully tested as a soil amendment, but it has not been evaluated as a phosphate source for livestock. Two experiments were conducted to measure the bioavailability of phosphorus in BSS and to study the effect of this byproduct upon animal performance.

The first experiment deals with a mineral balance using sixteen Florida native crossbred wether lambs. A basal diet containing .048% P and .45% calcium (Ca) was fed at a rate of 800 g (as fed basis)/animal/day for 25 days to deplete body P stores in sixteen lambs. The lambs were then randomly assigned to two P-supplemented diets: one with BSS-phosphate and the other with monosodium phosphate (MSP), to .21% total P. The repletion period lasted 15 days. During the last seven days of both basal and supplemental periods, samples of feed, orts, feces and urine

were collected for analysis, and for computing a P, Ca, and magnesium (Mg) balance. Feed intake, body weight, hemoglobin and hematocrit values were also measured. The data indicate that BSS-phosphate is almost as well utilized as that in MSP. Assuming 100% value for each balance variable for MSP, the biological availability of BSS-phosphate would be 77.8%, 83.8%, 86.7%, and 90.3%, respectively, for apparent absorption, retention, and absorption and retention of supplemental phosphorus. Compared to the basal period, BSS-supplemented lambs tended to decrease their feed consumption and serum Mg levels. Three of the lambs supplemented with BSS developed moderate diarrhea during the supplemental period.

A second experiment was conducted with day-old chicks fed for three weeks. Body weight, tibia ash, feed intake, and liver iron levels were used as the main criteria to compare three levels of BSS-phosphate supplementation (.07%, .14%, and .21% P) and the Fe content in BSS versus the same levels of P supplied as monosodium phosphate, and three levels of iron sulfate supplementation. BSS supplementation resulted in significant reduction in feed intake and body weight accompanied by a relatively high mortality. In most cases, tibia ash of chicks receiving BSS fell below that of birds receiving MSP. Iron supplementation increased liver Fe and mortality of chicks as compared to the MSP-supplemented birds receiving "normal" levels of dietary Fe. Basic-steel-slag-supplemented chicks did not differ from the MSP-treated birds in liver iron content.

Lee R. M. Dowell
Chairman

Abstract of Thesis Presented to the Graduate Council
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MINERAL STATUS OF GRAZING BEEF CATTLE IN THE TROPICS OF BOLIVIA

By

ARMANDO PEDUCASSE C.

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Chairman: Lee R. McDowell
Major Department: Animal Science

An experiment was conducted in Bolivia to determine the mineral status of 3 beef cattle ranches located at San Ignacio de Velasco, region I (60°58'W; 16°23'S) and 8 at San Borja, region II (66°50'W; 14°50'S). The sampling period corresponded to the dry season (October) in 1979 and 1980 for the cited regions, respectively. Experimental grazing animals were Zebu-Criollo, with varying degrees of crossbreeding 3 to 5 years old. Five to 9 soil and forage, 10 serum samples and 10 liver biopsies were collected from region I while 12 soil and forage and 9 to 13 bone (3rd to 4th caudal vertebrae) and liver samples from slaughterhouses were obtained from region II.

Mean soil extractable minerals (mg/kg, dry basis) from both regions were: Ca, 190.2, 430.0; Mg, 34.2, 157.5; P, 1.2, 1.0; Na, 15.5, 157.7; K, 90, 38.7; Cu, .3, .5; Fe, 24, 25; Zn, 1.3, .6; and Mn, 6.8, 14.7, respectively. Percentage of borderline to deficient mineral levels were Ca (<71) 4.5, 7; Mg (<9.1) 0, 7; P (<15.0) 100, 100; K (<60) 90, 100; Cu (<2) 100, 100; Fe (<30) 54, 74; Zn (<8) 100, 100; Mg (<10) 7, 26 of the total samples, respectively.

Mean forage nutrient concentrations were (%, dry basis): crude protein, 8.6, 5.6; Ca, .21, .25; Mg, .16, .19; P, .15, .12; Na, .01, .009; K, 1.38, .85; and on a mg/kg, dry basis: Cu, 5.94, 1.33; Fe, 133.6, 121.9; Zn, 30.2, 25.7; Mn, 133.2, 389.3; Co, .16, .13; Mo, .86, .85; Se, .07, .10. The percentage of borderline to deficient levels were: Ca (<.30) 90, 57; Mg (<.20) 75, 64; P (<.25) 100, 100; Na (<.06) 100, 100; Cu (<10) 85, 100; Zn (<30) 30, 81; Co (<.10) 0, 47.6; Se (<.10) 88, 47; and crude protein (< 7) 24 and 76 of the total samples, respectively. Forage K, Fe, Mn and Co met the cattle requirements, with Mo not in excess.

From region I, mean serum minerals were (mg/100 ml): Ca, 8; Mg, 2.1; P, 6.7; and (µg/ml) Cu, .62; and Zn, 1.1. The percentage of borderline to deficient levels for these elements were: Ca (<8) 43; Mg (<2) 37; P (<4.5) 0; Cu (<.65) 27; and Zn (<.80) 15 of the total samples. Mean serum P concentrations in this region were higher than expected and may have been influenced by stress that occurred during sampling that was difficult to control. From bone samples collected in region II, the following mean mineral contents were observed (% bone ash): Ca, 31.5; Mg, .76; and P, 17.1. Low to deficient levels were Ca (<37.6) 96, and P (<17.6) 45% of the total samples.

Mean liver mineral concentrations found from regions I and II were (mg/kg, dry basis): Cu, 133, 94; Fe, 246, 259; Zn, 89, 120; Mn, 9.2, 9.0; Co, .57, .30; Mo, 4.33, 4.51; and Se (region II), .70, respectively. Borderline to deficient levels were found for Cu (<75) 7, 46; Fe (<180) 14, 36; and Zn (<84) 57 and 8% of the total samples, respectively. Mn, Co, Mo and Se were within the normal ranges as considered for healthy cattle.

Lee R. M. Donell

Chairman

Peducassé C., Armando, Andres Parra L., L. R. McDowell, J. V. Wilkins and Hugo Pérez S. 1979. Situación mineral en ganado de carne en el área de Santa Cruz Central - Bolivia. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R - 40.

Resumen

Se diseñó este experimento para determinar el estado mineral del ganado de carne en pastoreo en el área de Santa Cruz Central-Bolivia. Se analizaron muestras de suelos (22), forrajes (22), suero sanguíneo y biopsia de hígado de animales de 1 a 2 años de edad, tipo Nellore, Santa Gertrudis, Brangus, Cir y animales cruzados con criollo. Las muestras se obtuvieron al final de la época lluviosa (abril-mayo). Se analizaron por métodos de colorimetría y espectrofotometría de absorción atómica. Los resultados obtenidos indican los siguientes promedios en la solución de los suelos analizados (ppm) y su grado de significancia entre estancias: Ca, 104.25 ($P < 0.01$), P, 36,36; Mg, 23.81 ($P < 0.05$); Cu, 1.117 ($P < 0.01$); Zn, 21.84 ($P < 0.01$); Fe, 68.708 ($P < 0.01$); Co, 0.806 ($P < 0.05$) y Mo, 0.290. Se encontraron concentraciones entre marginales y deficientes: Ca (< 71 ppm); P (<5 ppm); Mg (<9.1 ppm) y Zn (<1.5 ppm) con valores de: 22, 4.5 y 36.2%, respectivamente. Los valores encontrados para las concentraciones de minerales en los forrajes son como sigue (% materia seca): Ca, 0.54 ($P < 0.01$); P, 0.38; Mg, 0.17 (ppm materia seca); Cu, 6.5 ($P < 0.05$); Zn, 20.98 ($P < 0.01$); Zn, 36.87 ($P < 0.01$); Fe, 106.648; Co, 263 y Mo, 1.761; se encontraron concentraciones consideradas deficientes: Ca (<.25%); P (<25%); Mg (<.15%); Cu (<4 ppm); Zn (<35 ppm); Co (<.05 ppm); Mg (<20 ppm) y tóxico en Mo (<3 ppm) con valores de 5, 9, 27, 46, 90.5, 4.5 y 9.1%, respectivamente. Para suero sanguíneo se encontraron promedios de concentraciones en los siguientes materiales: Mg, 1.5 mg% ($P < 0.01$), Cu, 1.67 mg/ml ($P < 0.01$) y Zn, 1.26 mcg/ml. ($P < 0.01$); se encontraron niveles considerados deficientes en Mg (<1.0 mg%) en un 23% de las muestras analizadas. En biopsia de hígado Cu, 83.84 ($P < 0.01$); Zn, 132.27 ($P < 0.05$); Fe, 408.44 ($P < 0.05$) y Mn, 10.36. Se encontraron concentraciones bajas hacia marginales a deficientes: Cu (<75 ppm) y Mn (<8 ppm) en un 53 y 31% del total de muestras, respectivamente.

Perla, Ferdinando. 1979. Diagnóstico preliminar de la condición mineral en el ganado bovino, en 2 épocas, en la zona oriental de El Salvador (1976-1977). II Congreso de Medicina Veterinaria y Zootecnia, San Salvador, El Salvador.

En el presente trabajo se incluyen algunos resultados, obtenidos de la investigación mineral, realizada en la zona oriental de El Salvador con el objeto de contar con un diganóstico de las posibles deficiencias y/o toxicidades de minerales en el hato bovino de esa zona.

Se seleccionaron 10 haciendas, dedicadas a la explotación de ganado de carne y de leche, dos en las que se suministraba sales minerales comerciales y ocho en las que no se suministraba sales, unicamente sal común.

En dos épocas (lluviosa y seca) se tomaron un total de 240 muestras de hígado y 240 muestras de plasma de un total de 12 animales en cada hacienda.

El tejido hepático (Biopsia) se mantuvo en congelación (8°C) hasta el momento del análisis, luego se secó a 105°C durante doce horas, a continuación se sometió a una preincineración caliente con ácido clorhídrico al 50% y finalmente fue calcinado a 550°C durante 12 horas. En este tejido se analizó calcio*, cobre, magnesio, manganeso, hierro, zinc y molibdeno (horno de grafito) por el método de absorción atómica en el espectofotómetro Perkin Elmer 303 (Perkin Elmer, 1968).

En el plasma sanguíneo se determinó calcio y magnesio por el método de absorción atómica ya mencionado y el fósforo por el método colorimétrico de Fiske y Subarrow (1925).

Los resultados demuestran que existieron deficiencias de fósforo en 45% de los animales muestreados en la época lluviosa y en 63% de los animales en la época seca (cuadro 1).

En la época seca en 8% de los animales muestreados se reportaron deficiencias de calcio (cuadro 1).

Los valores deficientes de magnesio en los animales muestreados fueron de 29% en la época lluviosa y 18% en la época seca (cuadro 1). Seis por ciento (6%) de los animales muestreados manifestaron deficiencias de hierro en la época lluviosa y nueve por ciento (9%) de los animales muestreados en la época seca (cuadro 1).

Los porcentajes de animales muestreados que mostraron deficiencias de cobre en la época lluviosa y seca fueron de 25% y 30% respectivamente (cuadro 1).

Se establecieron deficiencias de zinc en 16% de los animales muestreados en la época lluviosa y 24% en la época seca (cuadro 1) el porcentaje de animales deficientes en manganeso fue de 1% en ambas épocas (cuadro 1). No se observaron niveles deficientes o tóxicos de molibdeno en los animales muestreados en ninguna de las épocas.

*Calcio no se determinó en la estación lluviosa.

Portillo Arteaga, Carlos G. 1977. Evaluación del estado nutritivo mineral en pastos y bovinos para la época seca en los distritos de Tilarán Centro, Upala Centro y Bijagua, Costa Rica. Tesis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia. San José, Costa Rica.

Resumen

La presente investigación fue realizada con el fin de determinar el estado nutritivo mineral en los pastos y en los bovinos durante la época seca, en los Ditritos de Tilarán Centro, Upala Centro y Bijagua.

Se utilizaron 18 fincas de diferentes tamaños, estas fueron tomadas al azar y de acuerdo a la población animal de cada distrito. Se utilizó para el análisis estadístico un diseño anidado y se efectuaron análisis de correlación de los datos. El trabajo de recolección de muestras se inició en el mes de diciembre de 1976 y se concluyó en mayo de 1977. Se tomaron muestras de tejido sanguíneo, tejido hepático y muestras de pastos. El tejido hepático no fue analizado estadísticamente, no sólo por no haber sido tomadas las muestras de las mismas fincas donde se tomaron las muestras de sangre y de forraje, sino tambien por su número reducido.

Los minerales analizados fueron:

Sangre:	Ca, P, Mg
Pasto:	Ca, P, Mg, Fe, Cu, Zn, Mn, K
Hígado:	Fe, Cu, Mn, Zn

Las concentraciones promedio de toda la zona para cada mineral fueron las siguientes:

	Pasto	Sangre	Hígado
Ca	0.145% M.S.	9.33 mg/100 ml	-
P	0.092% M.S.	6.62 mg/100 ml	-
Mg	0.127% M.S.	2.60 mg/100 ml	-
K	1.31% M.S.	-	-

	Pasto	Sangre	Hígado
Fe	0.362% M.S.	-	261 ppm
Cu	3 ppm	-	174 ppm
Mn	0.060% M.S.	-	11 ppm
Zu	18 ppm	-	118 ppm

En cuanto a niveles sanguíneos, el calcio el fósforo y el magnesio se presentaron en concentraciones normales.

En el pasto de calcio, magnesio, potasio, hierro, manganeso, zinc y cobre se presentaron en promedio general en concentración normal, sólo el fósforo resultó deficiente en promedio para la zona. El calcio, zinc y el cobre mostraron deficiencia en los pastos en algunas de las fincas unicamente. En el hígado no hubo deficiencias para ninguno de los elementos analizados (cobre, hierro, manganeso, zinc).

Se recomienda para toda la zona estudiada la suplementación fosforada y otros minerales en casos particulares.

Best Available Document

Quijano Cardala, Eduardo. 1979. Estudio del estado mineral de pastos y bovinos en la época seca en los distritos de Bejuco y Hojancha Guanacaste, Costa Rica. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

66 muestras de pastos y 66 de sangre de bovinos fueron analizadas para determinar su contenido de proteína, calcio, potasio, hierro, cobre, zinc y manganeso, y calcio, fósforo y magnesio, respectivamente. Los elementos del pasto y sangre se determinaron por absorción atómica (Fick et al., 1976) excepto la proteína por Kjeldahl (A.O.A.C., 1970) y fósforo por colorimetría (Fiske y Sublarow, 1925).

Las muestras, provenientes de 14 fincas de los distritos de Hojancha y Bejuco y correspondientes a la estación seca (Noviembre 1976 a Abril 1977), se analizaron estadísticamente por el modelo Stepwise y las correlaciones intraelementos.

Los elementos de minerales de la sangre resultaron en valores promedio que se sitúan dentro de rangos reportados como normales por diversos autores.

Se presentaron diferencias significativas ($P < .01$) entre fincas respecto a la variable magnesio.

Las muestras de pasto resultaron en valores normales, excepto el potasio con 36% de ellos menores que el ámbito normal y 48% sobre él; cobre con 63% bajo el ámbito normal y 36% sobre él; zinc con 66% bajo el ámbito normal y 36% sobre él; proteína con 83% de ellos bajo el ámbito normal; manganeso con 88% sobre el ámbito normal y hierro con 96% sobre el ámbito normal.

El fósforo presentó diferencias significativas ($P < .01$) respecto a las variables distrito. El magnesio presentó diferencias significativas ($P < .01$) para distritos. El potasio presentó diferencias significativas ($P < .01$) para fincas y distritos. El hierro presentó diferencias significativas ($P < .01$) para fincas y estado de madurez. El cobre presentó diferencias significativas ($P < .01$) para distritos. El manganeso presentó diferencias significativas ($P < .01$) para distritos, finca y estado de madurez. La proteína presentó diferencias significativas ($P < .01$) para distrito y finca y ($P < .05$) estado de madurez.

Se recomienda en base a los resultados la suplementación oral de zinc (óxido o cloruro), cobre (sulfato o carbonato), fósforo (harina de hueso) y proteína (urea en suplemento líquido).

Se debe investigar más el posible efecto directo e indirecto de la alta concentración de hierro, manganeso y potasio sobre la producción animal.

Robles Jara, Armando. 1969. Estudio preliminar del contenido de cobre y manganeso en cuatro especies de un matorral microfilo caducifolio. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que se desarrolló este experimento y los resultados obtenidos concluye lo siguiente:

1. Los contenidos de Cobre y Manganeso encontrados en las diferentes expecies estudiadas, son adecuados para la alimentación de los bovinos en pastoreo; por lo que las probabilidades de deficiencia de estos minerales en ganado en pastoreo son bajas.

2. El contenido de Cobre tiende a ser similar durante la primavera, en las especies arbustivas y en las gramíneas.

3. El contenido de Cobre tiende a ser diferente durante el verano, entre las especies arbustivas y entre las especies de gramíneas.

4. El contenido de Cobre varía de una época a otra en las especies estudiadas.

5. El contenido de Cobre tiende a ser diferente entre lso brotes tiernos y las hojas maduras, de las especies arbustivas en las dos épocas del año.

6. El contenido de Manganeso tiende a ser similar, en las diferentes especies estudiadas tanto en primavera como en verano.

7. El contenido de Manganeso en las especies arbustivas varía con las estaciones del año, siendo similar en las especies de gramíneas.

8. El contenido de Manganeso en los brotes tiernos y las hojas maduras tiende a ser similar para las dos especies arbustivas, en las dos épocas del año.

9. Se recomienda muestrear las partes tiernas y las maduras de las especies arbustivas para conocer con mayor seguridad su contenido de Cobre.

10. Se recomienda muestrear las especies en las diferentes épocas para conocer con más seguridad su contenido de Cobre y Manganeso.

Rosa, I. V., P. R. Henry and C. B. Ammerman. 1982. Interrelationship of Dietary Phosphorus, Aluminum and Iron on Performance and Tissue Mineral Composition in Sheep. J. Anim. Sci. (In press).

Summary

An experiment was conducted with 24 wether lambs (31 kg, initially) to study the interrelationships among dietary phosphorus, aluminum and iron. The 2 x 2 x 2 factorial arrangement of treatments included two levels of phosphorus (.17 or .42%), as NaH_2PO_4, two levels of added iron (0 or 760 ppm) as ferric citrate, and two levels of added aluminum (0 or 1450 ppm as $AlCl_3.6H_2O$). Dietary treatments affected average daily gain ($P < .01$), with added phosphorus improving and iron or aluminum depressing gain. Phosphorus increased ($P < .01$) feed consumption, while iron ($P < .01$) and aluminum ($P < .05$) decreased intake. A phosphorus x aluminum interaction affected gain ($P < .01$) and intake ($P < .05$) while a phosphorus x iron interaction affected gain ($P < .05$). Serum phosphorus was elevated ($P < .01$) by high dietary iron and reduced ($P < .01$) by aluminum.

Rosero, O. R., L. R. McDowell, J. H. Conrad and F. A. Capote. 1982. Effect of energy and protein on calcium, phosphorus and magnesium retention by sheep. J. Anim. Sci. Abstracts 1982 (Submitted for regional Animal Science meetings).

Abstract

Two trials were conducted to study the effect of different energy and protein levels on mineral utilization by sheep. Twelve wether lambs averaging 50 kg were adapted to matebolism cages for two mineral balance trials consisting of 8-day adjustment period and a subsequent 8-day collection period (feces and urine). In the first trial the animals were fed semi-purified diets high in minerals (2-20 times maintenance requirements), with two levels of energy and protein (low, .8 maintenance and high, 1.8 x maintenance). The animals were fed the two diets for three months before being placed in metabolism cages for retention studies. In the second trial the wethers were fed for another three months with a diet low in minerals (.8 maintenance requirements, with two levels of energy and protein, low and high). At the end of the second retention study the animals were sacrificed to obtain tissue samples (liver, kidney, muscle, heart and spleen). Blood samples, liver and bone biopsies were taken for mineral analyses. Average retention of Ca, P and Mg (respectively) g/days for four treatments were as follows: low energy-protein + low mineral diet (LEP + LM) 1.95, -2.52, 1.11. High energy-protein + low mineral diet (HEP + LM) -0.47, -9.43, 0.95. Low energy, protein + high mineral diet (LEP + HM) -10.05, -2.05, 0.67. High energy, protein + high minerals (HEP + HM) -2.83, -6.11, 2.71. Differences ($P < .05$) retention and plasma Ca, P and Mg mineral concentrations were found. The effect of the respective diets on tissue mineral concentration will be presented.

Salas Morgan, Olga Jeannette. 1978. Estado mineral de los pastos y del suero sanguíneo en el Pacífico Central de Costa Rica durante la época seca. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

El presente trabajo de investigación consistió en la evaluación de la situación mineral en que se encuentran los cantones de Abangares (Provincia de Guanacaste) y Cantón Central, Esparza y Montes de Oro (Provincia de Puntarenas).

Se analizaron muestras de sangre y de pastos de la zona. En el suero sanguíneo se determinaron los minerales calcio, fósforo, magnesio y en los pastos, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso, y zinc. Además se determinó la proteína cruda en los pastos.

El nivel promedio de calcio en el suero sanguíneo de los animales de la zona fue de 10.93 mg/100 ml de suero, no se presentó variación ($P<0.05$) entre los diferentes cantones. Si se encontró variación estadística en el nivel de fósforo en el suero para los cantones, cuyo promedio fue de 5.69 mg/100 ml de suero. El nivel de magnesio en el suero fue de 2.81 mg/100 ml de suero, encontrándose en este caso diferencia significativa ($P<0.05$) entre los cantones.

Para los pastos se obtuvo un promedio de 0.26% para el calcio y 0.09% para el fósforo, no habiendo variación ($P<0.05$) entre los diferentes cantones. Para el magnesio fue de 0.18%, no hubo diferencias significativas entre los cantones ($P<0.05$). El potasio obtuvo un promedio de 1.46% pero no presentó variación ($P<0.05$) entre los cantones. En el caso del hierro si hubo variación estadística ($P<0.05$) para los diferentes cantones y su promedio fue de 222 ppm. Para el cobre y el manganeso no se encontró ninguna variación ($P<0.05$), y sus promedios fueron de 4 y 56 ppm, respectivamente. El zinc con un promedio de 28 ppm no mostró diferencias significativas ($P<0.05$) para los cantones.

La proteína solo presentó diferencias significativas para las fincas, y su promedio fue de 4.97%.

Salih, Y. M., L. R. McDowell, R. M. Mason, Jr., and J. F. Hentges. 1981. Mineral status of grazing Florida Brahman beef cattle. J. Anim. Sci. Abstracts No. 735.

An experiment was conducted to determine the mineral status of Brahman beef cattle grazing Bermuda-Bahia pastures grown on sandy loam soils of Central Florida. During May, forage, blood and liver biopsy samples were collected from 36 (4-8 year old) Brahman cows in early pregnancy. Mean forage analyses are as follows: Ca, .30%; P, .22%; Mg, .22%; K, 1.43%; Na, .09%; Zn, 19 ppm; Cu, 15 ppm; Co, .12 ppm; Se, .04 ppm; Mn, 66 ppm; Fe, 29 ppm; and Mo, .20 ppm. Critical levels of forage Ca (<.30%), P (<.25%), Mg (<.20%), K (<.60%), Na (<.06%), Zn (<30 ppm), Fe (<30 ppm) and Mo (>3 ppm) were found in 43.8, 68.8, 31.3, 0, 0, 100, 37.3, 25, 100, 6.2, 68.8 and 0% of the total forages, respectively. Mean liver analyses are as follows: Se, .16 ppm; Co, .4 ppm; Cu, 229 ppm; Zn, 107 ppm; Mn, 9.9 ppm; Fe, 384 ppm; and Mo, 2.8 ppm. Serum means analyzed are as follows: Ca, 10.4 mg%; P, 5.2 mg%; Mg, 2.3 mg%; Zn, .84 μg/ml; Cu, .90 μg/ml; and Se, .005 μg/ml. The percentages of mean liver Zn (<84 ppm), Se (<.25 ppm) and Mn (<6 ppm), and serum P (<4.5 mg%), Zn (<.80 μg/ml) and Se (<.24 μg/ml) that were low to borderline to deficient were 11.8, 100, 6.6, 40.0, 46.7 and 100, respectively. Liver Co, Cu, Fe and Mo, and serum Ca, Mg and Cu were generally in the normal ranges. On the basis of the analyses, deficiencies of Se, Zn and P are likely.

Shultz, T. A., Elena Shultz, C. F. Chicco and J. Garmendia. 1979. Suplementos autorregulados de nitrógeno no proteíco para novillos alimentados con pastos secos. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-23.

Resumen

A fin de evaluar diferentes formas de suministro autorregulado de urea, 32 novillos mestizos Criollo x Cebú, de 298 kg de peso inicial y alimentados con pasto seco en corral, fueron asignados a cuatro tratamientos: 1) pasto únicamente (testigo); 2) pasto + suplemento de urea con sulfato de amonio (urea-sulfato); 3) pasto + suplemento de urea con cloruro de sodio (urea-sal) y 4) pasto + suplemento de melaza urea (urea-melaza). El pasto era guinea (Panicum maximum) secado en el campo con 4.1% PC y 84.9% TND. El suplemento urea-sulfato contenía 12% urea y 6% sulfato de amonio y el urea-sal 15% urea y 15% sal, ambos completados los 100 con harina de ajonjolí, afrecho de trigo, pulpa de yuca y melaza; el suplemento urea-melaza contenía 8% urea, 76% melaza y 15% sal. Los suplementos eran ofrecidos a voluntad con una relación de consumo estimada de 1:1:2, para así proveer el mismo aporte de nitrógeno. El experimento tuvo una duración de 120 días con pesajes cada 30 días. Al final del experimento con 2 animales/tratamiento se determinó la digestibilidad de las raciones, la retención del nitrógeno y la concentración de amoníaco y proteína microbiana ruminal. La ganancia de peso, consumo de heno y de suplementos fueron de - 14, 169, 216 y 123 g/animal/día; 7.2, 7.4 7.2 y 7.2 kg/animal/día; y 0.91, 0.58 y 1.88 kg/animal/día, respectivamente, para el testigo, urea-sulfato, urea-sal y urea-melaza, siendo las ganancias de peso significativamente inferiores ($P < 0.05$) únicamente en el grupo testigo. Se registraron tendencias similares entre tratamiento para la digestibilidad de materia orgánica, celulosa, retención de nitrógeno, proteína microbiana, amoníaco ruminal y urea sanguínea.

Siller Berain, Eduardo. 1977. Deficiencias y toxicidades de minerales en ganado bovino en pastoreo en Melchor Muzquiz, Coah. Invierno 1976-77 y Primavera de 1977. I. - Determinación de Niveles. Tesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, México.

Conclusiones

Bajo las condiciones en que se realizó esta investigación y en base a los resultados obtenidos, se concluye lo siguiente:

Para Invierno:

1. - Los niveles de Fósforo (P) en el Suero de los animales se encontraban bajos; los de Calcio, Magnesio, Sodio, Manganeso y Zinc, fueron altos y los de Potasio, Cobre y Hierro fueron normales. Hubo diferencia entre ranchos para Fierro y Fósforo.

2. - Los análisis de zacates dan cifras bajas en Fósforo, Magnesio, y Potasio, altas en Calcio, Sodio, Cobre, Hierro, Manganeso y Zinc.

3. - Para los análisis de arbustos hubo valores bajos en Fósforo, normales en Potasio y altos en Calcio, Magnesio, Sodio, Cobre, Hierro, Manganeso y Zinc.

4. - El análisis de suelo indicó valores bajos de Fósforo.

Para Primavera:

1. - Hubo niveles bajos en el animal de Fósforo, Cobre y Manganeso, normales de Potasio y Hierro y altos de Calcio, Magnesio, Sodio y Zinc.

2. - Los análisis de zacates dieron cantidades bajas de Fósforo, y Magnesio; normales de Potasio, y altas de Calcio, Sodio, Cobre, Hierro, Manganeso y Zinc.

3. - Para los análisis de arbustos hubo valores bajos de Fósforo y altos de Calcio, Magnesio, Potasio, Sodio, Cobre, Hierro, Manganeso y Zinc.

4. - El Análisis de Suelo indicó valores bajos en Fósforo.

5. - El contenido de Fierro, Cobre, Manganeso, Zinc y Sodio en animales fué mayor en Invierno que en Primavera. Calcio y Magnesio estuvieron en mayor cantidad en Primavera que en Invierno. Hubo diferencia en los animales para Hierro entre ranchos, en las dos estaciones.

6. - El contenido en Plantas (zacates y arbustos) de Fierro, Cobre y Zinc fué mayor en Invierno que en Primavera. Potasio y Magnesio estuvieron en mayor proporción en la planta en Primavera que en Invierno. Hubo diferencia en las plantas para Fierro entre ranchos, en las dos estaciones.

Siller Chapa, Victor A. 1977. Determinación de las deficiencias y toxicidades de minerales en bovinos en pastoreo en el municipio de Sabinas, Coah. (Mar.-Oct. 1977). I. Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Resumen

El presente trabajo se llevó a cabo en el Mpio. de Sabinas, Coah. durante el período de crecimiento de las plantas de Marzo a Octubre de 1977, muestreando suero sanguíneo, zacates, arbustos y suelo, muestreando 4 ranchos los cuales formaban una zona representativa del Municipio, con el objeto de determinar las deficiencias y toxicidades de minerales en el ganado bovino en pastoreo.

Las muestras tomadas fueron preparadas para su análisis en el Laboratorio de Zootecnia del Instituto y analizadas por el método de absorción atómica en el espectofotómetro de absorción atómica del C.I.A.N.E., con excepción del fósforo que fue determinado en otro espectrofotómetro (ver metodología en la sección Material y Métodos).

Se encontraron valores de Calcio muy altos en forrajes, en suero y en el suelo (más de 2000 kg/ha). Los valores de fósforo se encontraron muy abajo del rango considerado normal en muestras de zacates, arbustos y suero.

El magnesio se encontró en cantidades normales en el suero, ligeramente alto en las gramíneas y normal en los arbustos.

El potasio se encontró ligeramente alto en las muestras de suero, mientras que las de forraje arrojaron cantidades ligeramente altas.

El sodio existía en cantidades normales, tanto las muestras de suero como en las de forraje.

Los valores para cobre de los forrajes analizados, resultaron normales mientras que en suero estuvieron ligeramente bajos sin ser diferentes estadísticamente de la media teórica.

Los valores de manganeso resultaron ligeramente bajos en los arbustos, normales en gramíneas y un poco altos en el suero.

Los valores de zinc y fierro en los arbustos y gramíneas resultaron muy altos, sin embargo, el fierro estaba en cantidades normales en el suero, mientras que el zinc se encontraba en un nivel alto.

Las conclusiones a que se llegó fueron las siguientes:

I) Los niveles de Ca, K, Zn y Fe resultaron altos en las muestras de suero y de forrajes, con excepción del Fe en suero que resultó normal.

II) Se encontraron niveles de sodio normales en el suero y en los forrajes.

III) Los valores de Mg resultaron normales en el suelo a pesar de las variaciones en los forrajes.

IV) Los niveles de P resultaron muy bajos en la dieta y en consecuencia los valores en suero se encontraban deficientes.

Tumwasorn, Sornthep. 1981. Responses of beef calves to mineral supplement in the Central Thai Villages. Second Seminar on Mineral Nutrition in Thailand, Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand.

Abstract

Mineral mixture of bone meal, ground shell, and salt was given at free choice to 73 head of indigenous Thai native and 1/4 Brahman crossbred calves. The control group of 77 head were studied in comparison with the supplemented ones. Seven villages about 110 km west of Bangkok were selected as the area of the study during the years 1979 to 1980. Wet, dry, and the extra period of supplementation were investigated for the improvement of liveweight changes and blood parameters. The results showed that dry season supplementation had the highest percent improvement while the wet period treatment revealed the lowest responses. The ranges of improvement varied considerably from 14 to 23% within the indigenous native calves up to 21 to 31% of the Brahman crossbred calves. Changes in hematocrit and hemoglobin values due to mineral supplementation were not significant in all seasons. The analyses of plasma showed that beef calves raised in this area had very low P and Ca levels. It was also found that Ca level of the pregnant cow raised in the dry season showed milk deficiency. After the supplementation, all treated calves had higher mineral levels but the amounts were not significant. The supplemented cows had 17% more conception rate that the unsupplemented controls.

Tumwasorn, Sornthep, Chinatat Najasingha, Chairerk Kaeowphrormmarn and Arwoot Wanitchart. 1980. Mineral Supplementation for One-Fourth American Brahman Crossbred Calves in the Village. Proceedings First Seminar on Mineral Nutrition in Thailand, Bangkok, Thailand. pp. 13-33.

Abstract

Mineral mixture of bone meal, ground shell, and salt were given at free choice to 23 one-fourth American Brahman crossbreds in 3 villages of Kamphaengsaen district, Nakhon Pathom province. The nonsupplemented controls of 24 animals were compared in the same environment during one year from April 1978 to May 1979. Wet and dry periods supplementation were conducted in order to observe various effects on body weight change, viz. season, sex, village, and treatment. All factors affecting liveweight change were significant ($P < 0.01$). Duncan's New Multiple Range Test revealed that the supplemented group had heavier body weight than the nonsupplemented controls ($P < 0.05$) by the end of each six month period of the study. The analyses of hemoglobin, hematocrit, and mineral contents were conducted in relation to the body weight. More than 10 varieties of native grasses were collected for the analyses of nitrogen and phosphorus contents throughout the year. It was found that the relationship between mineral contents in forages and blood plasma was fairly low. In addition socioeconomic evaluation of supplementation was made by the end of the study.

Valdivia, Ricardo and Clarence B. Ammerman. 1979. Efecto de la ingestión de suelos en la absorción del fósforo en ovinos. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-60.

Resumen

Dieciocho ovinos capones con un peso promedio de 44.9 kg fueron asignados a 3 tratamientos en un diseño completamente al azar. Las dietas experimentales contenían 10%, respectivamente, de arena (A), suelo de Colombia (C) y suelo de Costa Rica (CR). La concentración de los suelos agregados corresponde a cantidades de suelos ingeridos normalmente en pastoreo. Un período de ajustamiento de 14 días fue seguido por un período de balance de 7 días. Se inyectó i.v. P^{32} para determinar el fósforo metabólico fecal. El contenido de aluminio, cobre, fierro y manganeso fue varias veces más alto en la dieta CR que en las dietas C y A. No se observaron diferencias en ganancia de peso, consumo de materia orgánica o niveles séricos de calcio y magnesio. El fósforo sérico (mg/100 ml) del grupo C (9.08) fue más alto ($P < .06$) que en los grupos CR (7.22) y A (7.33). La absorción verdadera (71.5%) y la retención neta (206 mg/animal/día) del fósforo fueron más altas ($P < .01$) en el grupo C que en CR (59.8% y - 11 mg/día) y en A (54.7% y 75 mg/día). No se observó efecto sobre la digestibilidad aparente de la materia seca, materia orgánica y absorción de cenizas, calcio, magnesio, cobre, zinc y manganeso. La absorción aparente del fierro del grupo CR (23.8%) y C (9.9%) fue más alta ($P < .05$) que en A (- 18.9%). Los resultados obtenidos sugieren que los suelos en el alimento, a través de su contenido de minerales, especialmente aluminio y fierro, afectaron negativamente la utilización del fósforo del alimento.

Valdivia R., Ricardo, Arturo L. Rosales & Héctor Huamán. 1980. Estado de la nutrición mineral (calcio, fósforo, cobre y fierro) de alpacas, llamas y vacunos en el Altiplano Peruano. VI Congreso Nacional de Ciencias Veterinarias, Piura, Perú.

Se muestrearon alpacas, llamas y vacunos en las zonas de la Raya (Sicuani-Cuzco), Santa Rosa (Ayavirí-Puno) y Sicuani (Sicuani-Cuzco). Se efectuaron determinaciones de calcio y fósforo en el suero sanguíneo de 106 alpacas, 9 llamas y 12 vacunos y concentraciones de cobre y fierro en el hígado de 20 alpacas y 12 vacunos con fines comparativos. También se determinó el contenido de estos minerales en pasturas naturales y cultivadas. El muestreo se realizó en el mes de Octubre, correspondiendo al final de la época seca. El fósforo se determinó por reacción colorimétrica del fosfomolibdato y los demás elementos mediante el método de absorción atómica. Los niveles de calcio y fósforo séricos (promedio ± D.E.) en mg/100 ml fueron, para alpacas 7.51 ± 2.61 y 6.25 ± 1.70, llamas 6.58 ± 2.09 y 5.74 ± 0.70 y vacunos 8.05 ± 1.74 y 4.94 ± 0.90, respectivamente. No hubo diferencias significativas en cuanto a los niveles de calcio sérico, pero los niveles de fósforo sérico fueron más elevados ($P < 0.01$) en las alpacas que en las llamas y vacunos. No fueron significativas las diferencias observadas en los niveles de calcio y fósforos séricos dentro de las alpacas cuando éstas se agruparon de acuerdo a su forma de alimentación: pasturas naturales, 7.93 ± 2.49 y 6.19 ± 1.78, pasturas cultivadas (Trifolium repens + Lolium perenne o Phalaris arundinacea) 6.42 ± 3.16 y 5.98 ± 0.78 y pasturas no determinadas 7.32 ± 1.74 y 6.91 ± 2.24, respectivamente. Los niveles de cobre y fierro en el hígado (promedio ± D.E.), en ppm, base seca, fueron para alpacas 48.0 ± 45.8 y 486.8 ± 166.6 y vacunos 9.7 ± 4.4 y 349.8 ± 166.9, respectivamente, siendo los niveles de ambos elementos más altos ($P < 0.01$) en las alpacas que en los vacunos. La concentración de cobre hepático en los vacunos fué indicativo de un estado carencial. En las pasturas los contenidos de calcio y fósforo (%), cobre y fierro (ppm) en base seca fueron: pasturas naturales, 0.119 ± 0.036, 0.078 ± 0.052, 9.3 ± 3.9, 528 ± 396 y pasturas cultivadas 0.496 ± 0.051, 0.276 ± 0.102, 14.7 ± 0.8 y 670 ± 144, respectivamente.

Valverde Conejo, Juan Carlos. 1977. Estado mineral del ganado y forrajes del canton de Coto Brus, Costa Rica. Tésis. Universidad de Costa Rica, Facultad de Agronomía, Escuela Zootecnia, San José, Costa Rica.

Resumen

Esta investigación se llevó a cabo con el fin de determinar el estado nutricional mineral del ganado en pastoreo del Cantón de Coto Brus, con base en análisis de forrajes y tejidos.

Se tomó muestras de forrajes, hígado y sangre de los cuatro distritos: San Vito, Sabalito, Limoncito y Agua Buena, con la excepción del último distrito, del que no se tomó muestras de hígado. Para el análisis de pastos se escogió nueve fincas por distrito, dando un total de 36 fincas y 60 muestras analizadas. En el caso del hígado también se tomó muestras de 9 fincas de cada distrito, excepto Agua Buena, para dar un total de 27 fincas estudiadas y 47 muestras. Se aclara que estas fincas no coinciden con las que se les tomó muestras de pasto. Para el análisis de sangre se tomó dos fincas por cada distrito, dando un total de 16 muestras en 8 fincas.

Los forrajes fueron analizados para Ca, Mo, K, Cu, Mn, Fe y Zn; el hígado para Mn, Cu, Fe y Zn, y la sangre para Ca, y Mg, por espectrofotometría y absorción atómica; y el P en sangre y forrajes por colorimetría.

Hubo diferencias significativas (prob menor 0.05) entre distritos en cuanto a forrajes se refiere, (ver cuadro 3). También es apreciable un aumento en la concentración de minerales conforme se avanzen en la zona de Sur a Norte, (ver mapa 1).

No hubo diferencias significativas ($P<0.05$) entre distritos para las concentraciones de Mn, Cu, Fe Zn en hígado.

En los análisis de sangre hubo diferencias significativas (prob menor 0.05) para P y Mg entre Sabalito y Agua buena y entre San Vito y Limoncito respectivamente. No hubo diferencias significativas ($P<0.05$) entre distritos con Ca.

Los niveles de Ca, Mg y K en forrajes se encuentran dentro del rango normal sugerido por Cunha.

El P es deficiente en los distritos de Sabalito, San Vito y Agua Buena, presentando niveles menores de 0.17%. Limoncito contiene el nivel más alto (0.26%), el cual aún no satisface las necesidades de vacas lecheras en producción. El 19% de las fincas estudiadas muestras valores mayores de 0.25% en base seca, que es el requerimiento mínimo para ganado lechero.

El análisis de Ca serico revela un nivel marginal en los cuatro distritos, con valores que oscilan entre 8.04 y 8.77 mg/100 ml. Sin embargo ese dato no revela la verdadera situación con respecto al Ca, el cual se presenta en cantidades adecuadas para el ganado en los forrajes de los cuatro distritos.

El analisis de P sérico señala como marginal el distrito de Sabalito con un valor de 4.3 mg/100 ml, sin embargo en los otros distritos se presentan fincas con niveles deficientes. El hecho de que el análisis de P sérico no manifieste deficiencias se debe más que todo a la suplementación mineral que realizan el 70% de las fincas estudiadas. La deficiencia de P es muy severa en el Cantón, a juzgar por los resultados obtenidos en los análisis de forrajes, además de que se reportan síntomas clínicos muy relacionados con dicha deficiencia.

El contenido de Mn en los forrajes también se encuentra en una situación marginal. De un total de 36 fincas estudiadas, solo el 44% contiene valores mayores de 20 ppm. que es el requerimiento para ganado lechero . Se encontraron también valores deficientes de Mn en el hígado con variaciones de 3 a 4 ppm.

El contenido promedio de Cu en el forraje a nivel cantonal fue de 3 ppm, mostrando Sabalito el nivel más bajo (2 ppm) y Agua Buena el nivel más alto (4 ppm). En el hígado, el distrito de Sabalito presenta niveles normales de Cu, no así San Vito, ni Limoncito, que contienen promedios menores de 100 ppm.

En cuanto al Fe, se encontró valores bajos en los forrajes pero que satisfacen los requerimientos del ganado lechero. Sabalito contiene el nivel más bajo (44 ppm) y Limoncito el más alto (105 ppm)

En hígado los valores encontrados son deficientes (menores 200 ppm) en los tres distritos estudiados, lo que sugiere una mala utilización del Fe de los forrajes.

El contenido de Zn en los forrajes es mayor que los requerimientos sugeridos, en todos los distritos. Sin embargo, los análisis de hígados manifiestan una clara deficiencia, con valores que oscilan entre 49 a 54 ppm.

Vargas, R., M. A. Laredo, C. Buitrago. . Effect of supplementation of Ca, P, Cu and Zn on beef cattle. Contribución del Programa Nacional de Nutrición Animal - División de Ciencias Animales - CNIA - Tibaitata. Bogotá, Colombia.

Summary

This experiment was carried out at "Los Guayabos" farm of Fondo Ganadero del Tolima. Using Cebu heifers at 10 to 14 months of age. The two groups were grazing angleton grass (Dichantium aristatum) areas. One groups received an experimental mineral mixture and the test group received a commercial mixture.

The results showed that in the first periods the weight gain was 101.8 and 92.0 kg and in the total periods 141.8 and 137.8 kg. for experimental and test groups respectively. The 9.7 kg of difference in the first periods was significant ($P<0.05$) but not in the second period.

At the end of the two periods the weight gain was 78 kg for experimental mineral mixture, with 3.9 kg per animal, this difference was not significant, but a net increase of $140 per head was obtained, when compared with the test group.

At the end of the experiment 70% of experimental group and 65% of the test group were able to conceive.

The mineral content in pasture (Ca, P, Mg, K, Cu, Fe, Mn) showed that in the rainy season the values were higher than in the dry season in both groups.

In blood sample (serum) the mineral content was similar in both groups however, in the liver only the Mg, Zn and Fe were higher than the test group. At the beginning of the experiment the Cu content was low, but reached the normal level at the end of the experiment.

Vargas, Emilio, Ruth Vargas and Carlos Campabadal. 1981. Contenido de proteína y mineral de especies forrajeras durante la época seca y lluviosa en Costa Rica. VIII Reunión Asociación Latinoamericana de Producción Animal (ALPA) Resumenes, P-8.

El estudio tuvo como objeto conocer la composición mineral y de proteína de los principales especies forrajeras utilizadas para pastoreo de ganado de carne y leche en Costa Rica. Con este propósito se recolectaron durante la época seca (diciembre - mayo) 1143 y durante la época lluviosa (junio - noviembre) 1441 muestras de forraejs cultivados en 325 fincas localizadas en diferentes áreas geográficas del país. En todas las muestras se cuantificó su contenido de proteína, calcio, fósforo, magnesio, potasio, hierro, cobre, manganeso y zinc. Los resultados indican que el contenido de proteína y fósforo de los forrajes en la época seca es significativamente menor que en la época lluviosa, mientras que el contenido de magnesio y zinc es superior. Se encontró un promedio de la época seca. La información indica que durante la época lluviosa, al madurar las especies forrajeras, su contenido de hierro, manganeso y zinc aumenta, mientras que los otros nutrientes estudiados permanecen constantes. Se encontró que todas las especies forrajeras estudiadas sufren grandes cambios en su composición mineral por efecto del clima y suelo donde éstos son cultivados. Los datos sugieren asimismo, una deficiencia general en todo el país de fósforo, zinc y cobre. La proteína constituye un nutriente limitante únicamente durante la época seca en la zona árida del país.

Velásquez, José A. and Anibal Mata. 1979. Situación de la nutrición mineral en el estado Monagas. VI Reunión Asociación Latinoamericana de Producción Animal (ALPA), R-42.

El objetivo del presente trabajo fue estudiar la situación de la nutrición mineral del ganado bovino en siete fincas ganaderas ubicadas en las sabanas del Estado Monagas, mediante el análisis de muestras de suelo, forrajes y sangre de bovinos, durante las épocas secas y lluviosas de 1977. En las fincas seleccionadas se tomaron muestras del suelo de los primeros 20 cm., y muestras de sangre de la vena yugular a cinco vacas y cinco novillos por finca. Los promedios obtenidos en las muestras de suelo para pH, materia orgánica, calcio, magnesio, potasio, aluminio y fósforo 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 mg/100 g; 3.52 y 4.10 ppm, respectivamente. Los contenidos medios de nitrógeno, calcio, fósforo, magnesio, hierro, manganeso, zinc y cobre en las muestras de forrajes para las épocas resultaron ser: 0.16% y 0.19%; y 0.08 y 0.09%; 0.08 y 0.14%; 176 y 568 ppm; 106 y 143 ppm; 23 y 40 ppm; 3 y 7 ppm, respectivamente. La concentración media 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.

Velásquez, José A. 1981. Nutrición mineral en fincas ganaderas del oriente de Venezuela. VIII Reunión Asociación Latinoamericana de Producción Animal (ALPA) Resumenes, R-42.

Se estudió la situación mineral en fincas ganaderas ubicadas en las sabanas de los Estados Monagas, Anzoategui y Bolívar durante la época lluviosa del año 1979. Se muestrearon siete (7) fincas en el Estado Monagas, seis (6) fincas en el Estado Anzoategui y cinco (5) fincas en el Estado Bolívar, tomándose muestras de suelo de los primeros 20 cm., de forrajes a una altura mínima de 10 cm., y muestras de sangre de la vena yugular a diez vacas y diez novillos por finca. Los valores promedios obtenidos en las muestras de suelo para pH, materia orgánica, calcio, magnesio, potasio y fósforo para los Estados Monagas, Anzoategui y Bolívar fueron los siguientes: 4.82, 5.38 y 5.85; 1.18, 1.20 y 1.60%; 0.88, 0.50 y 0.80; 0.33, 0.48 y 0.70; 0.09, 0.06 y 0.11 meq/100g suelo; 4.10, 8.90 y 6.64 ppm, respectivamente. Los contenidos promedios de nitrógeno, calcio, fósforo, magnesio, hierro, manganeso, zinc y cobre en las muestras de forrajes para los Estados Monagas, Anzoategui y Bolívar resultaron ser: 1.18, .94 y 1.07%; .19, .29 y .29%; .09, .12 y .09%; .14, .21 y 18%; 567.5, 145.5 y 108.6 ppm; 143.0, 287.5 y 222.7 ppm; 40.4, 65.0 y 52.6 ppm; 6.5, 12.3 y 5.8 ppm; respectivamente. La concentración promedio de calcio, fósforo y magnesio en el plasma sanguíneo de los animales muestreados para los Estados Monagas, Anzoátegui y Bolívar fueron de 10.4, 9.3 y 9.7; 4.1, 5.7 y 4.8; 2.8, 1.9 y 1.8 mg/100 ml, respectivamente.

Villarreal Buenfil, Miguel H. 1977. Determinación de deficiencias y toxicidades minerales de ganado bovino en pastoreo en el municipio de Abasolo, N.L. (Invierno 1976). I. - Determinación de niveles. Thesis. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico.

Conclusiones

Bajo las condiciones en que se llevó a cabo este experimento y con los resultados obtenidos se puede concluir lo siguiente:

1. - Los análisis de forraje reportan niveles capaces de cubrir los requerimientos del animal en Ca, Mg, K, Mn, Zn y Fe.

2. - A su vez los forrajes reportaron cifras por debajo de los requerimientos de los animales en Sodio y Cobre.

3. - Se encontraron niveles bajos en suero de los animales en Cu, altos en Ca, Zn y Mn y normales en Mg, K, Na y Fe.

4. - Hubo diferencia significativa ($P < 5\%$) entre ranchos para Fe y altamente significativa ($P < 1\%$) para Na, Zn y Cu.

5. - Los contenidos de P fueron mayores para animales jóvenes que para adultos.

GRADUATE STUDENTS PARTICIPATING IN MINERAL RESEARCH SINCE 1974 TO PRESENT AND SOURCES OF FINANCIAL SUPPORT

Name	Country	Degree Program	Source of Funding
Carlos Lang	Costa Rica	M.S.	AID Feed Composition and AID-211D
Kiatoko Mangeye	Zaire	M.S. Ph.D.	Rockefeller Foundation Rockefeller Foundation
Ricardo Valdivia	Peru	Ph.D.	Rockefeller Foundation
Soekanto Lebdosoekojo	Indonesia	Ph.D.	Rockefeller Foundation
Marcelo de Oliveira Mendes	Brasil	Ph.D.	Ministery of Agriculture (EMBRAPA)
Julio Cesar de Sousa	Brasil	Ph.D.	Ministery of Agriculture (EMBRAPA)
David Morillo	Venezuela	M.S.	Universidad Central de Venezuela
Edmundo Espinoza	Bolivia	M.S.	Ministery of Agriculture (IBTA)-AID
Maximo Jerez	Dominican Republic	M.S.	Latin American Scholarship Program of American Universitie
Rodrigo Tejada	Guatemala	Ph.D.	Personal funds and AID Guatemala support
Oswaldo Rosero	Venezuela	Ph.D.	Universidad del Zulia
Ivan Rosa	Brasil	Ph.D.	Ministery of Agriculture (EMBRAPA)
Joshua. Mtimuni	Malawi	Ph.D.	FAO and Bunda College of Agriculture
Yousif Salih	Sudan	Ph.D.	Veterinary Research Administrati Khartoun
Esvan Paz	Venezuela	M.S.	Universidad del Zulia
Roberto Vargas	Colombia	M.S.	Personal Funds
Armando Peducasse	Bolivia	M.S.	Ministery of Agriculture (IBTA)-AID
Ana Maria Rocha	Mexico	M.S.A.	Ministery of Agriculture
Paul Gartenberg	U.S.A.	M.S.	Personal Funds
Scot Williams	U.S.A.	Ph.D.	University of Florida Assistanship
Maria Isabel Montalvo	Spain	Post Doctoral	Instituto Nacional de Edafologia y Agrobiologia Jose M. Albareda