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A survey of goat and cattle diseases in the Artibonite Valley, Haiti, West Indies

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Une étude de 40 semaines portant sur 43 fermiers, 60 chèvres et 60 bovins a été effectuée afin d'identifier des conditions anormales ou des maladies, et les facteurs prédisposants saisonniers, liés à la gestion ou à la nutrition. Les exploitations ont été visitées 4 fois, approximativement toutes les 10 semaines, les fermiers ont été questionnés, les animaux examinés et leur sang prélevé pour l'hématocrite, le nombre total de leucocytes et le taux de certains vitamines et minéraux dans le sérum. Des poils, de la terre et du fourrage ont été prélevés pour analyse. La condition du bétail était généralement passable, la croissance et la reproduction étaient mauvaises. Une déficience calorique inattendue pendant la saison des pluies, et des déficiences graves en phosphore et moindres en vitamine A et E, ont été constatées. Une anémie due au parasitisme était fréquente chez les deux espèces, surtout chez les chèvres. Les bovins avaient des tiques, les chèvres des poux. Une diarrhée et de la mortalité néonatales étaient signalées chez les chèvres, et on a observé une dermatite exfoliative, des verrues, une dermatophytose et peut-être de l'ecthyma contagieux. Le charbon bactéridien et la babésiose étaient signalés chez les bovins, et une vaginite vésiculaire, de l'orchite et des verrues des trayons ont été observées.

Mots clés : Bovin - Caprin - Enquête pathologique - Carence minérale - Parasitisme - Méthode d'élevage - Croissance - Performance de reproduction - Alimentation des animaux - Influence de la saison - Haïti.

INTRODUCTION

Poor reproductive and growth performance in Haitian goats and cattle has been consistently observed by two of the authors (ANGERT, VEIT) for as long as 28 years and by others. The cause had been presumed to relate to nutritional deficiencies but had not been confirmed by much objective data (5). This study was initiated to identify obvious abnormal conditions or diseases that existed in a defined group of goats and cattle over a period of 40 weeks and to identify related seasonal, nutritional, and management factors. Livestock were examined up to four times in their local environment, forages and related soils were examined and analyzed, and animal handlers were interviewed at each visit. This report reviews the diseases or abnormal conditions reported or noted in the livestock, along with the major predisposing seasonal and nutritional factors. An associated report will focus on reviewing the relationship of Haitian ruminant production management to these diseases.

MATERIALS AND METHODS

Selection of farms and livestock

The region of study was within a 12-mile radius of Deschapelles, Haiti, within the Artibonite Valley, and was selected because of a long-term (about 37 years), community development program provided by Hospital Albert Schweitzer (HAS) for the study region, which included veterinary medical, animal husbandry, and horticultural extension programs, and technical support. This long-standing relationship between HAS and the participating farmers enhanced the cooperation and reliability of questionnaire responses of the farmers with our investigative team. Therefore, the farmers selected were not a random sampling of small Haitian farmers or even of those within the Artibonite Valley. Also, this region had long-term irrigated soils as well as non-irrigated highlands, allowing us to examine the effects of irrigation and/or topography on soil and forage conditions and indirectly on animal health. Finally, the Artibonite Valley region has been considered a highly productive agricultural region in the country. Hence, agricultural research in this region is potentially useful to any future agricultural production improvement in Haiti. The specific criteria for selection of farmer participants in this study were :

- They must have been participants in a new voluntary program for preventive deworming of goats offered by the HAS veterinarian just prior to this study. Participation by these farmers in this deworming program showed above average interest in their animals' health.

- They had to be regularly responsible for the care of study goats and/or cattle during the time of the study.

- They must live near the nearby communities of Desarmes, Halaire, Marin, or Hatte Bellanger for logistical and topographical reasons.

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- They must be small farm managers. They were grouped into one of three economic farming classes based on their responses to two questions "Have you ever bought any land?" and "Do you ever sell your daily labour?" Those answering "yes" to the first question and "no" to the second were classified in the highest economic group, those answering oppositely to these two questions were considered lowest on the economic scale, and those answering either "yes" or "no" to both questions were grouped between the first two groups. Farmers from all three classes were included.

- They must have a small-to medium-sized goat and/or cattle herd (range 1-31 head, mean = 5.6 head/farmer). From a pool of 121 farmers who were given initial questionnaires, 43 farmers with 56 cattle and 56 goats (about half of their stock) were selected for this study. The HAS veterinarian, four of his goats, four of the HAS cattle, and some HAS farm soils and legumes were also included for comparison with the Haitian farms, providing a starting total of 60 goats and 60 cattle and a finishing total of 45 cattle and 34 goats.

Farm visitations

The investigation team consisted of three Haitian animal technicians, a Haitian interviewer, an expatriate veterinarian, and an expatriate coordinator fluent in Haitian Creole. Visits were conducted January 27 - February 6, March 31 - April 5, June 9 - 14, and August 18 - 22, 1986. At the initial visit, all participating animals were ear tagged. At all visits, a physical examination was performed on each animal, age estimated by dentition and by farmer's estimation, and weight estimated by girth tape measure for goats and cattle and also by scale weight for goats. Any missing animals were accounted for on subsequent visits. The haircoat, skin, eyes, conjunctiva, oral cavity, mammary glands, external reproductive organs, legs, tail, and feet were examined. Rectal examination of cattle was usually performed. Respiration rates were recorded, and lungs, hearts and rumens were ausculted. Blood was collected by jugular venipuncture into EDTA and clotting tubes. All blood was stored in an ice-chilled, lightfree environment until freezing or processing two to eight hours later. Blood was analyzed for hematocrit, total and differential white blood cell counts, serum Ca, P, Mg, Fe, Se, Zn, and vitamins A and E. Bovine switch or caprine tail hair was collected in plastic bags, iced, and frozen two to eight hours later, for analysis for Ca, P, Mg, Fe, Se, and Zn. A total of 38 soil samples were taken, based on observed use for grazing or feeding of goats or cattle, crop types, topography, and irrigation availability. Standard soil samples and soil sampling boxes were used ; samples were double bagged and frozen at -2°C two to eight hours after collection until analyzed. Sixty-two forage samples in the process of consumption or harvested for consumption were collected in cotton bags, oven dried at 60°C for 24 hours, sealed in plastic bags, and stored at room temperature until analysis. On each visit, a questionnaire was administered to the person responsible for daily management of each animal. Topics covered, respectively, were reproduction, feeding and nutrition, health and disease, labour and marketing. The questionnaires were written in both English and Haitian Creole with all dialogue done in Creole. Questionnaires and physical exam data were summarized in table or graph forms. Where possible, comparison to known normal values was made.

Laboratory analyses

Hematology

Blood was collected for serum mineral and vitamin analysis, hematocrit, and total and differential white blood cell counts. Hematocrits were determined by standard micropipette procedures and total white blood cell counts done with pipette and hemocytometer procedures. Differential white blood cell counts were done after Wright staining of blood smear slides, using standard laboratory procedure (200 cell counts).

Vitamin and mineral assays of serum, hair and forages

Serum samples were iced in a light-free environment for two to eight hours after collection, centrifuged, then frozen at -2°C and analyzed for Ca, P, Mg, Fe, Se, Zn, vitamin A, and vitamin E at Virginia Polytechnic Institute and State University. Ca, Mg, Zn, and Fe were determined with a Perkin-Elmer atomic absorption spectrophotometer (model 403) using standard operation manual procedures. Serum Se was determined after digestion with nitric acid and perchloric acid in a model 460 Perkin-Elmer atomic absorption spectrophotometer at 196 nm (9). Serum P was determined by a colorimetric procedure (7) and absorbance read on a spectrophotometer at 660 nm. Serum vitamin E was assayed by a microprocedure of FABRANEK *et al.* (6), and serum vitamin A by the KIMBLE procedure (10) with modifications described by DUGAN *et al.* (4). Hair and feed samples were analyzed as described above with the additional steps of washing the hair using a previously described procedure (3), and wet ashing of hair and feed by nitric acid/perchloric acid digestion (9).

Soil analysis

Standard procedures were used for soil samples including air drying, grinding and sieve passage, pH determination, and analysis of extracts for P, K, Ca, Mg, Zn, Mn, Fe, and Cu, by inductively-coupled plasma optical emission spectrometry and chromic acid oxidation determination of organic matter.

RESULTS

Rainfall

In the region of this study, there is a cyclic wet (March-Oct.) and dry (Nov.-Feb.) season. Through 1986, the Deschapelles rainfall measured by HAS staff rain gauge was 7.2, 43.2, 75.1 cm, and 24.2 cm per quarter, respectively, with December having the least rain (less than 1 cm), July the most (29.6 cm), and the other months showing intermediate levels between those of December and July.

Questionnaire data

The questionnaires were usually answered by the person most responsible for the daily care of a given animal. Usually, the caregiver was the owner or in the owner's immediate family but rarely was unrelated and hired to do the work. We received excellent cooperation and reliability of responses, due to the selection for participants with a previous history of cooperation with HAS. Even so, the responses often lacked preciseness or objectivity to many questions. Given the lack of quantitation, subtle relationships could have been missed ; however, variations (of management, animal health or disease, and body condition) generally were noted between herds but not noted between economic groups, location, or herd size.

Feed availability for goats was reported as highest in December (early dry season) and lowest in February and March (late dry season), while feed availability for cattle was reported highest in July (mid rainy season), and lowest in February and March. The reported unavailability of feed for both goats and cattle during February and March coincides with the late dry season general shortage of feed. The difference in feed availability between goats and cattle was thought to be due to the fact that goats are fed more consistently by browsing or scavenging harvested fields or human crop residuals, while cattle are more consistently tethered and fed whatever is available from cultivated or perennial plants. This makes the rainy season more likely to provide cattle feed while the early dry season tends to provide more feed for goats.

None of the 43 farmers in this study reported planting any crop dedicated to feeding goats or cattle, and none provided any concentrate or mineral supplement, beyond salt which was used on dry corn husks to stimulate their consumption or as a treatment for presumptive parasitic diarrhea. Water was reported to be carried to goats daily by 93 % of the handlers, and all cattle were reported to be walked to water sources at least once daily. Observations led to a suspicion by our study team that the watering practices were not as fastidiously practiced as reported, especially during the rainy season. Such times left farmers busy planting, and there was a tendency to neglect livestock. Also, because of increasing rainfall, there was a presumption by some handlers that if the stock were rained on, they likely consumed sufficient water directly or via plant material.

A summary of reproductive activity is in table I. The status of goat reproduction was poorly observed by the Haitians. Only 50 % knew the age of puberty for their bucks, but it appeared to range from two to six months with three to four months most commonly reported. Inbreeding was suspected to be common by us but rarely acknowledged by the farmers. Was suspected such because of the general ease of contact between most sexually active male and female goats year round but particularly during the dry season. No defined sire selection or breeding management was identified. Does appeared to reach puberty at 10 to 12 months of age with about 50 % of farmers recognizing œstrus behavior or signs with highest sexual activity in March and April, and greatest kidding incidence in August and September confirming that breeding activity was highest when reported. Apparently, there is also a smaller breeding season in September and October with February to March kiddings. The kidding interval was estimated to be about 11 months with 1.9 kids per parturition based on composite calculations using questionnaire data and direct observations. Two abortions and one stillbirth were reported within the 47 female goats (28 pregnancies) within the 40 weeks of the study. Some owners claimed a plant called "lian pwagrate" (*Mucuna pruriens* or cow itch) caused abortion in goats. We could not verify this. Interestingly, this plant is used as an anthelmintic in other parts of the West Indies.

Cattle reproduction also was difficult to assess due to sketchy observations of farmers. Most (2/3) did not know the age that their bull reached puberty while the others estimated 15-18 months. Of those observed, all bulls over 18 months were determined to be sexually active. Higher

TABLE I Summary of reproductive activity in Haitian goats and cattle.

	Goats	Cattle
age of puberty - males	3-4 m	15-18 m
- females	10-12 m	20-24 m
breeding seasons	Mar.-Apr.	Mar.-Apr.
	Sept.-Oct.	Déc.-Feb.
gestation interval	11 m	24 m
services per gestation	ND[a]	ND
progeny per gestation	1.9	1.0
abortion rate[b]	7.2 %	0.0 %[c]
stillbirth rate[b]	3.6 %	0.0 %[c]
dystocia rate[b]	0.0 %[c]	0.0 %[c]

a - ND = Not determined due to insufficient data.
b - rate = event per pregnancy x 100 %.
c - Covered in the questionnaire but not reported by farmers or observed by investigators in study animals.

sexual activity was reported in March and April, as with goats and to a lesser degree, in December through February. There was no knowledge of breeding rates or conception rates in females of this study. Slightly less than half of the owners remembered first œstrus of their heifers or cows, but it appeared to average 24 months. Signs of œstrus recalled in order of frequency were vocalization, swollen vulvas, mounting behavior, and tail lifting. Œstrus activity was reported as highest in February to April with calvings highest November to February. Nearly all cow handlers said their cows were bred by someone else's bull, but they could not recall the number of services per conception. Most cow handlers knew approximately when their cows were bred if pregnant and when they would calve. Pregnant cattle were occasionally (12 % of the time) given extra care or feeding. Dystocia and abortions in cattle were not reported or observed in any cattle of this study. Age at first calving was known by only one-third of the farmers (N = 8) and was calculated to a mean of 29 months ; calving interval thereafter averaged 22 months (N = 11). Based on the age of first calving, it has to be presumed first œstrus must be occurring prior to 24 months, at least by 20 months, but is not recognized. Based on observed calvings, the calving interval was estimated to be 24 months. Part of the discrepancy in data also may be due to the fact that those cattle handlers who recalled breeding or gestational events were better managers of their livestock and had slightly better performance statistics. Postparturient œstrus activity was poorly recognized when it occurred ; it was reported from three to one hundred four weeks with a mean of nineteen weeks. If the true calving interval was about 24 months, there was an average of a 15-month interval between parturition and next conception.

The general perception and reported incidence of disease by these Haitian farmers is that 74 % of their goats and 82 % of their cattle were never sick. Supporting this perception, the attending HAS veterinarian reported a low incidence of severe clinical illness or deaths in goats or cattle other than persistent thinness often with internal parasitism. The observations, physical examinations, and questionnaires confirm that while there was little catastrophic disease among the study animals, there were a number of important health problems. A summary of the more commonly reported and observed diseases or conditions of goats and cattle is in table II.

Goat handlers considered "diarrhea" as their most serious sickness (91 % response*), the most frequently seen illness (53 %), and associated with the early rainy season (April and May). Most goat handlers (93 %) did not know any cause of diarrhea, a few reported sweet potato vine ingestion could cause diarrhea. HAS veterinarians see a high correlation of such diarrhea with internal parasite loads which are highest in the early rainy season. About one-third of goat handlers gave salt to their diarrhea-producing goats. Seven percent took them to the veterinarian for deworming. About 60 % did not know of, or use any treatment, 40 % of these people reporting goat deaths, 47 % recovering, the rest maintaining chronic diarrhea. Those goats in the group which were provided salt or taken to the veterinarian for deworming did not die and usually recovered. Lice were reported as the second most common problem (47 % frequency). Death rate of affected animals due to lice was reported to be 17 %, and recovery 65 %, especially with either of two treatments : one-fourth of the farmers visited the veterinarian, while one-fourth bathed the goats in the leaves of the "ti labé" tree (*Alveradoa hautiersis*). Most Haitians had no idea about cause or predisposing factors for lice infestation. Some cited rainy weather or "bad" food as the cause.

"Malcharbon" or anthrax was named as being the most frequently seen bovine disease (58 % response) and the most serious (71 % response). The disease is reported to affect both young and old cattle, but it was never mentioned to occur in goats, horses or swine. No reported treatments were named. No cases of anthrax were noted or diagnosed by the investigative group of the authors or the HAS veterinarians. Internal parasites, diarrhea, and colic attributed to parasites were named by 18 % of the handlers as the second most frequent problem. The only treatment mentioned for diarrhea was going to the veterinarian, and no deaths were reported to be associated with internal parasitism with or without treatment. Ticks were mentioned as the next most frequently noted problem (16 % response). Animals were rarely treated, and all handlers said the animals recover with no treatment.

Physical examination

Physical examinations of the goats and cattle were highly enlightening. Average weight of mature nonpregnant goats was 62 pounds. Examination of body weights over the four periods of this study indicated that goats lost weight from the early to late rainy season, while cattle gained during the rainy season (table III). Even so, only 3 of 60 goats examined were classified as emaciated. No ticks were ever found, and only one female goat had a heavy louse infestation while one other had a few lice. Many goats (26.6 %), nearly all females, had a dull hair coat with distinctively dry, flaky skin or dandruff which we called a superficial exfoliative dermatitis. A few kids had ringworm-like lesions, three goats had fibroma-like solitary skin nodules, one female had teat ulcers and her kid had mouth ulcers compatible with contagious ecthyma. Another goat had oral lesions which the owner ascribed to the ingestion of a cactus plant, "kandelab" (*Euphorbia*

* Reported response is the perception of the farmer to the incidence and seriousness of a disease in his area. It is not the actual incidence of the disease in his herd. The latter incidence and mortality figures are present in table II.

TABLE II Estimates of reported and observed diseases or conditions in goats and cattle from selected farms in the Artibonite Valley (Dechapelles region), Haiti, West Indies.

A. Goats

Goat diseases or conditions reported via questionnaires		
Condition name	Incidence (%)	Overall mortality rate (%)
1. Internal parasitism, presumptive	16.0	6.4
2. Pediculosis (lice)	12.0	2.0
3. Abortion	7.2[a]	7.2[a]
4. Neonatal death, cause unknown	7.2[a]	7.2[a]
5. Stillbirth	3.6[a]	3.6[a]
6. Neonatal death, with diarrhea	3.6[a]	3.6[a]
7. Neonatal death, with maternal mastitis	3.6[a]	3.6[a]
Goat diseases, conditions or lesions observed during study		
1. Low serum phosphorus	80.0	0.0[b]
2. Low serum vitamin E	76.0	0.0
3. Parasitic anemia, presumptive	42.0	0.0
4. Superficial exfoliative dermatitis	26.6	0.0
5. Low serum vitamin A	23.0	0.0
6. Teat lesions	7.0	0.0
7. Fibroma(s)	5.0	0.0
8. Vaginal discharge, mucoid	5.0	0.0
9. Contagious ecthyma, presumptive	4.0	0.0
10. Ringworm, presumptive	3.3	0.0
11. Pediculosis (lice)	1.9	0.0
12. Mastitis	1.7	0.0
13. Solar dermatitis	1.7	0.0

a - This is the incidence based on 28 reported pregnancies.
b - No mortalities were reported for any of the study animals within the duration of this study

B. Cattle

Cattle diseases or conditions reported during questionnaires		
Condition name	Incidence (%)	Overall mortality rate (%)
1. Internal parasitism, presumptive	18.0	0.0
2. Ticks	2.8	0.0
3. Anthrax, possible	2.0	2.0
Cattle diseases, conditions or lesions observed during study		
1. Low serum phosphorus	85.0	0.0
2. Tick infestation, few to light	55.0	0.0
3. Vesicular vaginitis	32.0[a]	0.0
4. Low serum vitamin A	31.0	0.0
5. Low serum vitamin E	27.0	0.0
6. Parasitic anemia, presumptive	19.0	0.0
7. Testicular hypoplasia	17.6[a]	0.0
8. Orchitis/epididymitis	11.8[a]	0.0
9. Papillomas	11.6	0.0
10. Focal dermatitis, presumptive	10.0	0.0
11. Teat lesions, including warts	8.1[a]	0.0
12. Parasitic diarrhea	6.7	0.0
13. Mastitis	5.4[a]	0.0
14. Oral ulcers, mild	5.0	0.0
15. Vulvar dermatitis	3.3[a]	0.0
16. Babesiosis	1.0[b]	0.0

a - This incidence is of the eligible members of the appropriate gender, not all the animal species of the study.
b - This animal was outside the study, but within a group of HAS cattle in the study. Diagnosis was made by the attending HAS veterinarian.

Table III Mean animal weights (lbs.) by sampling period.

	1st Period (1/1-2/6)[b]	2nd Period (3/3-4/5)	3rd Period (6/9-6/14)	4th Period (8/18-8/22)
Point in rainy season	(Dry)	(Early Rainy)	(Rainy)	(Rainy)
Mature Female Goats[a]	73	68	57	57
Mature Female Cattle[a]	612	639	641	663

[a] No animals who kidded or calved during the course of the study were included in these figures.
[b] Month/date.

lactes). Males appeared free of any reproductive tract lesions while three females (5 %) were noted to have a mucoid (nonpurulent) vaginal discharge without other signs of œstrus. Of 25 births, four neonatal deaths were reported, one associated with maternal mastitis, and one with neonatal diarrhea. Severe mastitis was noted in one mature lactating female, and a variety of teat wounds in four others. One male was noted to be coprophagic, while two adult females were observed with diarrhea. Conjunctival grading (pink, pale, or white) was successful in detecting the severe anemias in 62 % of the goats having hematocrit values of 20 or below but tended to miss the less anemic states (hct of 20-24 %). Blood analysis showed low packed cell volumes in 33-73 % of the goats, depending on sampling period, and high total white cell counts in 5-87 % (mean = 43 %) of the goats, compared to normal values of U.S. goats (tables IV and V). Random differential WBC showed 19 % of goats had an eosinophilia and 25 % had monocytosis.

The average weight for mature, nonpregnant cattle was 639 pounds as estimated by girth measurements (table III). Body condition was fair or better in 15/17 males and

Table IV Normal values for hematocrits (PCV) and wite blood cell counts.

	WBC (x10³/cu mm)	PCV (%)	Basophils (%)	Eosinophils (%)	Band Cells (%)	Neutrophils (%)	Lymphocytes (%)	Monocytes (%)
Goats	4-13	24-38	0-2	3-8	rare	30-48	50-70	1-4
Cattle	4-12	26-46	0-2	2-20	0-2	15-45	45-75	2-7

Table V. Hematology by sampling period.

	1st Period			2nd Period			3rd Period			4th Period		
	LOW PCV[a]	HIGH WBC[b]	LOW WBC[c]	LOW PCV	HIGH WBC	LOW WBC	LOW PCV	HIGH WBC	LOW WBC	LOW PCV	HIGH WBC	LOW WBC
Goats	42 %	27 %	2 %	35 %	5 %	5 %	33 %	87 %	0 %	73 %	57 %	0 %
Cattle	22 %	5 %	2 %	18 %	0 %	18 %	19 %	38 %	0 %	17 %	22 %	0 %

[a]*Low PCV = 24 % or less for goats, 26 % or less for cattle.*
[b]*High WBC = above 13,000 for goats, above 12,000 for cattle.*
[c]*Low WBC = below 4,000 for goats and for cattle.*

38/43 females. Examination of cattle showed ticks present 55 % of the time with 35 % of the incidents having only 1-12 ticks. Few cattle had enough ticks to cause large blood loss, but many had enough to transmit blood-borne diseases. No lice were observed. Skin lesions included seven females with warts, six of which were on the udder, one of which involved the teats so severely as to prevent milking or nursing. There were six cases of "gal", a Creole term for raised, plaque-like epidermal lesions listed as focal dermatitis in table I. The etiology of these nodules was unclear but may have been flattened papillomas, fibromas, or more likely solitary focal epidermal infections, possibly fungal or bacterial. These lesions did not appear troublesome for the affected animals. Two of the 17 males (11.8 %) had signs of orchitis and/or epididymitis, indicated by swelling and sensitivity of the testes and/or epididymal tissues. Three of five young males (under one year of age) had abnormally small or undescended testes. Twelve of the 37 sexually active females (32 %) had a vesicular vaginitis at one or more physical examinations. There were a few cases of vulvar dermatitis, a few teat wounds, and two cases of mastitis. Three cattle had a few oral ulcers, three had diarrhea or bloody feces with no other clinical signs, and one had tapeworm segments in the feces. Total white blood cell counts of cattle showed abnormally high counts in up to 38 % of the cattle at each period (mean – 16 %), and the hematocrit was low from 17-22 % of the time, per period, or a mean of 19% of the time (tables IV and V). Random cattle differential white blood cell counts showed an eosinophilia 3 % of the time and a monocytosis 10 % of the time.

Serum mineral and vitamin analysis

The caprine serum values obtained for the six minerals and two vitamins over the four periods of this study are summarized in table VI. Ca, Zn, Mg, Fe, and Se were normal to high normal in all four time periods. P values were low for two (third and fourth period) of the four time periods, and in 21 % of the animals in the other two time periods. Mean serum vitamin E was low in two of the four time periods and pervasive in that 76 % of the goats had at least one low serum vitamin E value. There was an expected increase in serum P in younger stock, presumed proportional to milk intake from nursing, and a converse reduction in nursing does versus nonlactating does. Mean vitamin A values were all normal (>20.0 µg/dl) for each period. However, 23 % of the goats had at least one subnormal serum value for vitamin A. Low serum vitamin A values are potentially more serious in goats than cattle because of a lack of plasma betacarotene in goats.

Mean bovine serum P values were subnormal in the third and fourth periods (table VII) with 23 % of individual animals also having subnormal serum P in the first two periods. Serum P tended to be higher in nursing calves. Mean serum vitamin A values were in low normal range for all four time periods and mean serum vitamin E values low normal in two of four periods ; however, 27 % of the cattle had at least one subnormal serum vitamin E value, and 31 % of the cattle had one subnormal serum vitamin A value during the study. Mean serum Fe levels were at the upper end of normal values in all four periods, while serum Ca, Mg, Se, and Zn were normal to high normal.

TABLE VI Mean and minimal acceptable mineral and vitamin serum levels of goats.

Nutrient	Overall mean serum level	Mean serum levels by period				MAC for Cattle
		1	2	3	4	
Ca (mg/dl)	11.7	13.7	11.8	10.3	10.0	8.0[a]
P (mg/dl)	4.78	6.08	6.42	2.46	2.37	4.5[a]
Mg (mg/dl)	3.90	3.67	3.79	4.18	4.17	1.0[a]
Fe (µg/dl)	261	276	274	249	229	90.0[a]
Se (µg/ml)	0.35	0.36	0.32	0.38	0.34	0.03[a]
Zn (µg/dl)	119	122	112	130	117	60.0[a]
Vit. A (µg/dl)	28.5	26.4	27.3	29.5	33.0	20.0[b]
Vit. E (µg/dl)	68	105	94	36	37	70.0[c]

[a] *McDOWELL et al., 1983. (Nomenclature « Critical Serum Levels » changed to « Minimal Acceptable Concentrations (MAC) ».)*
[b] *FRASER, CM, Ed., Merck Veterinary Manual, 6th ed., 1986.*
[c] *NORTON & McCARTHY, 1986. (All of above in bibliographical references).*

TABLE VII Mean and minimal acceptable mineral and vitamin serum levels of cattle.

Nutrient	Overall mean serum level	Mean serum levels by period				MAC for Cattle
		1	2	3	4	
Ca (mg/dl)	13.0	15.8	12.0	11.7	11.2	8.0[a]
P (mg/dl)	4.47	5.04	5.66	2.72	3.08	4.5[a]
Mg (mg/dl)	3.96	3.93	3.81	4.06	4.16	1.0[a]
Fe (µg/dl)	264	245	292	266	258	90.0[a]
Se (µg/ml)	0.36	0.35	0.36	0.41	0.36	0.03[a]
Zn (µg/dl)	145	147	137	145	152	60.0[a]
Vit. A (µg/dl)	27.7	26.0	26.2	31.5	30.7	20.0[b]
Vit. E (µg/dl)	132	161	158	84	81	70.0[c]

[a] *McDOWELL et al., 1983. (Nomenclature « Critical Serum Levels » changed to « Minimal Acceptable Concentrations (MAC) ».)*
[b] *FRASER, CM, Ed., Merck Veterinary Manual, 6th ed., 1986.*
[c] *NORTON & McCARTHY, 1986. (All of above in bibliographical references).*

Hair mineral analysis

Only Zn levels were lower in Haitian goats than in other goat hair analyses (table VIII). Other minerals (Ca, P, Fe), were higher than in reported normals, while Mg was slightly lower. We could not find normal goat hair values for Se (1.18 ppm in this study), but by using cattle hair Se values (table IX), the caprine hair Se value was low normal. More studies have been done with cattle hair, allowing greater comparison (table IX). Based on the data of the authors, P was very low, Mg and Fe were lower than normal, Ca and Se were in low normal range, while Zn was in normal range.

TABLE VIII Hair mineral concentrations in Haitian goats and concentrations reported in other studies.

Mineral	Mean Haitian goat values (ppm)	Previously reported values[a] (ppm)
Ca	2395	1605
P	343	279
Mg	205	264
Fe	36	20
Se	1.18	–
Zn	82	128

[a] *COMBS (D.K.) Dept. of Dairy Sci., University of Wisconsin, Madison. (Personal communication).*

TABLE IX Hair mineral concentrations in Haitian cattle and concentrations reported in other studies.

Mineral	Mean Haitian cattle values (ppm)	Previously reported values[a] (ppm)
Ca	590	265 – 3,208
P	38	190 – 516
Mg	60	114 – 270
Fe	11	29 – 70
Se	0.31	0.06 – 10.00
Zn	219	122 – 342

[a] *COMBS (D.K.) Dept. of Dairy Sci., University of Wisconsin, Madison. (Personal communication).*

TABLE X Comparison of hight- and medium-access Haitian goat forages with recommended sheep mineral requirements.

Mineral	Mean forage levels by period				Dietary requirements[a]
	1	2	3	4	
Ca (%)	1.00	1.11	0.54	0.50	0.21 – 0.52
P (%)	0.07	0.09	0.06	0.06	0.16 – 0.37
Mg (%)	0.15	0.15	0.21	0.14	0.04 – 0.08
Fe (ppm)	252	383	252	262	30 – 50
Se (ppm)	0.15	0.11	0.20	0.25	0.1
Zn (ppm)	79	61	49	49	35 – 50

[a] *National Research Council (NRC), Washington, D.C. (1975). All values are expressed as concentrations in dry matter.*

TABLE XI Comparison of hight- and medium-access Haitian cattle forages with recommended cattle mineral requirements.

Mineral	Mean forage levels by period				Dietary requirements[a]
	1	2	3	4	
Ca (%)	0.81	0.85	0.53	0.56	0.22
P (%)	0.07	0.07	0.06	0.08	0.20
Mg (%)	0.13	0.14	0.20	0.17	0.10
Fe (ppm)	271	427	215	311	20
Se (ppm)	0.19	0.13	0.27	0.20	0.1
Zn (ppm)	87	58	34	71	40

[a] *Requirements for Ca and P from NRC (1976). Requirements for other minerals from NRC (1983). All values are expressed as concentrations in dry matter.*

Forage analysis

Forage samples were analyzed for mineral content and accessibility at the four different sampling time points (tables X and XI). These tables show a high forage Ca level and persistently low P levels, creating an absolute P deficiency for goats (16-56 % of requirement) and cattle (30-40 % of requirement). Forage values below 0.10 % in dry matter usually are compatible with clinical signs of P deficiency (15) ; in all but two cases, all forage analyses were below 0.10 % P. In this study, the Ca to P ratio ranged from 7.0:1 to 14.3:1, well above the recommended 1:1 at low P dietary intake or 2:1 at higher P levels (11). Forage Se and Zn were generally adequate with a few forages below minimal values. Forage Fe was very high (17-21 times cattle requirements and 8-13 times the goat requirements), but still below 1000 ppm, considered the maximum tolerable limit. The high serum Fe levels and low caprine hair Zn noted raise the possibility of interference with Zn metabolism even though serum Zn levels were adequate for both cattle and goats.

Soil analysis

The soils taken for analysis showed they were classified as Eutric Flurisols by FAO/UNESCO Soil Map of the World (1972), which is equivalent to Eutric Fluvents by

the USDA Soil Taxonomy System (2). The soils were relatively fertile, had a basic reaction, contained free carbonates, and were relatively high in organic matter. The soils were low in P and Zn, with 71 % of samples expected to respond to P fertilization and 55% expected to respond to Zn supplementation when cropped with corn, sorghum, grasses, or beans. A few soils (under 10 %) had marginal magnesium levels, and the aforementioned plants could be expected to respond to magnesium supplementation in these soils.

DISCUSSION

The Haitian farmers in this study were not representative of all Haitian farmers in the Artibonite Valley or elsewhere in Haiti. As a group, these farmers appeared to have above average interest in goat and cattle production. They had variable management skills but had had access to veterinary care and animal science programs for approximately 37 years at Hospital Albert Schweitzer. Further, the Artibonite Valley is considered a "bread basket" for Haiti, in that it has been endowed with excellent soils, reliable rainfall, and fairly consistent irrigation capabilities since French colonial times. Therefore, the data collected and presented in this report are presumed to overestimate general ruminant health and underestimate the incidence or severity of goat and cattle diseases in both the Artibonite Valley itself and elsewhere in Haiti. Given this sampling bias, what was found still was not encouraging and suggests there is much potential for improvement of reproduction and production efficiency.

The major focus of this report is goat and cattle disease assessment. However, consideration needs to begin with the soils of this region. Clearly, the soils are reasonably fertile with one major exception, that is, a pervasive P deficiency. There is also a lesser Zn deficiency, relative to optimal plant growth, particularly with the interference of Zn availability due to the high pH, Ca, and Fe levels. Evaluation of the available forages indicates remarkably high Ca/P ratios and nearly complete plant deficiency of P. Only two plants (okra leaves, *Hibiscus esculentus*, at 0.2 ppm and a plant termed "balé" in Creole, *Sida* spp., at 0.1 ppm) exceeded the minimal level of P (0.10 ppm of dry matter) necessary to avoid clinical phosphorus deficiency (15).

The plants absorb P poorly, not only because it is in low absolute amounts in these soils, but also because of the high organic and carbonate levels, and the basic pH, all of which reduce plant availability. Given that little or no concentrates or mineral supplements were fed to the goats and cattle, it can be appreciated that nearly all of the animals in this study were consuming a diet very likely to cause an absolute P deficiency. In addition to the absolute P deficiency, its combination with high soil Ca creates Ca/P ratios (7.0:1 to 14.3:1) which are also acknowledged to affect growth rate, reproduction, and lactation of ruminants (17). It was noted that the mean serum P levels for both goats and cattle were low in two of four periods, and 23 % of cattle and 21 % of goats had at least one subnormal serum P value in the other two periods. The goat and cattle serum P and bovine hair P values support the diagnosis of P deficiency in both goats and cattle which was particularly bad during the middle to late rainy season (third and fourth sample periods). This points to seasonal or climatic effects which affect P availability and/or solubility in the soil and ultimately in the plants and livestock. Lactation and pregnancy provided particularly strong metabolic stress on the mature females, while lactation helped the neonates receive P. These variable effects were confirmed by trends in differences of serum P in the respective subgroups of goats and cattle.

Phosphorus deficiency is reported to produce a variety of effects including reduced growth rate, impaired reproduction, pica, and bone and joint abnormalities (15). All of these signs except noticeable bone or joint diseases were commonly observed or reported in the animals of this study. Poor haircoats or skin condition are sporadically associated with P deficiency, and such was noted with the female goats, and in other animals to a lesser degree. In cattle, another sporadic disease associated with P deficiency is called post-parturient haemoglobinuria, which appears about three to eight weeks postparturition in lactating cows. Whether this disease occurs in Haiti is unknown, but if it does, it could be mistaken for a variety of clostridial diseases (including anthrax), babesiosis, anaplasmosis, or leptospirosis. Elsewhere, anthrax is reported to occur not only in cattle but also in goats, sheep, swine, and horses (8). In this study, anthrax was reported only in cattle, but never observed. Hence, we suspect the common but unconfirmed diagnosis of anthrax may be incorrect at least some of the time. This needs to be resolved.

Infertility associated with P deficiency is often reported but not well understood (1, 11,15). It is best known in cattle but can also occur in goats (13). Cattle fed a P deficient diet show a delayed onset of puberty and postpartum œstrus, increased services per conception, and possibly an increased incidence of cystic follicles. Anœstrus is the most often reported affection in goats with cystic follicles, which is occasionally noted in goat herds with P deficiency. There is a high probability that the slow growth, longer time to puberty, and the long kidding and calving interval seen in the cattle and goats of this study are related to the obvious P deficiency as reported by others (11,12, 13).

Zinc was marginally low or suboptimal in some of the soils, plants, and animals of this study. Gonadal hypoplasia noted in male calves also is compatible with Zn deficiency. The low serum vitamin A and vitamin E, and low goat hair Zn values also raise the possibility that these nutrients were occasionally deficient and could also have produced or contributed to the infertility and poor growth

of the animals in this study in a synergistic effect with the known P deficiency. Although not measured, the authors also suspect protein and caloric deficiencies contributed to the poor reproductive performance of the livestock in this study, in addition to the P and other mineral or vitamin deficiencies noted.

The orchitis/epididymitis noted in two bulls were potentially serious lesions, possibly due to unidentified infections or traumatic cause. From a public health standpoint, infection by *Brucella abortus*, *Mycobacterium bovis*, or *Leptospira* species would be serious for both cattle and humans. Certainly, there are other bacteria which are pathogenic for the reproductive tract of bulls. The absence of reports or observations of bovine abortions or stillbirths was encouraging. Fetal deaths, if present, were occurring in early pregnancy in order to escape gross detection. The vesicular vaginitis noted in 12 of 37 (32 %) mature female cattle was pervasive enough to warrant further investigation as to its etiology. Infectious agents, such as ureaplasmas or viruses could be potential causes, but there was a lack of other clinical signs such as signs of systemic disease, fever, abortions, or stillbirths, to support such causes. Nutritional deficiencies (e.g., protein, vitamin A, vitamin E, or Zn) may also be causing fragility of vaginal epithelium, which could produce the vesicle-like erosive or ulcerative vaginal lesions.

The anaemia (low hct) noted in the goats about 43 % of the time and in cattle 19 % of the time most certainly reduced reproductive efficiency as well. Anemia in these cattle and goats was suspected to be caused by internal parasitism. There was a high incidence of eosinophilia in goats (19 % of random blood smears) and a low incidence in cattle (3 % of random blood smears). Also, there were variable episodes of occasionally bloody diarrhea which, based on the HAS veterinarian's testimony, corresponded with high faecal egg counts and were clinically responsive to deworming treatment. Finally, the mean hct dropped 11% in the late rainy season ; this parallels the time of expected high worm infestation. Anemia caused by *Babesia* and *Anaplasma* species was reported and confirmed in only a few random Haitian animals (personal communication, Rod Frank, DVM, HAS, Deschapelles, Haiti). When seen, these infectious agents caused clinical disease in larger herds, such as those owned by HAS.

Beyond reproductive diseases, there were a variety of integumentary system diseases or lesions. There were two goats with lice. At least one doe and its kids had lesions compatible with contagious ecthyma. This disease can be highly detrimental by predisposing the udder to mastitis due to teat lesions with soreness and resultant reduced nursing. The kids can starve due to the dam's teat sensitivity and resultant reluctance or refusal to nurse and/or the kid's oral nursing pain. Therefore, even though it was a singular observation, the possible presence of contagious ecthyma in this area of Haiti needs diagnostic confirmation because of its significant biological effects. The presence of the superficial exfoliative dermatitis in 16 of 60 goats (26.6 %) was of concern mainly because of its high incidence rather than any observed adverse effect. The authors are unsure of its etiology but suspect it may be due to vitamin E deficiency which produces a dermatosis very similar to what was seen (16) and because the goats in general had a high incidence of low serum vitamin E levels (76 % of goats had one or more subnormal serum vitamin E levels). The fact that only females had this skin lesion is interesting. If the condition is due to vitamin E or some combination of nutrient deficiencies (e.g. Zn, P, as well) one could rationalize that females might have higher requirements for such nutrients, and are more predisposed to the clinical dermatitis observed.

The common presence of small numbers of ticks on cattle suggested that they might be important vectors for blood-borne disease without producing significant blood losses. Integumentary lesions in cattle were generally minor with the one exceptional case of udder and teat warts (papillomatosis) which obliterated normal milking or nursing of this cow. The common (6/37 females or 16 %) occurrence of udder and/or teat warts suggests milking or nursing is involved in its spread. Digestive system lesions or signs were also minor, with the exception of three cattle with diarrhea, sometimes bloody. These diarrhea cases appeared to be secondary to internal parasitism, the latter of which is likely involving 19 % or more of the cattle based on hematologic abnormalities.

CONCLUSION

This study included examination of a selected group of nutrients (Ca, P, Mg, Fe, Se, Zn, Vit A, Vit E) through parts of the food chain (soil, forages, serum, and hair). There was an absolute and relative P deficiency which was noted in the soil, forages, and animals. Correction of the above would require soil and animal supplementation with products high in P and low in or free of Ca. There were less obvious vitamin E and vitamin A deficiencies in both goats and cattle. There was a Zn deficiency in some soils, which appeared in some forages and some low goat hair Zn values. Soil Zn supplementation is likely to be beneficial for most of the soils tested.

External parasitism was uncommon (3 % incidence) in goats with only one goat heavily infested with lice and one other having just a few lice. External parasitism (ticks only) was seen in 55 % of cattle but only in low numbers. Therefore, the ticks may be a vector for blood-borne diseases but were not directly contributing to sufficient blood-letting to produce the anaemias noted in the animals of this study.

Anaemia, eosinophilia, high white blood cell counts, and diarrhea responsive to deworming and relating to the

rainy season were noted to be worse in goats but common to both species. Weight loss of goats during the rainy season was also noted. This combination of clinical signs was compatible with internal parasitism. Not all anaemias noted were necessarily due to internal parasitism; conversely, numerous animals with normal hematocrits could have been internally parasitized but were not so identified. However, if abnormally low hematocrits are used as a screening marker for internal parasitism goats had serious parasitism about 43 % of the time and cattle 19 % of the time.

There was circumstantial evidence (by gross examination) for contagious ecthyma in goats. This needs diagnostic confirmation.

A superficial exfoliative dermatitis or dermatosis was often seen in female goats. Its cause awaits further evaluation, but vitamin E deficiency and/or zinc deficiency dermatoses have been reported in goats and may be occurring here.

There was evidence of vaginal and testicular lesions in cattle but not goats, without evidence for widespread stillbirths or abortions in cattle, hence, the cause(s) for, or the significance of, the bovine lesions are unclear.

There was a relatively high incidence of bovine udder and teat papillomas (infectious warts) suggesting milking or nursing transmission.

One disease issue of cattle identified by this study but not resolved was the Haitian farmers' perception that anthrax was the "most frequently seen" bovine disease and "most serious." This investigation did not confirm this diagnosis since no cattle in the study were seen or reported with a disease similar to anthrax. In considering the reported signs, the "charbon" or anthrax may be some other clostridial disease, postparturient hemoglobinuria, acute babesiosis, acute anaplasmosis, acute leptospirosis, or an acute toxicosis, unique to cattle. This issue needs clarification.

A group of low incidence diseases was noted and includes possible dermatophylosis, mastitis, and neonatal diarrhea in goats, and mastitis, focal cutaneous masses, and babesiosis (one case in HAS bull) in cattle. These diseases or lesions were uncommon and/or mild, but with major management changes such as formation of large herd units, these diseases could occur more frequently or more seriously.

The disease incidence noted in goats and cattle was not related to the economic status of the owner, the location of the stock, or size of the total herd. Most variability occurred from herd to herd, suggesting owner management differences were significant.

There was only slight evidence of widespread catastrophic disease in the goats and cattle of this study but plenty of evidence for a variety of disease problems which collectively produce major production and reproductive inefficiency. Estimates of production and reproduction efficiency based on the data of this study suggest that goat and cattle raising on small Haitian farms is well below 50 % of what is theoretically possible.

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VEIT (H.P.), McCARTHY (F.), FRIEDERICKS (J.), CASHIN (M.), ANGERT (R.). A survey of goat and cattle diseases in the Artibonite Valley, Haiti, West Indies. *Revue Élev. Méd. vét. Pays trop.*, 1993, **46** (1-2) : 27-38

A 40 week study of 43 farmers, 60 goats and 60 cattle was conducted in order to identify abnormal conditions or diseases and predisposing seasonal, managemental or nutritional factors. Farms were visited, farmers interviewed and animals examined up to 4 times, about every 10 weeks, and bled for Ht, total WBC, selected serum vitamins and minerals, hair collected for mineral analysis. Soil and forages were collected for analysis. Animals were generally in fair condition, with poor growth and reproduction. Unexpected wet season caloric deficiency, severe P deficiency and lesser vit. A and E deficiencies were noted. Anaemia, secondary to parasitism, was common to both species, worse in goats. Cattle had ticks, while goats had lice. Goats had reported neonatal diarrhea and mortality; observed exfoliative dermatitis, warts, dermatophytosis and possible contagious ecthyma. Cattle had reported anthrax and babesiosis; observed vesicular vaginitis, orchitis and teat warts.

Key words : Cattle - Sheep - Disease survey - Mineral deficiency - Parasitism -Farming system - Growth rate - Reproductive performance - Animal feeding -Seasonal effect - Haiti.

VEIT (H.P.), McCARTHY (F.), FRIEDERICKS (J.), CASHIN (M.), ANGERT (R.). Estudio de las enfermedades en caprinos y bovinos en el Valle Artibonita, Haití, Antillas. *Revue Élev. Méd. vét. Pays trop.*, 1993, **46** (1-2) : 27-38

Se llevó a cabo un estudio en 43 establecimientos , en 60 caprinos y 60 bovinos, con el fin de identificar los estados anormales o enfermedades, así como las predisposiciones estacionarias, de manejo y/o nutricionales. Los establecimientos fueron visitados, los finqueros interrogados y los animales examinados hasta 4 veces, a intervalos de 10 semanas. Se tomaron muestras de sangre para hematocrito, recuenta de leucocitos, selección de vitaminas y minerales séricos. El análisis de minerales se hizo gracias a la colecta de pelo de los animales. Se recolectaron también suelo y forrajes, para los análisis respectivos. Los animales se encontraron a menudo en mala condición, con baja tasa de crecimiento y reproducción. Se observaron deficiencias calóricas durante la época lluviosa, deficiencia de P severa y en menor escala, deficiencias de vitamina A y E. La anemia, como resultado de parasitosis, fue comun en ambas especies, aunque peor en las cabras. En el ganado bovino se observaron garrapatas, mientras que en el caprino se encontraron piojos. En cabras se reportó diarrea neonatal y mortalidad, se observaron dermatitis exfoliativas, estrías, dermatofitosis y un posible ectima contagioso. En bovinos se reportó antrax y babesiosis, se observaron vaginitis vesiculares, orquitis y estrias en los pezones.

Palabras claves : Bovino - Caprino - Encuesta patológica - Carencia mineral - Parasitismo - Sistema ganadero - Crecimiento - Reproductividad - Alimentacíon animal - Efecto estacional - Haití.