

ENVIRONMENT AND FEED RESOURCES IN SEMI-ARID NORTHEAST BRAZIL

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INTRODUCTION

More than 90% of the Brazilian goat production is located in the Northeastern (NE) semi-arid region, one of the last areas in the National Territory where the presence of man has not been synonymous with eradication of natural vegetation. As opposed to what has occurred in the NE coastal area, the interior has developed cultivation, producing and exploration systems which make use of the natural vegetation (fibers, forage, fruits, wood, medicinal and aromatic substances, firewood and charcoal, melliferous plants, etc...) in a multitudinous manner (Luetzelburg, 1923). Also, the vegetation on this semi-arid region plays an important role in protecting the soil, and preserving the fauna by maintenance throughout the year, even during the dry season, important their synergetic potential.

Covering an area of more than 800,000 km², the vegetation of this semi-arid region is referred to as "caatinga", a vernacular term adopted by the phytogeographers (Kuhlmann, 1974). Caatinga is of indigenous origin and means white or light wood. The prefix "ca" is found in other words relating to vegetation: "capim" (grass), "carrasco" (brushwood), "capoeira" (new growth of herbs and shrubbery on cleared land), and "capao" (an isolated group of trees in the midst of an open plain). Phytogeography up to the middle of the century, used the plural form "as caatingas". Nowadays, the singular usage is common, which portrays the idea of homogeneity, eclipsing an extraordinary diversity. Actually, there is no other type of vegetation in Brazil with the spatial and temporal variety that exists in the caatinga. Frequently the vegetation is represented by the stereotyped rocky outcroppings where "xique-xiques" (cactus) and "macambira" (a common bromeliaceae) grow; however, these represent an infinitesimal part of the caatinga.

Although recent progress has been made in establishing pastures resistant to drought, the caatinga is the basic forage supporting the majority of the cattle raising systems in the NE sertoes, especially in goat raising (Araujo Filho, 1978). However, there have been no studies which give a coherent scientific vision of this floristic-vegetational universe.

To evaluate the forage potential of the caatinga and its relationship to goat production, it is necessary to have an integral and global view of the spatial-temporal variability of the ecological characteristics of this semi-arid region (Nobrega, 1969). This picture does not materialize automatically, nor is it explicit in available studies.

RESEARCH PRIORITIES FOR THE CAATINGA ECOLOGY

Most of the mapping efforts that have been done on the caatinga, range from a small scale (1/5,000,000 to 1/1,000,000) to a large scale (1/5,000 to 1/1,000), but in a punctual way. The small scale studies, done mainly by phytogeographers, are the most common (Andrade-Lima, 1981). At the same time, there are studies carried out by botanists and plant physiologists who usually use scales of 1/100, 1/10, and 1/1, and sometimes 100/1 and 1,000/1. This diversity of scales and perception level have generated a "Babel Tower" of terminology. In summary, three main points stand out: intermediate studies (1/50,000 to 1/200,000) are practically nonexistent; almost nonexistent is the research in phytosociology and phytoecology; and the diversity of methods and terminology used in the descriptions of the vegetation. In Biology as in Physics, the scale creates the phenomenon. A practical approach to organizing research priorities on the forage potential of the caatinga is through successive levels of perception. Due to the incipient stage of NE research on vegetation of the semi-arid region which still has very controversial boundaries, it is of basic importance to establish research priorities (Miranda, 1984).

Studies have been done on the physiology of species but their actual importance in terms of plant population in the various areas of the NE is totally unknown. High cost studies on caatinga management, goat nutrition, and their productive and reproductive behavior, etc., are carried out at the local level and require, for the formulation of results and recommendations, detailed maps of the semi-arid NE vegetation. Perhaps, if these maps existed, the areas being studied today would not have been chosen because they are not representative in terms of vegetation. Or perhaps, among other things, to increase the forage potential of the caatinga one has to study the selection or pruning of less palatable vegetation, mainly shrubs, introduction of grains and other native or exotic species with high production potential, etc. These kinds of research recommendations have not always been founded on an ecological point of view and as a result they have brought about important changes in a complex and diversified natural environment (Albuquerque, 1978; Albuquerque-Araujo, 1982; Lima et al, 1982).

It would appear that there are six research priorities for the caatinga, to be carried out successively, (even though simultaneous studies already exist at these proposed levels):

1. detect, identify and classify the large units of vegetation of the semi-arid region on a scale of 1/500,000 or 1/1,000,000);
2. quantify and map these vegetation units in terms of their present state and potential use;
3. detect and identify the plant communities that make up each of these units;
4. identify the ecological variables that influence the taxonomic composition of these communities;
5. define these communities in terms of organization, structure, function and identify their production and protection needs; and
6. Characterize the plant chronological sequence at inter and intra community levels in relation to various events and management systems.

Time limits and available personnel exert an influence in developing methods and using logistics that are feasible and will form the basis for developing research on these priorities. In recent years, EMBRAPA and a few universities have taken the initiative at regional levels. These include, the utilization of spatial teledetection and remote sensing, and the creation and development of computerized retrieval systems to obtain, treat, and manage data on semi-arid flora and vegetation. EMBRAPA, with greater inter-institutional articulation, may bring about in these late 80's, strong scientific knowledge of the caatinga plant communities, which will unite economic exploration and environmental protection objectives.

DETECTION AND IDENTIFICATION OF THE LARGE UNITS OF CAATINGA

The first two research priorities have not yet been completely achieved, but the use of satellite images, like those of the LANDSAT, have provided a first approximation of the large units of semi-arid vegetation on a 1/500,000 scale. Color pictures taken during the dry and rainy seasons have been studied. The boundaries of the caatinga area with other types of vegetation, like the "cerrado" (savanna) can be clearly outlined. However, the subdivision of these units in different areas should be done with complementary documents, like geological, altimetric, climatic, and soil maps. For some areas, the use of digital treatment of the satellite images on a greater scale (1/100,000) is necessary. By using mathematical and statistical logarithms it has been possible to delineate the confusing vegetational limits. This type of treatment has been done on the "Chapada (Plateau) do Araripe" region, in the "Vale do Rio Moxoto" in Pernambuco; in the "Serra de Sao Francisco", in the foothills of the "Chapada Diamantina" mountain chain; and in the Eastern "Sertao de Canudos" reaching part of the "Raso da

Catarina" in the state of Bahia. A study is being done on the entire state of Pernambuco, in cooperation with French researchers of the Operational Ecology of the Centre de Cooperation Internationale en Recherche Agronomique pour le Developpment (CIRAD). Another study, on a greater scale, is being carried out in the middle part of the Sao Francisco region, in conjunction with ORSTOM research, centered in the county of Juazeiro, Bahia. All this research is taking place with the collaboration of the Instituto de Pesquisas Espaciais (INPE).

At first glance, approximately 50 large plant units can be detected in the caatinga. These are very distinct in complexity, economic interest, spatial division and surface. This general identification permits an evaluation of the importance of the location of ecological stations, biological reserves and experimental stations already existing in this region. Important empty spaces in terms of research activities have been found.

These studies, together with others being done on semi-arid regions should produce, on a short term basis, a consolidated vision, at first glance, of the ecological nature of the caatinga spatial variability. But, phytosociological (Drummond et al, 1979) and phytoecological (Jordy Filho & Salgado, 1981; Veloso et al, 1973) studies point out the absolute need to complement this phytogeographical approach (Egler, 1951) with research on identification and classification of the plant communities that make up the large caatinga units.

ECOLOGICAL IDENTIFICATION AND CLASSIFICATION OF THE PLANT COMMUNITIES

Phytoecological and phytosociological studies are necessary to discern the production potential and the protection requirements of the caatinga. Most of the quantified research has always been directed towards a precise plant community, which produces a broad limit to the generalizing of the results. Unfortunately, to date, the plant communities of the caatinga are not known (Hayashi & Numata, 1976). Various studies in this area required homogenized computer cards to make surveys of the plants and the environment (Godron et al, 1968). These cards, pre-coded for computerized study, allowing for slight adjustments for each region or problem studied, have permitted a quite objective and unified description of the flora, vegetation, and the environment. As a result, a data bank of the caatinga ecology is being set up by the "Centro de Pesquisa Agropecuaria do Tropico Semi-Arido" (CPATSA/EMBRAPA). Over 1,000 studies and surveys have been run on the various NE regions, with emphasis on the priority caatinga units. Due to methods used for gathering the data, based on satellite images, pre-codified phytoecological survey cards and data treatment, computerized mathematical theory, and parametric and non-parametric statistics, it has been possible to characterize the large plant communities and determine the main ecological factors that rule their taxonomy. Results obtained in different regions (Gomes, 1979; Lira, 1979) show the existence of

similar plant communities in very distant caatinga units. A first evaluation would indicate that the number of plant communities is around 200 for the entire region, especially upon examination of the existing transition states, mainly for antropic reasons, a hierarchical synthesis of these communities is of great relevance for the next few years and will only be possible through the use of modern ecological research methods where computerization is a fundamental instrument. Research concluded on the "Vale do Rio Moxoto" (Rodal, 1983), on the flooded depressions in the Ouricuri region (Silva, 1985), and on the San Francisco river delta (Rocha, 1984), show the importance and necessity of this classification so that studies on the quantification of caatinga production aspects may be carried out in a pertinent manner.

ECOLOGICAL ASPECTS AND FORAGE RESOURCES

To quantify in an ecological perspective, the forage potential of a caatinga plant community requires its identification in terms of organization, structure, and function. Many studies use goats in an indirect and exclusive way, to evaluate forage potential (Oliveira & Albuquerque, 1980). The results and their ecological explanation are in some respects insufficient and contradictory to the traditional forage management practices. Still, this is one of the most studied areas of the caatinga, even though many of the researchers cannot generalize the results spatially or geographically because they do not give precise references to the type of plant community studied. This is very different from giving a description of the vegetation.

In reference to the forage potential it is important to point out some of the main difficulties between the caatinga and other types of vegetation in the semi-arid region of the world. These differences, so characteristic of the area, should lead to the utilization of the methods appropriate to the caatinga and not merely to apply in an integral way methods used in other countries, as so often is the case.

One of the main problems in measuring the forage potential is the definition of this concept. The plant formations of the caatinga are characterized mainly by high and low woody plants and by a marked lack of the herbaceous level. The dominance of trees and bushes is general at bio-volume and phytomass levels.

The presence of an important contribution of woody material together with green and photosynthetically active component, in addition to the problem of acceptance by the animal of leafs and terminal shoots, imposes, in fact, a correspondence between potential and aerial phytomass available to the animal.

During the dry season, the falling of the leaves, even in an area where the animal density is high, does not lead to an important degradation of the vegetation, as is the case in north Sahel, in the Southern Sahara region, in semi-arid regions of

Australia, and the Americas. In these areas, with the exception of Chaco and Madagascar, the vegetation is made up of herbaceous plants and a few bushes, and there is a natural hay of the phytomass which continues to be eaten down to the roots by grazing animals. In the caatinga the woody covering cannot be degraded in the same manner as occurs in other regions. In this sense, even though the rehabilitation and equilibrium of the caatinga is not infinite after an over-grazing, it is, at least, well superior to other vegetation in similar conditions.

The effect of a prolonged over-grazing when not combined with other antropic activities produces not only alterations in the total floristic or phytomass production, but also in the vertical divisions of this phytomass. Studies on the vertical profile of the phytomass of the caatinga plant communities are still rare, but are proving to be an excellent indicator of the ecological equilibrium. Identical communities can have comparable values of aerial phytomass but with very distinct and almost opposite vertical distribution, depending on the history of the grazing system which they underwent. Thus, the over-grazing would tend to distribute the aerial phytomass as being more concentrated at the medium levels between the upper plant boundary height and that accessible to the animal. In the future, it is important that the stratification of these measures follow arithmetic or logarithmic vertical scales and not be restricted to dominant vegetation or to levels of the greatest apparent bio-volume.

Recent studies have shown the need to stimulate grazing to obtain phytomass weight parameters, by collecting leaves and terminal shoots in areas and at a height accessible to animals. Under these conditions, it is possible to observe variations in the contribution of different species in the grazing potential of a plant community due to time availability tied to the rhythm of the dry and wet seasons.

This type of study carried out in the Ouricuri (Pernambuco) region, which took into consideration true plant acceptability by the animal, showed the weak participation of legumes in the actually available forage, although the usage is well represented at a floristic level and in the total phytomass. The tiny leaves which are frequently feathered make it possible for this deciduous forage to be used by animals at soil level. Species of euphorbiaceous, like the "marmeleiro" (Croton sonderianus Muell) and the quebra-faca (Croton sp.) have proved to be one of the main sources of forage with dry leaf fall. The role of dry leaf fall in the diet of animals represents a differential time in available forage, which is of great ecological and zootechnical interest.

Three distinct and very representative plant communities, in terms of area for regional cattle raising, have been studied in Ouricuri. The results showed greater spatial than time variability in the dry material samples (Lima, 1984). Differences

between locations showed floristic and quantitative variations in plant density. The total phytomass measured yielded average values of 3,555, 1,018, and 1,841 kg. ha⁻¹ of dry material in the three plant communities. Time variation between the average phytomass values collected in 3 periods, from the rainy to the dry season, was small: 2,102, 2,094 and 2,217 kg. ha⁻¹ of dry material. This smaller variability is a result of collecting leaf fall during the dry period. Even if the forage from the wet period is qualitatively much richer, this actual availability together with drier environmental and more favorable conditions for goats is quite coherent with the breeding behavior of these animals.

CONCLUSION

Although the caatinga is the basis for animal raising activities, much more needs to be known about its ecology and forage potential. Studies in recent years have shown the need to define research priorities, and to broaden relationships between local and international institutions. If the caatinga is undoubtedly the food base for goat raising, the fact that it carries out important breeding and environmental protection functions, must also be kept in mind. Certain areas such as the importance of woody phytomass, and phytosociological and phytoecological diversities require the development of adequate research methods, different from those used in other semi-arid regions of the world, using modern techniques such as computerized data processing and remote sensing.

To study the caatinga forage resources requires a prior definition of the type of animal and its management system. Actual forage available to the animal should play an important role in studies in this area. First results in synchronized characterization of the caatinga on small and medium scales show the existence of about 50 very distinct plant population units in an area of 800,000 km². This can be mapped out on a 1/1,000,000 or 1/500,000 scale that can be carried out on a short term basis. The characterization of the plant communities that make up these macro plant units has already begun. Studies carried out in Bahia, Ceara, Pernambuco, and Paraiba indicate the existence of 200 distinct plant communities, taking into consideration transitory states with quite variable surface and agro-economic importance.

The few studies available in the interpretation of spatial time variability show the importance of vertical and horizontal structure parameters of the vegetation in obtaining consistent results. There is great interaction between animal management and the evolution of vertical profile phytomass and its actual availability to the animal. This objective seems to be essential so that present research can be inserted into the ecology of this region, thus permitting the conciliation of breeding of goats and protection of the caatinga.

LITERATURE CITED

- Albuquerque, S. D. de. Melhoramento de pastagens nativas, 1977. In: Semana Brasileira do Caprino, 1, Sobral, CE. I Semana Brasileira do Caprino, Sobral, EMBRAPA-CNPC, 1978. pp. 7-21.
- Albuquerque, S. G. de; J. G. G. Soares; J. A. de Araujo Filho, 1982. Densidade de especies arboreas e arbustivas em vegetacao de caatinga. Petrolina, PE, EMBRAPA-CPATSA, 9 p. (pesquisa em andamento, 16).
- Andrade-Lima, D. de, 1981. The caatingas dominium. R. bras. Bot. 4:149-53.
- Araujo Filho, J. A. de, 1977. Pastagem nativa do Ceara. In: Semana Brasileira do Caprino, 1, Sobral, CE. I Semana Brasileira de Caprino. Sobral, EMBRAPA-CNPC, 1978. pp. 1-7.
- Drummond, M. A.; P. C. F. Lima; S. M. de Souza & J. L. S. Lima, 1979. Sociabilidade de algumas especies que ocorrem na caatinga. In: Congresso Nacional de Botanica, 30, Campo Grande, MS. Resumos... Campo Grande, SBB, 1979, pp. 30-31.
- Elger, W. A., 1956. Contribuicao ao estudo da caatinga pernambucana. R. bras. Geog. 13-(4):65-78, 1951.
- Godron, M.; P. Daget; Long; G. Sauvage; L. Emberger; E. Lefloc'h; J. P. Wacquant; & J. Poissonet, 1968. Code pour le releve methodique de la vegetation et du milieu; principes et transcription sur cartes perforees. Paris, Centre National de la Recherche Scientifique, 292 p. il.
- Gomes, M. A. F., 1979. Padroes de caatinga nos Cariris Velhos. Paraiba. Recife, PE., Universidade Federal Rural de Pernambuco, 88 p. Tese Mestrado.
- Hayashi, I. & M. Numata, 1976. Structure and succession of caatinga vegetation in the brasilian Northeast. Tokyo Geogr. Papers, 20:23-44.
- Jordy Filho, S. & O. A. Salgado, 1981. Vegetacao; as regioes fitoecologicas, sua natureza e seus recursos economicos- estudo fitogeografico. In: Brasil. Ministerio das Minas e Energia. Secretaria Geral. Projeto Radambrasil. Folha Sa. 24-Fortaleza; geologia, geomorfologia, pedologia, vegetacao e uso potencial da terra. Rio de Janeiro, pp. 309-360. (Projeto Radambrasil. Levantamento de Recursos Naturais, 21).
- Kuhlmann, E., 1974. O dominio da caatinga. B. Geog., 33 (241):65-72. jul./ago.

- Lima, G. F. da C., 1984. Determinacao da fitomassa aerea disponivel ao acesso animal em caatinga pastejada - regioao de Ouricuri/PE. Recife/PE, Universidade Federal Rural de Pernambuco, 244 p. il. Tese Mestrado.
- Lima, M. de A.; A. de P. M. Fernandes; M. A. Silva; M. E. O. Vieira; M. J. A. Silva; & W. M. de Silva, 1982. Estudos em pastagem nativa e cultivada em areas de caatinga do semi-arido de Pernambuco. I. Selectividade botanica. In: Reuniao Anual da Sociedade Brasileira de Zootecnia. 19, Piracicaba, Anais... Piracicaba, SBZ, 1982. p. 381-382.
- Lira, O. C. de, 1979. Continuum vegetacional nos Cariris Velhos, Paraiba. Recife, PE, Universidade Federal Rural de Pernambuco, 113 p. il. Tese Mestrado.
- Luetzelburg, P. von. O sertanejo, 1923. In: Estudo botanico do Nordeste. Rio de Janeiro, Inspetoria Federal de Obras Contra as Secas, 1922/1923. v. 2, p. 105-108. (Brasil. IFOCS. Publicacao, 57, Serie 1, A).
- Miranda, E. E. de, 1984. Ecologia das comunidades vegetais da caatinga; prioridade de pesquisa. Petrolina/PE, EMBRAPA-CPATSA. 1984, 5 p. Trabalho apresentado no Simposio sobre Caatinga e sua Exploracao Racional. Feira de Santana/BA.
- Nobrega, E. A. T. da, 1969. Consideracoes sobre a ecologia das zonas semi-aridas da caatinga. Vicososa, MG. Universidade Federal de Vicososa. 16 p. il.
- Oliveira, M. C. de; S. G. de Albuquerque; & C. M. M. de S. Silva, 1980. Avaliacao indireta da producao de forragem de plantas arbustivas e arboreas da caatinga. Petrolina, EMBRAPA-CPATSA. 3 p. (Pesquisa em andamento, 7).
- Rocha, R. de F., 1984. Vegetacao e flora do delta do rio Sao Francisco, Alagoas. Recife/PE, Universidade Federal Rural de Pernambuco, 186 p. il. Tese Mestrado.
- Rodal, M. J. N., 1984. Fitoecologia de uma area do medio vale do Moxoto/PE, Recife/PE, Universidade Federal Rural de Pernambuco, 143 p. il. Tese Mestrado.
- Silva, G. C. da, 1985. Flora e vegetacao das depressoes inundaveis da regioao de Ouricuri/PE, Recife/PE, Universidade Federal Rural de Pernambuco. 215 p. il. Tese Mestrado.
- Soares, J. G. G., 1983. Dieta de caprinos em vegetacao de caatinga sob diferentes taxas de lotacao. In: Congresso Brasileiro de Forrageiras e Pastagen Nativas, 1. Olinda. 1983. Resumos... Recife, IPA. n.p.
- Veloso, H. P.; A. M. S. Japiassu & L. Goes Filho, 1973. As regioes fitoecologicas, sua natureza e seus recursos