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COLOMBIAN COFFEE CENSUS 1.980

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I. ABSTRACT

The Colombian Coffee Census was carried out by the National Federation of Coffee Growers of Colombia, incorporating Remote Sensing Techniques. This paper shows the followed methodology.

It describes the experiences in taking aerial photographies by using helicopter in some coffee areas where it is difficult to use aircrafts different from that one, due to the tropical atmospheric conditions-low clouds.

It presents the usage of the black and white aerial photographies, 1:10.000 scale, to the photointerpretation of the coffee areas, its clasification, technical condition and counting of the coffee trees.

Finally, it presents the process of transfering, digitizing and computer system for the coffee census.

II. INTRODUCTION

The Remote Sensing Techniques have an important position in the present and the future research of the natural resources in our country.

The aerial photography is ideal to make the remote sensing surveys and studies in different disciplines with large agricultural areas.

The National Federation of Coffee Growers of Colombia decided in 1978 to develop the Colombian Coffee Census using the remote sensing techniques with aerial photography and photo-interpretation.

The coffee areas are located in the mountain ranges, between 1.000 and 2.000 meters of altitude and from 1° to 10° of north latitude.

The objectives of the Colombian Coffee Census were to obtain the statistics, make the maps and computer processing of all coffee areas in our country, its localization, its clasification and its production.

The acquired experiences are being used in different projects in our country.

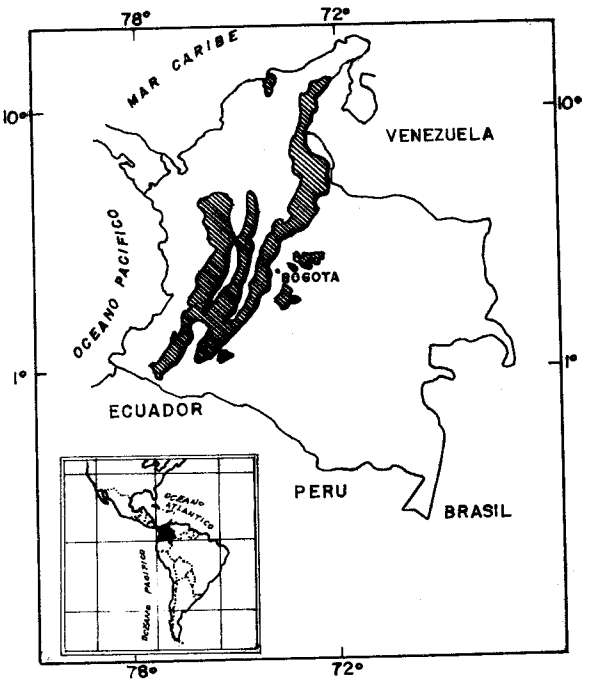


Figure 1. Map of Colombian Republic. Showing the general localization of the coffee areas, which reach 8,5 millions hectares approximately.

III. ACTIVITIES

The determination of the coffee areas, its clasification, its density and its production for the different geographic coffee regions required the next activities:

A. PROJECT PLANNING

In order to develop the project it was necessary: to research the methodology to apply the technical specifications for the Colombian Coffee Census and the organization for all the activities; as well as defining the working team and the equipment needed for each part of project; and finally, to calculate the project costs, and permanent control over all these activities.

B. AERIAL PHOTOGRAPHIC PICTURES

Several investigations were carried out in order to determinate both the apropriate film and the scale. We took aerial photographies in 1:5.000, 1:10.000 and 1:15.000 scales using pancromatic, infrared, black and white and color film.

The pancromatic film showed a better resolution than the infrared film. We didn't use color film because its cost was very high in comparison with the black and white film.

We picked out the pancromatic film in order to take aerial photographies 1:10.000 scale. We took approximately 80.000 pancromatic aerial photographies.

The film used was the Kodak Plus X Aerographic film No. 2402 estar base. The aerial cameras were fairchild T-11 and T-12 and wild RC 8. For the copies we were using paper Azo, and paper kodabrome RC N-N, NH, N-EH, N-UH and N-M produced by Eastman Kodak.

The aerial photographies were taken over 8,5 millions hectares from June 1978 to December 1980, with twelve aircrafts Cessna 180, 162 and 260 and two helicopters Bell 206 B Ranger III.

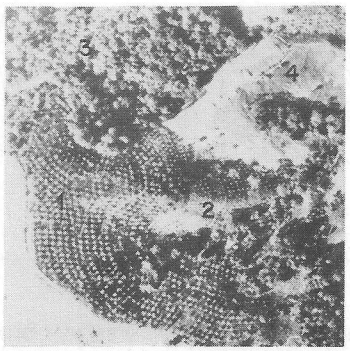


Figure 2. Part of one aerial photograph, 1:12.000 scale approximately, showing the Colombian coffee areas. (1) Productive technified coffee trees. (2) Young unproductive technified coffee trees. (3) Forest. (4) Grass.

Helicopter Working. As it is well known, our country is located in a tropical area, the weather changes frecuently and it shows low clouds; for this reason, it is very difficult to take the aerial photographies in some coffee areas. With the aircrafts we took the 70% of the Colombian coffee areas. The rest of the coffee area showed the most difficult atmospheric condition.

We took the alternative to use a machine more versatile to fulfill the technical specifications to take pictures in order to be useful for the coffee photointerpretation.

We undertook a literature survey and we found the report No. 16-1 1974 written by S.A. Veress of Washington University. The author made the aerial photographies in large scale with helicopter above Washington city in 1974.

These experiences were adjusted to the conditions of our country and with Colombian Technology, the aerial photographies in difficult areas with low clouds were taken.

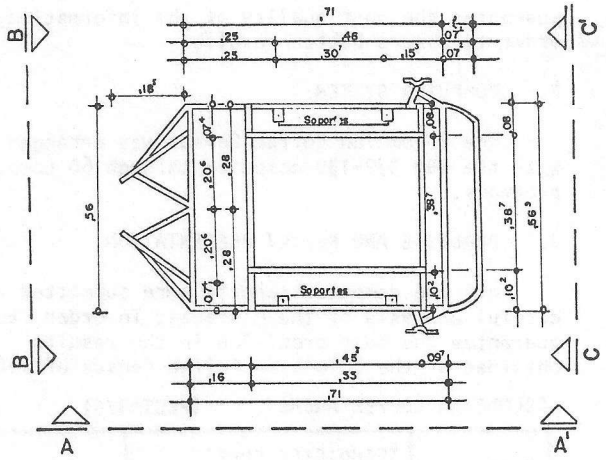
We used a helicopter Bell 206 B, Ranger III. The speed of the aerial photographies was 90 miles per hour, and the maximum ceiling of the helicopter was 20.000 feet.

The system used for mounting aerial camera, the aerial navigation equipment and the aerial photographic equipment had to take into account a set of elements to eliminate the damage to the photographic imagery, specially the damage originated by the vibration and the angular movement; in reason to the above considerations we determinated in first instance the gravity center of the helicopter, and we placed aerial photographic camera coincident with the Y axis and the most possible with the horizontal plan to the fly of the X axis.

The aerial camera holder was built in a basket forms with steel-chromium tube of 1/2 an inch. The tensile angles were calculated to eliminate the basket deflections.

	AIRCRAFT	HELICOPTER	TOTAL
PHOTOGRAPHIED HECTARES	6.412.079	2.126.182	8.538.261
AVAILABILITY DAYS	5.043	265	5.308
FLIGHT HOURS	7.500	1.059	8.559
YIELD Hectare/day	1.271	8.023	-
COST/Hectare U.S. Dollar	0.35	0.27	-

Table 1. Yields and costs in taking aerial photographies.



GENERAL PLAN
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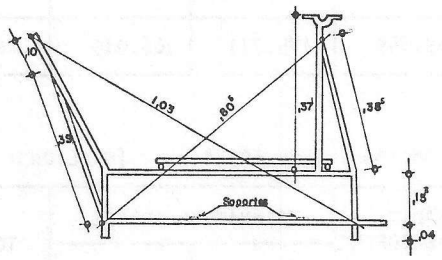
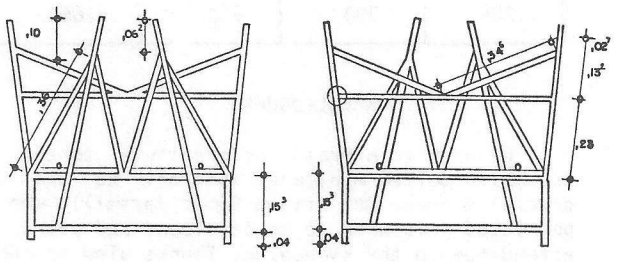


LATERAL VIEW A-A'



FRONTAL VIEW B-B' FRONTAL VIEW C-C'

Figure 3. Sketch to the support box for the aerial camera using helicopter.

C. COFFEE PHOTOINTERPRETATION

With the aerial photographies, systematic analysis was carried out to find the photographic elements: tone, texture, scale, cultural pattern, etc., to enable the recognition and identification of the coffee areas.

The coffee photointerpretation was developed taking into consideration the coffee types and its plantation density.

The coffee density (the number of coffee trees per hectare) was calculated using the density net and the millimeter magnifying lenses.

COFFEE TYPE	CULTURAL PATTERN
TRADITIONAL	Decrepit
	Wrong cultivated
	Right cultivated
TECHNIFIED	At shade
	At sunlight

Figure 4. Clasification used by the coffee Census 1980.

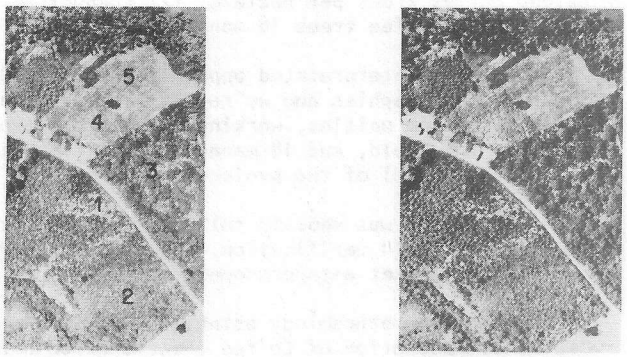


Figure 5. Stereograme. 1:11.000 scale approximately. Showing: (1-2-3) the coffee areas planted with traditional coffee trees. (4-5) coffee areas planted with technified coffee trees.

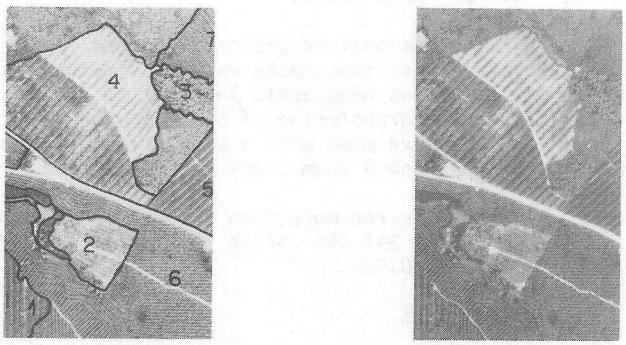


Figure 6. Stereograme. 1:13.000 scale approximately. Showing: (1) technified coffee area with 6.700 coffee trees per hectare. (2) Young unproductive technified coffee trees. (3) Large bamboo. (4) Technified coffee area at plantain shade with 4.500 coffee trees per hectare. (5) Technified coffee area at sunlight with 4.200 coffee trees per hectare. (6-7) Technified coffee areas at plantain shade with 4.500 coffee trees per hectare.

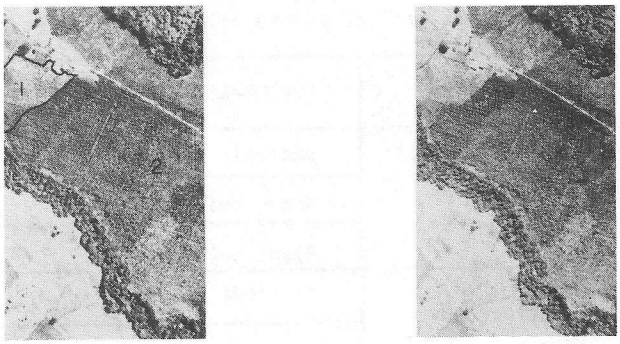


Figure 7. Estereograme. 1:12.000 scale approximately. Showing: (1) Young unproductive technified coffee trees at plantain shade and 2.800 coffee trees per hectare. (2) Productive technified coffee trees 18 months old.

We photointerpretated approximately 75.000 aerial photographies and we recognized more than 348.000 coffee unities, working 117 photointerpreters in the field, and 18 manager photointerpreters the control of the project.

This work was made in coffee areas with its respective field verification. We were using 100 mirror and pocket estereoscopes.

With the methodology established by the National Federation of Coffee Growers of Colombia, we prepared a Manual of Coffee Photointerpretation wich contains the photointerpretation keys to recognize, identify and classify the coffee areas as they appear in the field.

D. COFFEE TRANSFERING

The coffee unities photointerpreted were transferred into topography maps manufacturated by the Colombian Geographic Institut to scale 1:10.000. The transfering of the photoinformation of the maps were made with 9 zoom transfer scope model ZT-4H, and 5 zoom transfer scope model ZT-4V

We transferred more than 50.000 aerial photographies, with 348.000 coffee unities over 3.465 maps scale 1:10.000.

E. DIGITIZING

The areas measured were made with 3 digitizing tables by summagraphics and 3 computer system by pertec. We were processing 348.000 coffee unities.

All the information was impressed on diskets. They were read and processed by the National Federation of Coffee Growers IBM 370-130 computer.

We had made more than one million measure - ments of the coffee unities and we established automatic controls in the digitizing tables to guarantee the best quality of the information, in order to assure better results.

F. COMPUTER SYSTEM

The Colombian Coffee Census was arranged with the IBM 370-130 computer through 60 computer programs.

G. ANALYSIS AND RESULT PRESENTATION

All the computer reports were submitted to a careful analysis of the mistakes, in order to guarantee the best precision in the results obtained by the Colombian Coffee Census of 1980.

COLOMBIAN COFFEE AREAS (HECTARES)

TRADITIONAL COFFEE	TECHNIFIED COFFEE		TOTAL
	At sunlight	At shade	
665.849	175.711	168.019	1.009.579

COLOMBIAN COFFEE TREES (MILLIONS)

TRADITIONAL COFFEE	TECHNIFIED COFFEE		TOTAL
	At sunlight	At shade	
1.204	793	662	2.660

IV. AKNOWLEDGMENT

We wish to express our gratitude to the Colombian Coffee managers, specially to the general manager Dr. Arturo Gómez Jaramillo who permitted this work to be developed and our attendance to the symposium. Thanks also to those people who were in charge of the organization of the symposium and for their kind invitation.

V. REFERENCES

1. AMERICAN SOCIETY OF PHOTOGRAMMETRY, Manual of photographic interpretation. Washington 1960, 868 p.

2. _____ Manual of photogrammetry. 3. ed. vol I y II. Virginia. 1966, 1,199 p.

3. _____ Manual of color aerial photography Virginia, 1968, 550 p.

4. _____ Manual of Remote Sensing. vol. I and II, Virginia. 1975, 2,144 p.

5. _____ Procedings of the 45th Annual Meeting. vol. 1. Washington, D.C. 1979

6. ASTIE, W y MONCAYO, F. Manual para el uso de fotografías aéreas en dasonomía. Mexico, Dirección General del Inventario Nacional Forestal, 1970, 121 p.

7. AVERY, E. Forest guide to aerial photointerpretation. Washington, Forestal Service, 1966, 41 p.

8. BRUCE, D. SCHUMACHER, F. Medición forestal. Mexico, Centro Regional de Ayuda Técnica, 1965, 473 p.

9. FEDERACION NACIONAL DE CAFETEROS DE COLOMBIA. Atlas Cafetero de Colombia. Bogotá. División de Investigaciones Económicas, 1970, 187 p.

10. FORBES, R. Forestry handbook. New York, Society of America Foresters, 1962, 1,107 p.

11. KODAK COMPANY. Data for aerial photography. New York, 1976, 89 p.

12. MONCAYO, F. Formulación de una clave para fotointerpretación de los bosques de conf - feras en Michoacán. Mexico, Escuela Nacional de Agricultura, 1963, 133 p.

13. SHORT, N. etal. Mission to Aerth: Landsat Views the World. National Aeronautics and Space Administration. Washington, D.C. 1976, 459 p.

14. VERESS, S.A. Cooperative photogrammetry study. Seattle, University of Washington, Departament of Civil Engineering, 1974, 146 p.

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