A LAND-USE MAP FROM CENSUS DATA—PARANA, BRAZIL, AS AN EXAMPLE

ROBERT L. CARMIN
University of Illinois, Urbana

Introduction

Brazil is a large, important country with a rapidly growing population which has been extending the area devoted to crops. Furthermore, there has been a conscious effort to diversify farm output throughout Brazil, and evidence indicates changing land-use in the old, settled portions of the country. Field reconnaissance carried out by the writer in the summer of 1956 and a review of the literature indicate existing land-use maps of Brazil are out of date in many respects. Thus, a new land-use map is needed for a clearer understanding of the agricultural picture of Brazil.

The recently published, 1950-census of agriculture for Brazil offers specific data for making up-to-date land-use maps of the country. This paper explains the methods used in making a land-use map of Paraná state—a first step toward mapping the land-use of the country itself. Paraná was chosen as a test case for evaluating methods of transforming numerical data into map patterns that show land-use generalizations sufficiently simple to be comprehended for the whole of Brazil.

Paraná appears appropriate as a choice for a preliminary land-use map because within this state there is a variety of conditions broadly representative of large sections of Brazil. For example, geologic and landform features such as the diabase plateau, the great escarpment, and a strip of coastal plain are to be found. Also, the state straddles the frost line, a factor reflected in the variety of agricultural crops and natural vegetation existing there. Finally, the state has long-settled areas as well as sections of an expanding agricultural frontier, hence various stages of land occupance are to be found.

Kind of Census Data Available

The 1950 agricultural census of Brazil presents a variety of data by municipios (counties). The municipio information used in making the land-use maps included the following: 1) total area of each municipio reporting—the area where occupancy or ownership was sufficiently clear for responsible persons to complete and return census forms; 2) area in annual and perennial crops; 3) area in natural and planted pasture; 4) area in virgin forest and area planted to "useful" trees; and 5) uncultivated areas which include fallow lands, natural second-growth forest, and scrub forest. Other tables list the areas devoted to principal crops which for Paraná included 10 perennials (bananas, coffee, apples, etc.) and 15 annuals (cotton, rice, corn, etc.).

Determining Gross Land-use Patterns

Preliminary work involved adding together the area devoted to the two kinds of crops, pasture, and forest. The uncultivated land was added to the areas of forest. Calculations were then made to find the percentage of land occupied by crops, pasture, and forest in each municipio. Later the percentage of the cropland occupied by individual crops was found.

The census information cited above was analyzed in many ways and numerous patterns were mapped. The various criteria used were then tested in two ways. First, by attempting to correlate these mapped patterns with a variety of published materials such as maps of natural vegetation, geology, corn production, and cattle grazing. Second, the patterns were judged by personal observations made during automobile field trips in 1948 and 1956.

Thus, the following method of mapping the gross land-use patterns evolved. Municipios with less than 25% of their total area reported in any manner on census returns are considered "undeveloped." In municipios with less than 10% of the reported area in crops the land-use is classified as "pasture" or "forest" according to whether pasture or forest leads in area occupied. Municipios with 10 through 19% of their reported areas in crops are classified as "crop-pasture" or "crop-forest" according to whether pasture or forest occupies the greater area. In those municipios where crops occupy 20% or more of the total area reported, the land-use is classified as "cropland" (Fig. 1).

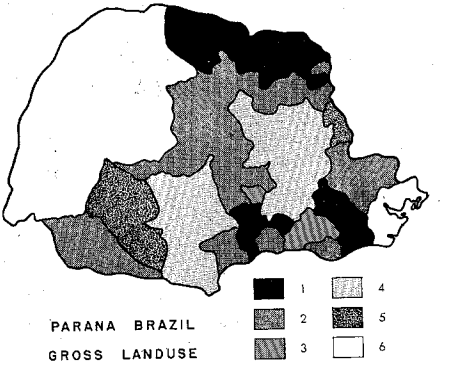

Fig. 1.—Gross land-use: 1) cropland; 2) crop-forest; 3) crop-pasture; 4) pasture; 5) forest; 6) undeveloped.

Gross Land-use and Other Patterns Compared

Maack's (1950) map of natural vegetation corresponds with the gross land-use patterns in many ways. The tropical rain forest area associated with the sea-facing escarpment nearly coincides with one of the two areas mapped as undeveloped—that is, areas where census returns were made for less than 25% of the land area. Naturally this near coincidence is more than a relationship between vegetation and land-use. The sparce occupancy is related, however, to a number of conditions observable on Maack's map—namely steep slopes, poorly drained areas near the foot of the escarpment, and sandy regions along the coast. This is an area long exposed to settlement but one where the natural environment has not favored dense occupancy by man. The other region of undeveloped land is very large and is on or beyond the frontier of settlement. It is not clear whether land quality as reflected in natural vegetation has

restricted settlement here, but this is implied by the close similarity of the boundaries of the undeveloped area and a vast area of tropical and subtropical forest distinguished by Maack. By comparing the land-use map with Maack's (1953) geology map of Paraná one can see that much of the northern half of the undeveloped area is made up of Jurassic sandstone (Caiuá), whereas most of the important cropland area in northeastern Paraná is shown as diabase.

The validity of the gross land-use map based on census returns is further attested to by comparing the map's pasture areas with the *campos limpos* or grass lands sections of Maack's vegetation map. If space permitted other correlations could be pointed out.

Determining Crop Land-use Patterns

For simplification the pasture, forest, and undeveloped areas are left blank on the crop land-use map (Fig. 2). The three areas indicated as cropland, crop-forest, and crop-pasture on the gross land-use map are refined on the second map where dominant crops and crop combinations are shown.

First, only crops occupying 10% or more of the cropland were considered. Weaver (1956:564) pointed out that "If the percentage of total harvested cropland for a given crop in a township or county is 10 or 11, it may be presumed that the crop will be found on about two-thirds of the farms" in the Middle West of the United States.

For simplification only the two highest-ranking crops were considered and second-ranking crops were grouped as to type. Thus corn, rice, wheat, and rye are classified as "grain" when any of these four are secondary in area occupied by crops.

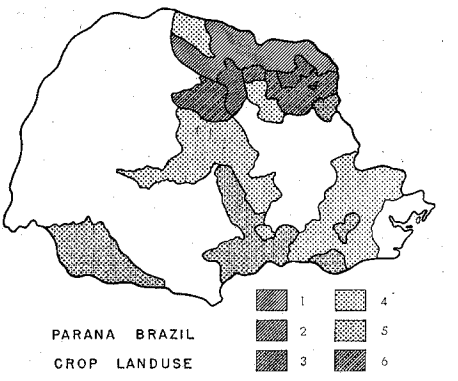

Fig. 2.—Crop land-use: 1) coffee; 2) coffee-grain; 3) coffee-cotton; 4) corn; 5) corn-grain; 6) corn-coffee.

Results of the Method

The result is a simple map (Fig. 2) requiring only six patterns to show the dominant crops and crop combinations of the state. In 33 municipios a single crop dominates —16 are coffee municipios and corn is the dominant crop in 17 others. In the remainder of the crop areas two or more crops occupy at least 10% of the cropland.

The method here employed in making a land-use map of Paraná is meant to serve as a guide for developing a one-color land-use map of the whole of Brazil. To be most useful, such a map should be sufficiently generalized to convey a clear picture of crop patterns to the map user. Weaver's (1954) map of the Middle West presents 31 crop com-

binations that would make comprehension of distribution patterns next to impossible on a one-color map. Weaver's complicated map results from his inclusion of all crops produced. Paraná's 90 municipios account for less than 5% of Brazil's municipios and to make crop combinations of all crops occupying only 5% of the cropland would result in 17 combinations. Considering only those crops accounting for 10% or more of the cropland gives us 11 combinations, if the second crop is not grouped under a common heading as described above. With this number of patterns for Paraná alone, a map of Brazil would be too complex for easy comprehension.

Summary

The Brazilian state of Paraná has been used to illustrate a method of making an up-to-date land-use map for Brazil. A primary objective has been a map on which the patterns representing crops and crop-combinations are few enough in number to result in a map that is simple to comprehend but accurate in its portrayal of the agricultural land-use of Brazil. The map resulting from the system described in this paper appears to meet this objective.

Literature Cited

I.B.G.E. Conselho Nacional de Estatistica. 1955. VI Recenseamento Geral do Brazil-1950, Estado do Paraná, Censos Demográfico e Econ., Rio de Janeiro, 496 pp.

Maack, Reinhard. 1950. Mapa Fitogeográfico do Estado do Paraná, 1:750,000. Curitiba, Brazil, Inst. Biol. e Pesquisas Tecn.

1953. Mapa Geologico do Estado do Paraná, 1:750,000. Curitiba, Brazil. Inst. Biol. e Pesquisas Tecn.

Weaver, John C. 1954. Crop combination regions in the Middle West. Geog. Rev., 44:175-200.

1956. The county as a spatial average in agricultural geography. Geog. Rev., 46:536-565.